European Commission

JRC TECHNICAL REPORT

INSPIRE-MMTIS: overlap in standards related to the Delegated Regulation (EU) 2017/1926

Final report with recommendations to Member States and to the EC

Bourée, K., De Vries, B., Duquesne, C., Dodson, C., Jugelt, S., Martirano, G., Minghini, M., Pignatelli, F.

2019

Joint Research Centre

EUR 29975 EN

Contact information
Name: Francesco Pignatelli
Address: Via E. Fermi, 2749 – 21027 Ispra (VA), Italy
Email: francesco.pignatelli@ec.europa.eu
Tel.: +39.0332.786319

EU Science Hub
https://ec.europa.eu/jrc

JRC118744

EUR 29975 EN

PDF ISBN 978-92-76-13046-8 ISSN 1831-9424 doi:10.2760/404745

Luxembourg: Publications Office of the European Union, 2019

How to cite this report: Bourée, K., De Vries, B., Duquesne, C., Dodson, C., Jugelt, S., Martirano, G., Minghini, M., Pignatelli, F., *INSPIRE-MMTIS: overlap in standards related to the Delegated Regulation (EU) 2017/1926*, EUR 29975 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-13046-8, doi:10.2760/404745, JRC118744.

Contents

Acknowledgements

The work presented in this report has been funded by the ELISE Action[1] of the ISA[2] Programme[2] of DIGIT[3] and is part of a series of activities coordinated by Unit B.4 Sustainable & Intelligent Transport of DG MOVE[4] in the context of the ITS (Intelligent Transport System) Directive[5].

Authors

Kasia Bourée (coordinator and Transmodel Expert), KBIC, Saint Cannat – France

Bard de Vries, (DATEX II expert) U-trex B.V., Utrecht - The Netherlands

Christopher Dodson, (IATA expert): Lewes - United Kingdom

Christophe Duquesne, (NeTEx expert) Guyancour - France

Stefan Jugelt (TAP-TSI expert), European Union Agency for Railways, Valenciennes - France

Giacomo Martirano, (JRC external consultant), Joint Research Centre – European Commission

Marco Minghini, (scientific officer), Joint Research Centre – European Commission

Francesco Pignatelli, (programme manager), Joint Research Centre – European Commission

1 European Location Interoperability Solutions (https://joinup.ec.europa.eu/collection/elise-european-location-interoperability-solutions-e-government)

2 Interoperability solutions for public administrations, businesses and citizens (https://ec.europa.eu/isa2/home_en)

3 The European Commission Directorate-General for Informatics

4 The European Commission Directorate-General for Mobility and Transport

5 Directive 2010/40/EU of the European Parliament and of the Council of 7 July 2010 on the framework for the deployment of Intelligent Transport Systems in the field of road transport and for interfaces with other modes of transport (https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32010L0040)

Executive summary

The aim of the INSPIRE-MMTIS study is to identify and analyse the overlaps and gaps existing among the relevant standards to be used for the sharing and reuse of data under the remit of Commission Delegated Regulation (EU) 2017/1926 on the provision of EU-wide multimodal travel information services (MMTIS)[6].

The Annex of the MMTIS Regulation lists a number of "data categories" which allow to achieve the Article 3 of the Regulation: "Each Member State shall set up a national access point. The national access point shall constitute a single point of access for users to at least the static travel and traffic data and historic traffic data of different transport modes, including data updates, as set out in the Annex, provided by the transport authorities, transport operators, infrastructure managers or transport on demand service providers within the territory of a given Member State".

The data categories are divided into two main groups, namely **static travel data** and **dynamic travel and traffic data**, each of them further classified into three Levels of Service. Some data categories are not spatially related, e.g. Timetables, Hours of operation and Operational calendar. **Error! Reference source not found.** lists the spatially related data categories for static travel data of Level of Service 1. The corresponding data should be provided by data providers referred to in Article 3 of the MMTIS Regulation and made accessible through the National Access Points (NAPs), by 1 December 2019 at the latest.

Table 1. MMTIS data categories for static travel data of Level of Service 1

Typology of service within Level of Service 1	Data category
Location search (origin/destination)	Address identifiers
	Topographic Places
	Points of interest
Location search (access nodes)	Identified access nodes
	Geometry/map layout structure of access nodes
Trip plan computation – scheduled modes transport	Connection links
	Network topology and routes/lines (topology)
	Stop facilities access nodes
Trip plan computation – road transport (for personal modes)	Road network
	Cycle network
	Pedestrian network and accessibility facilities

Regarding the data categories data model, the MMTIS Regulation, in Article 4, requires that:

1. Transport authorities, transport operators, infrastructure managers or transport on demand service providers shall provide the static travel and traffic data and historic traffic data listed in point 1 of the Annex, of the different transport modes by using:
    a. for the road transport, the standards defined in Article 4 of Delegated Regulation (EU) 2015/962;

6 Commission Delegated Regulation (EU) 2017/1926 of 31 May 2017 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to the provision of EU-wide multimodal travel information services (https://eur-lex.europa.eu/eli/reg_del/2017/1926/oj)

b. for other transport modes, the use of one of the following standards and technical specifications: NeTEx CEN/TS 16614 and subsequent versions, technical documents defined in Regulation (EU) No 454/2011 and subsequent versions, technical documents elaborated by IATA or any machine-readable format fully compatible and interoperable with those standards and technical specifications;

c. for the spatial network the requirements defined in Article 7 of Directive 2007/2/EC.

2. The relevant static travel and traffic data listed in point 1 of the Annex that are applicable to NeTEx and DATEX II shall be represented through minimum national profiles.

3. Transport authorities, transport operators, infrastructure managers or transport on demand service providers shall provide the static travel and traffic data through the national access point in the required formats in line with the following timetable: …".

The overall objective of the study, elaborated by experts on each applicable standard (i.e. Transmodel, NeTEx, DATEX, TAP-TSI, IATA, INSPIRE), is to identify and analyse the overlaps and gaps existing among the relevant standards.

Specifically, the study:

- provides a definition for each data category (in the Annex of the MMTIS Regulation the data categories are just listed without any definition);
- for each data category, identifies one "reference standard" and one or more "contributing standard(s)"[7]; and
- formulates recommendations for both data providers and data users on how to deal with the overlaps/gaps, including the use of mapping tables when relevant.

Although the MMTIS Regulation mentions INSPIRE as the mandatory source of requirements only for spatial networks, the analysis reveals that INSPIRE can play the role of reference/contributing standard also for other data categories than the Road Network, e.g. for Address identifiers or Points of interest.

A methodology is applied to identify and then classify different types of overlaps and to produce mapping tables from a contributing standard towards a reference standard.

Five use cases are developed in order to:

- illustrate the overlaps in standards in concrete situations,
- identify the actors addressed by the problem of overlaps,
- show the usefulness of the reference standards,
- show where mapping tables are most useful,
- help formulating recommendations.

The use cases address two types of target actors, potentially affected by the overlaps:

- data providers: providers of datasets to be made accessible through the NAPs,
- data consumers: consumers of datasets provided through the NAPs.

Actors such as "NAP managers" are not addressed, because organisational aspects related to the governance of the NAPs and are out of scope of this study.

Based on the developed methodology and use cases, recommendations are formulated to both NAP data consumers and data providers for each data category. For data consumers, recommendations represent a guidance to select the most suitable datasets among those published in the NAPs; for NAP data providers, recommendations represent a guidance for publication aimed to avoid semantic duplication in the data. Finally, some recommendations are also formulated to the EU Member States and/or the Commission, which identify the need for further developments in order to increase data interoperability across the different standards.

7 A Reference Standard is a specification of which the scope covers a particular data category in a most comprehensive way. Other standards are Contributing Standards of a data category.

In the analysis of standardisation gaps the following cases are identified:

- the standard is elaborated but not yet published (e.g. it is currently in the commenting/formal vote period) or planned to be developed,
- the Project Team is not aware of any plan to develop the standard,
- absence of a reference standard.

In conclusion, the analysis performed in the study represents a first step to support Member States in the implementation of the MMTIS Regulation. Results demonstrate that the analysed standards are sufficient to start implementing the Regulation, although several recommendations show that further work is necessary (given e.g. gaps in standardisation and the need for European profiles and conversion tools).

1 Introduction

The COMMISSION DELEGATED REGULATION (EU) 2017/1926 of 31 May 2017 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to the provision of EU-wide multimodal travel information services provides a list of static and dynamic data categories to be made available by Member States through the National Access Points. A range of data standards are required for the publication of such data categories, of which a subset (20 data categories) refers to static spatial data which are also linked to the INSPIRE Directive (Directive 2007/2/EC).

This final joint report presents:

- the different standards cited in the Regulation 2017/1926 to be used for dataset publication (in section 2),
- the definitions of the static spatial data categories and a first identification of overlaps of the corresponding datasets (in section 3),
- the methodology for identifying and handling of the overlaps (in section 4),
- examples of Use Cases where overlaps appear (in section 5),
- the full list of recommendations for each data category (in section 6).

Annex 1 provides documentation of each relevant data model.

Annex 2 provides relevant mapping tables.

Both Annexes are provided as separate documents.

2 Recommended standards for the Delegated Regulation (EU) 2017/1926

The Delegated Regulation (EU) 2017/1926 expresses i.a. the following requirements:

(...) Each Member State shall set up a national access point. The national access point shall constitute a single point of access for users to at least the static travel and traffic data and historic traffic data of different transport modes, including data updates, as set out in the Annex, provided by the transport authorities, transport operators, infrastructure managers or transport on demand service providers within the territory of a given Member State.

(...)

Transport authorities, transport operators, infrastructure managers or transport on demand service providers shall provide the static travel and traffic data and historic traffic data listed in point 1 of the Annex, of the different transport modes by using: (a) for the road transport, the standards defined in Article 4 of Delegated Regulation (EU) 2015/962[8]; (b) for other transport modes, the use of one of the following standards and technical specifications: NeTEx CEN/TS 16614 and subsequent versions, technical documents defined in Regulation (EU) No 454/2011[9] and subsequent versions, technical documents elaborated by IATA or any machine-readable format fully compatible and interoperable with those standards and technical specifications; (c) for the spatial network the requirements defined in Article 7 of Directive 2007/2/EC[10].

Figure 1. Standards of importance for the Delegated Regulation (EU) 2017/1926

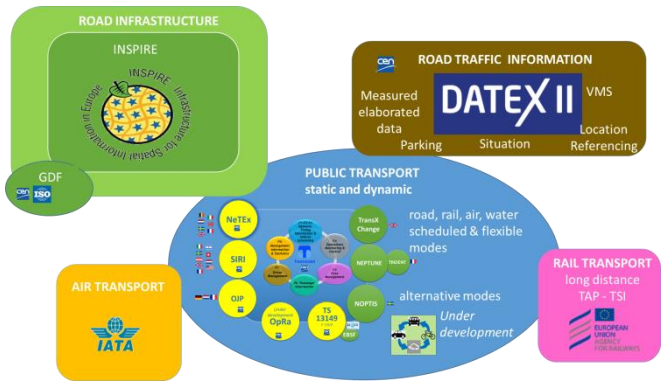
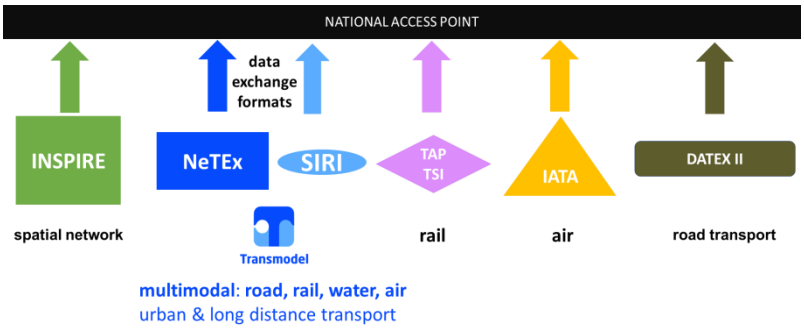


Figure 2. Publications through NAPs using standards



2.1 INSPIRE

INSPIRE is the acronym of the Directive 2007/2/EC of the European Parliament and of the Council, establishing an Infrastructure for Spatial Information in the European Community.

The INSPIRE Directive aims to create a Spatial Data Infrastructure for the purposes of EU environmental policies and policies or activities which may have an impact on the environment.

8 referring to DATEX II
9 referring to TAP-TSI
10 the INSPIRE Directive.

This European Spatial Data Infrastructure will enable the sharing of environmental spatial information among public sector organisations, facilitate public access to spatial information across Europe and assist in policy-making across boundaries.

INSPIRE is based on the infrastructures for spatial information established and operated by the Member States of the European Union. The Directive addresses 34 spatial data themes, one of them being Transport Networks.

To ensure that the Spatial Data Infrastructures of the Member States are compatible and usable in a Community and transboundary context, INSPIRE requires that common Implementing Rules are adopted in a number of specific areas: Metadata, Data Specifications, Network Services, Data and Service Sharing, Spatial Data Services, Monitoring and Reporting. The Implementing Rules have been adopted as Commission Decisions or Regulations and are binding in their entirety.

In addition to the Implementing Rules, non-binding Technical Guidance documents describe detailed implementation aspects and relations with existing standards, technologies and practices, providing guidance to Member States about how to implement what is required in the Implementing Rules.

The Directive came into force on 15 May 2007 and will be implemented in various stages, with full implementation required by 2021.

INSPIRE is based on a number of common principles:

- Data should be collected only once and kept where it can be maintained most effectively.
- It should be possible to combine seamless spatial information from different sources across Europe and share it with many users and applications.
- It should be possible for information collected at one level/scale to be shared with all levels/scales: detailed for thorough investigations, general for strategic purposes.
- Geographic information needed for good governance at all levels should be readily and transparently available.
- It should be easy to find what geographic information is available, how it can be used to meet a particular need, and under which conditions it can be acquired and used.

2.2 Transmodel

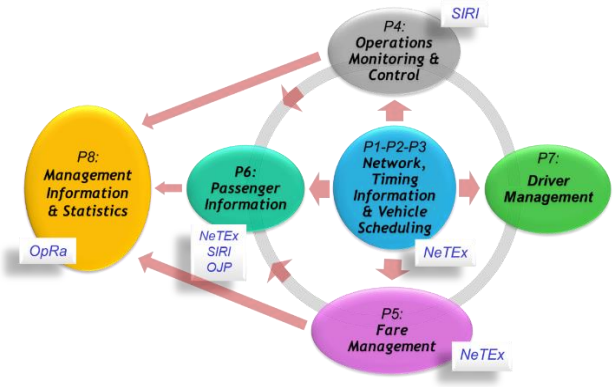
Transmodel is the European Public transport Reference Data Model, i.e. it provides reference data structures that express the semantics of the public transport domain.

Transmodel version 5.1 issued in 2006 is being revised. The revised version (V6) splits into 8 parts. Transmodel is defined in UML.

- Part 1: Common Concepts
- Part 2: Public Transport Network
- Part 3: Timing Information/Vehicle Scheduling
- Part 4: Operations Monitoring & Control
- Part 5: Fare Management
- Part 6: Passenger Information
- Part 7: Driver Management
- Part 8: Management Information & Statistics

Parts 1 to 3 have been published in 2016 and Parts 4 to 8 are under CEN publication in 2019.

Figure 3. - Transmodel parts and related implementation standards



2.3 NeTEx

NeTEx i(Network and Timetable Exchange) is a data exchange standard (provided using XML) for public transport network, timetables and fares based on Transmodel.

NeTEx is divided into three parts:

- Part 1: network topology (networks, lines, routes, stops, connections and geographic elements, etc.). NeTEx Part 1 also provides a framework and reusable objects used by all the other parts.
- Part 2: timing information (vehicle journeys passing times, day types, calendars, etc.)
- Part 3: Description of the tariff offer (fare product, access rights, usage parameters, prices, etc.).

NeTEx-Part 1 corresponds to Transmodel-Part 1 & 2, NeTEx-Part 2 to Transmodel-Part 3 and NeTEx-Part 3 to a part of Transmodel-Part 5. Data used for NeTEx services (queries/responses) are modelled in Transmodel-Part 6.

2.4 TAP-TSI

The Commission Regulation (EU) 454/2011 (TAP-TSI) is a regulation addressing the railway undertakings, rail infrastructure managers and ticket vendors to standardise the data exchange for timetables, fares, reservation messages and operational messages between railway undertakings and infrastructure managers.

The TSI defines the protocols and data formats for the exchange of:

- timetable data
- tariff data
- reservation messages
- ticketing
- information to passengers in railway stations and vehicles

The TSI is in force since 2011 and currently in implementation within the EU. For the analysis of the overlaps between the standards, mainly the timetable and fare data exchange have been analysed.

2.5 IATA

IATA is a trade association for the world's airlines and currently has 290 member airlines representing 82% of total air traffic. IATA is currently developing the Airline Industry Data Model (AIDM) which aims to become a single point of access to store: industry agreed vocabulary, data definitions and their relationships, and related business requirements. This will allow the generation of interoperable, faster and easier messaging standards related to passenger services from scheduling, distribution to passenger experience and airport operations.

The content of AIDM is growing as new industry data exchange standards are developed and existing standards are moved to the AIDM. For example, standards supporting New Distribution Capability are already fully covered by and generated from the AIDM, however standards defined in Standards Scheduled Information Manual (SSIM) are only partially covered in the current release.

AIDM is presently being used to develop API standards supporting travel communications, which should also satisfy requirements of the Delegated Regulation (EU) 2017/1926 when providing flight-related information. As such, since AIDM represents the strategic direction for IATA data, it has been exclusively selected as subject matter for the ELISE project.

AIDM is a contributing standard in this analysis, and is in general not concerned with geospatial details, commercial aviation activities such as schedule of flights, dynamic updates of flights or distribution of airline services.

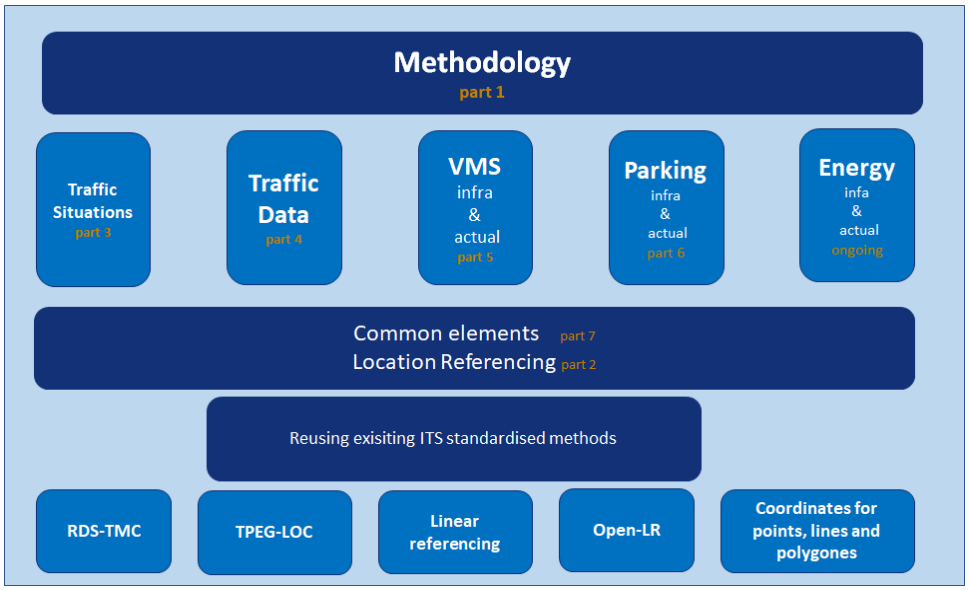
AIDM is maintained by the Architecture and Technology Strategy Board (ATSB) of IATA and details of the model can be viewed here: https://www.iata.org/whatwedo/passenger/Pages/industry-data-model.aspx

2.6 DATEX II

DATEX II defines a common set of data exchange specifications to support the vision of a seamless interoperable exchange of traffic and travel information across boundaries, including national, urban, interurban road administrations, infrastructure providers and service providers. Standardisation in this context is a vital constituent to ensure interoperability, reduction of risk, reduction of the cost base, promotion of open marketplaces and many social, economic and community benefits to be gained from more informed travellers, network managers and transport operators.

DATEX II is a multipart standard, whose structure is depicted in the **Figure 4** below.

Figure 4. DATEX II parts and related location referencing parts



DATEX II Part 1 Context and Framework: is targeted towards all stakeholders that want to understand the modelling methodology applied throughout the DATEX II specifications.

DATEX II Part 2 Location Referencing: deals with the DATEX II location referencing of traffic and travel information. It references existing location referencing Standards or European Standards and specifies the use of those standards in the Traffic and travel information domain of DATEX II.

DATEX II Part 3 Situation Publication: deals with the publication of situation information. It specifies the structures and definitions of information that may be exchanged to convey situation information relating to a road network, both from a road network manager and road user point of view. Examples of information that can be expressed in this part are congestion messages, road works, road closures, alternative routes, temporary road lay outs, traffic affecting weather conditions, etc. (journalistic traffic information).

DATEX II Part 4 VMS Publication: deals with the publication of variable message sign (VMS) information.

DATEX II Part 5 Measured and elaborated data publications: deals with the one or more publication sub-model(s) within the DATEX II model that support the exchange of measured and elaborated information, such as traveltimes on links, traffic flow on pointlocations, etc.

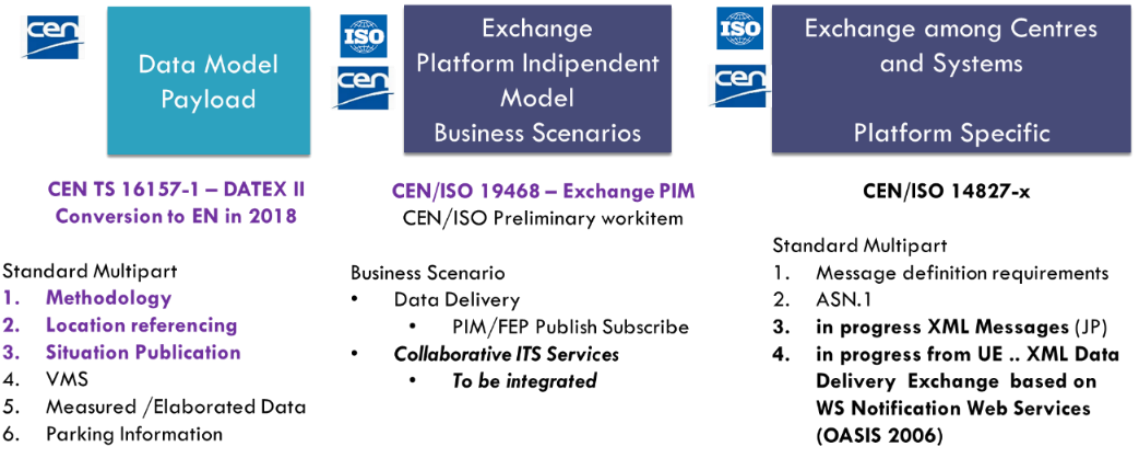
DATEX II Part 6 Parking publications: deals with the publication of parking information, both static and dynamic status data. It specifies the structures and definitions of information that may be exchanged to convey urban parking information or Truck Parking information. A DATEX II profile for Truck Parking is specified, which is in accordance with the "EU Truck Parking regulation". Furthermore a comprehensive and a lean version of an urban parking profile is provided.

DATEX II Part 7 Common Data: is targeted to deal with the common elements that are used in more than one publication. It specifies reused structures and definitions of information that may be exchanged to convey information described in the other parts of the standard.

The relevant standard for the information model is a multipart standard standardised by CEN with number 16157.

For the exchange of the content two ISO Work items are active in ISO WG9. The relation between all the set of DATEX II standards is shown in Figure 5.

Figure 5. Datex II environment



3 Data category definition

Each data category mentioned in the Annex of the Delegated Regulation (EU) 2017/1926 needs a definition. The definitions are based on the different standards (mainly INSPIRE and Transmodel). Moreover, each data category is underpinned by a data model presented in Appendix 1.

Data Category	Definition[11]
Address identifiers (building number, street name, postcode)	Locations of properties based on address identifiers, usually by road name, house number, postal code (INS: Addresses)
Topographic Places (city, town, village, suburb, administrative unit)	Names of areas, regions, localities, cities, suburbs, towns or settlements, or any geographical or topographical feature of public or historical interest (INS: Geographical Names)
Points of Interest	Types of places to or through which passengers may wish to navigate as part of their journey.[12] (TRM/NTX: POINT OF INTEREST)
Identified access nodes (all scheduled modes)	Topological aspect: Zero-dimensional nodes of the network (that may be located by coordinates in a particular Coordinate Reference System) used for the spatial description of the network, where passengers can board or alight from vehicles. (TRM/NTX: SCHEDULED STOP POINT) Geographical aspect: Places comprising one or more locations where vehicles may stop and where passengers may board or leave vehicles or prepare their trip (TRM/NTX: STOP PLACE)
Geometry/map layout structure of access nodes (all scheduled modes)	A map representing schematically the layout of the topographic structure of places or the public transport network (e.g. a set of lines). (TRM/NTX: SCHEMATIC MAP)
Connection links where interchanges may be made	Topological aspect: Couples of places located sufficiently near that it may represent for a passenger a possibility to reach one of these points when starting at the other one in a timescale which is realistic when carrying out a trip. (TRM /NTX: TRANSFER and its specialisations CONNECTION, SITE CONNECTION, DEFAULT CONNECTION) Geographical aspect: Designated paths between two places, which may include an ordered sequence of links within a place or between two places that represents a step in a possible route for pedestrians, cyclists or other out-of-vehicle passengers (TRM/NTX: NAVIGATION PATH)
Network topology and routes/lines (topology)	Service topology determined by routes, lines and service patterns (TRM/NTX: ROUTE, LINE, SERVICE PATTERN)
Stop facilities access nodes (including platform information, help desks/information points,	Types and locations of fixed equipment or facilities related to access nodes.

11 Sources of the definitions are provided in brackets

12 Some Points of Interest types are published by INSPIRE themes: Utilities and Governmental Service, Buildings, Protected Site.There are no other standards, except the INSPIRE Themes as mentioned.

ticket booths, lifts/stairs, entrances and exit locations)	(TRM/NTX: FACILITY, EQUIPMENT, EQUIPMENT PLACE)
Road network	Link and node structure to represent a road system used for the transportation of vehicles in the form of a linear network (INS Road Transport Network)
Cycle network (segregated cycle lanes, on-road shared with vehicles, on-path shared with pedestrians)	Self explanatory Gap in standards (Placeholders present in INS & TRM/NTX)
Pedestrian network and accessibility facilities	Road reserved for pedestrian use and closed for regular vehicular use by a physically barrier (INS: walkway)
Park & Ride stops	Under development (TRM/NTX draft proposal: A SITE containing at least one STOP PLACE and a PARKING connected by a SITE CONNECTION)
Bike sharing stations	Under development (TRM/NTX draft proposal: Specialisation of PARKING AREA which is a marked zone within a PARKING containing PARKING BAYs (places to park an individual vehicle)).
Car-sharing stations	Under development (TRM/NTX draft proposal: Specialisation of PARKING AREA which is a marked zone within a PARKING containing PARKING BAYs (places to park an individual vehicle)).
Publicly accessible refuelling stations & charging stations for electric vehicles	Locations that can contain one or multiple points at which the fuel/gas/energy is transferred to the customer (DTX)
Secure bike parking (such as locked bike garages)	Parking place for users allowing them to avoid unsuitable parking and contributing to safety of their bicycle. (based on TRM/NTX: EQUIPMENT PLACE of CYCLE STORAGE EQUIPMENT)
Where (and how) to buy tickets	Locations (physical or on-line) of ticketing service. (TRM/NTX: EQUIPMENT PLACE related to TICKETING EQUIPMENT)
Fare network data (fare zones/stops and fare stages)	Tariff zones used to define a zonal fare structure in a zone-counting or zone-matrix system and/or if applicable, fare zones composed of fare sections built of consecutive points used to define elements of the fare structure (TRM/NTX: TARIFF ZONE, FARE ZONE, FARE SECTION)
Where (and how) to pay for car parking, public charging stations for electric vehicles and refuelling points	Locations (physical or on-line) of service related either to the payment of parking and/or refuelling or recharging. (TRM/NTX EQUIPMENT PLACE related to TICKETING EQUIPMENT)
Detailed cycle network attributes (surface quality,	Self explanatory

side-by-side cycling, shared surface, on/off road, scenic route, 'walk only', turn or access restrictions (e.g. against flow of traffic)	Gap in standards (Placeholders present in INS & TRM/NTX)

4 Methodology leading to overlap handling

4.1 Overview

The project has developed a general methodology leading to recommendations as regards the handling of the overlaps. The methodology is lead in 2 stages:

a. rough identification of the overlaps: in many cases, the different standard specifications mentioned in the Delegated Regulation (EU) 2017/1926 seem to publish overlapping datasets. However, this first impression has to be confirmed by a more detailed analysis of the specifications introducing the concept of "semantical equivalence", the concepts of a Reference Standard and a Contributing Standard. This step splits into 3 steps:

- a1. Extract of a submodel corresponding to each data category as specified in each standard;
- a2. Detailed study and comparison of this submodel to other submodels related to the data category;
- a3. Choice of the Reference Standard/Contributing Standard.

b. detailed analysis overlaps: using the concept of a Reference Standard and a Contributing Standard, a mapping and a Mapping Table are defined for the "semantically equivalent" data models (and thus datasets). This step splits into 2 steps:

- b1. Agreement on a common mapping template and of the principle to follow for the mapping task (semantical equivalence);
- b2. Provision of a mapping table.

4.2 Rough identification of overlaps

The analysis of the extracted data models[13] relies on the expertise present in the project. The analysis of the scope of the different models leads to the introduction of the Reference Standard and the Contributing Standard.

A *Reference Standard* is a specification of which the scope covers a particular data category in a most comprehensive way. Other standards are *Contributing Standards* of a data category. In other words: the scope of a *Reference Standard* is such that the standard is specifically designed to publish data for a particular data category D, whereas the scope of a *Contributing Standard* is such that this standard only refers to (uses) the data category D to better describe other concepts.

Example: NeTEx describes Access Nodes (is a Reference Standard for Access Nodes) and is a Contributing Standard for Addresses (of which the Reference Standard is INSPIRE);

First conclusion: the different overlapping data models underpinning each data category may have different purpose and scope and contribute in different ways to the data category publication; either as a Reference Standard or as a Contributing Standard.

Once an overlap is present, the analysis of the overlaps relies on the elaboration of detailed correspondences (mappings) between the data structures referring to the same data category considered in the different standards.

4.3 Detailed analysis of overlaps: the overlap table

The considered overlaps are presented in the **Table 2** below. In some cases, a note is provided to explain the specific contribution of a particular standard to the data category. The explanation why only a note is provided and why the particular standard is not considered as a Contributing standard is provided in the next sections.

Table 2. Synthesis of the overlap analysis

Data Category		TRM/NTX	INSPIRE	TAP-TSI	IATA	DATEX

13 See Appendix 1

Level of service 1						
Address identifiers	1	C	R	C		C
Topographic Places	2	C	R			C
Points of Interest	3	C	R[14]			
Identified access nodes	4	R	C[15]	C	C	
Geometry/map layout- structure of access nodes	5	R				
Connection links	6	R	note	C	note	
Network Topology & Routes/Lines (topology)[16]	7	R	note	C[17] note	C	
Stop facilities access nodes	8	R		note		
Road Network	9	note[18]	R			note
Cycle network	10	note	C[19]			
Pedestrian network and accessibility facilities	11	note[20]	C[21]			

14 for a limited number of POIs
15 air/rail only
16 This data category concerns the transport service network, the transport infrastructure network is provided by INSPIRE
17 Contributing standard only for Service Patterns (no Routes, Lines)
18 Provides the projection of the service network on the infrastructure network
19 Only for segregated cycle lanes
20 Only schematic view with accessibility features
21 No accessibility features

Data Category		TRM/NTX	INSPIRE	TAP-TSI	IATA	DATEX
Level of service 2						
Park & Ride stops	12	R[22]		C[23] note		C
Bike sharing stations	13	R[24]				
Car-sharing stations	14	R[25]				C
Publicly accessible refuelling stations & charging stations for electric vehicles	15	C note	C note			C note
Secure bike parking (such as locked bike garages)	16	R[26]				
Where to buy tickets	17	R		C note	C note	C[27] note
Fare network data (fare zones/stops and fare stages)	18	R		C[28] note		
Level of service 3						
Where (and how) to pay for car parking, public charging stations for electric vehicles and refuelling points	19	C note				C[29] note
Detailed cycle network attributes (surface quality, side-by-side cycling, shared surface, on/off road, scenic route, 'walk only', turn or access restrictions (e.g. against flow of traffic)	20					

22 Transmodel extension carried out in CEN TC278 WG17 (PT1711)
23 Parking&station accesibility
24 Transmodel extension carried out in CEN TC278 WG17 (PT1711)
25 Transmodel extension carried out in CEN TC278 WG17 (PT1711)
26 Transmodel extension carried out in CEN TC278 WG17 (PT1711)
27 only for parking
28 for long distance fares
29 Refuelling Infrastructure Publication not published standard

4.4 Methodology for handling the overlaps

To formalise how to establish a comparison between the standards that may create an overlap, the concept of a mapping and a Mapping Table are introduced.

4.4.1 Mapping

A mapping is defined as an (oriented) correspondence m between a 'source' model S and a 'target model' T.

Figure 6. Mapping between Source and Target

The 'source' model is in the proposed mapping, the Contributing Standard (marked by a 'C') and the 'target' model, the Reference Model (marked by an 'R').

Any Contributing Standard model is 'mapped on' the Reference Standard model, i.e. the mapping is carried out from the (source) Contributing Standard to the (target) Reference Standard.

For the comparison of data models, the following cases are of particular interest:

a. for a source element of S there is one element of T (with the same semantics). This correspondence is marked 1:1 (at the level of a class or an attribute);

b. for a source element of S there is no corresponding element in T, but S is not contradicting any element or group of elements in T (at the level of a class or an attribute). This correspondence is marked 1:0;

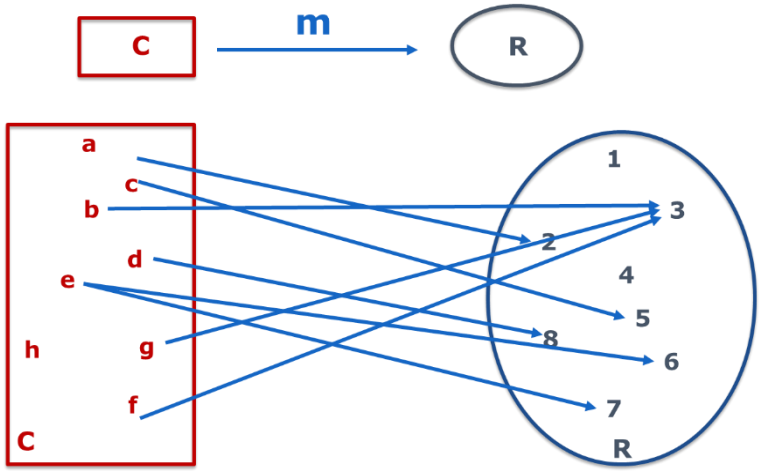
c. a grouping of elements of S corresponds to an element of T. This correspondence is marked N:1;

d. for a source element of S there is a grouping of elements of T. This correspondence is marked 1:N;

e. other: for example, for a source element of S there is one similar element of T(similar semantics);

f. a target element of T has no correspondence in S: this may happen, but the mapping table will not make evidence of this case, as the mapping is 'starting from the set of elements of C and picking the corresponding elements in T'. It has to be noted, however, that essential elements of T shall be present in S, otherwise, there is no semantical equivalence.

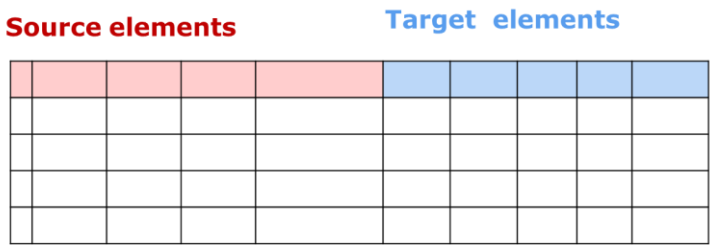
Figure 7. Mapping between Contributing and Reference Standard



4.4.2 Mapping Table Template

In order to be able to represent the correspondence in a simple way in form of a Mapping Table, a Mapping Table template has been agreed.

Figure 8. General layout of the Mapping Table Template



The following information is provided for the Mapping Table:

Figure 9. Header of the Mapping Table

#	Source Class	A (O=Own; R=Relationship)	Source Attribute Relationship (blue)	Source Attribute type Simple Type Complex type Enumeration	Source multiplicity	Description (as in the Source)

Target elements = result of mapping

Target correspondence indication; comments	Corresponding Target class/attribute	Exact corresp. to Target class 1:1	Exact corresp. to Target attribute 1:1	Source specific - new (class.) 1:0	Source Additional attribute without contradiction 1:0	Belonging to a group of Source elements corresponding to a Target class N:1	Source element derived from several Target attributes 1:N	Other

4.4.3 Semantical equivalence

After a further analysis of the data models, in particular of the semantics of the different object classes existing in the data models underpinning the data categories, the concept of *semantical equivalence* of the models has been introduced.

Two models M1 and M2 underpinning the data category K are considered as semantically equivalent when the information they represent is equivalent, i.e. when M1 may be replaced by M2 without loss of information.

The mapping between two models underpinning the same data category has the objective to qualify a somehow intuitive comparison done in a first stage, in a more precise way: at the level of classes/attributes in order to provide an indication if the two models related to a Data Category are semantically equivalent or semantically different.

If the models are semantically equivalent: this means that an overlap is present and the determination of correspondences between the elements of C and R is meaningful[30].

Otherwise, if an overlap is not really present (for instance, there is a different purpose/scope of the standards), a detailed mapping is not carried out. In this case a standard initially considered as Contributor may not be considered as a Contributing Standard; the mapping will be annotated, i.e. an explanatory note will be provided to clarify this. **Table 2** above already shows for each Data Category, which standard is the Reference Standard, the Contributing Standard and/or a note, explaining what type of contribution is provided by a standard.

30 see also 6.2 where overlaps are identified in the case of a similar scope but complementary information.

5 Use Cases

5.1 Introduction

The consideration of the Use Cases (UC) has the following purposes:

- To illustrate the overlaps in standards in concrete situations,
- To identify the actors addressed by the problem of overlaps,
- To show the usefulness of the Reference Standards,
- To show where Mapping Tables are most useful,
- To help formulating recommendations.

The Regulation cites, i.a., the following functional contexts (followed by the list of data categories identified as the most important) in which the information made available through the NAP is particularly useful:

- Location search (origin/destination):
    - Address identifiers (building number, street name, postcode)
    - Topographic Places (city, town, village, suburb, administrative unit)
    - Points of Interest (related to transport information) to which people may wish to travel
- Location search (access nodes):
    - Identified access nodes (all scheduled modes)
    - Geometry/map layout structure of access nodes (all scheduled modes)
- Trip plan computation — scheduled modes transport:
    - Connection links where interchanges may be made
    - Network topology and routes/lines (topology)
    - Stop facilities access nodes (including platform information, help desks/information points, ticket booths, lifts/stairs, entrances and exit locations).

The Use Cases chosen by the project team describe how specific situations are referring to these functional contexts.

5.2 Actors

Two types of target actors are identified, concerned by the overlapping standards and data publications:

- data providers: providers of datasets for the NAP and
- data consumers of information provided through the NAP.

The recommendations on 'how to manage the overlap' will be addressed to these two actors.

However, as regards the Use Cases related to the functional context location search or trip computation (i.e. which may be implemented as an application, for instance a journey planning applicaton), they are describing specific situations, where:

- the input data of a Use Case are datasets made available through the NAP and the data provider for each Use Case is the NAP, i.e. the *NAP data consumer;*
- the output data of a Use Case is dedicated either to another data consumer (e.g. application system provider) or to an end user.

Note: actors such as “NAP managers” are not considered here. Actions concerning the NAPs are organisational issues, related to the governance of the NAPs and are out of scope of this study.

In order to create a link between each Use Cases and *NAP data providers*, two scenarios are considered. The two scenarios differ by preconditions (or objectives) as regards the data publication standards (i.e. NAP data provision) and allow for different types of recommendations:

Scenario 1:

- Objective: to allow for the usage of all standard formats specified in the Regulation for data publication.
- In this scenario, recommendations are formulated *to NAP data consumers* (the consumers of the data made available through the NAP):
    - if relevant, the usage of mapping tables is recommended to build data converters.

Scenario 2:

- Objective: to avoid overlaps of information published through the NAP
- In this scenario, recommendations are formulated mainly *to NAP data providers, to avoid overlaps*. The recommendations are intended to lead to either:
    - avoid double effort in data publication, recommending, for particular data categories, the usage of a particular standard, or to
    - limit the overlaps to dataset overlaps, which may easily be suppressed by adequate governance rules established by the NAPs.

For any Use Case, the overlap Table 2 for the data categories of level of service 1 has to be considered.

5.3 Use Case Description Methodology

5.3.1 Introduction

The project intends to consider situations (Use Cases) related to the publication through the NAPs of information necessary for: Location Search and Trip Plan Computation.

Each Use Case may be considered in the context of either Scenario 1 or 2 as this will enable distinct recommendations.

5.3.2 Use case description template

The following simple template will be used for the Use Case description:

Table 3. Use Case Description template

Use Case Description	
Name	A short name for the use case, usually describing an activity
Functional Context	Reference to the functional context cited in the Delegated Regulation
UC Data provider	The provider of input data which will be elaborated in the use case The possible overlapping standards providing datasets for the UC
Goal	The goal of the primary actor
Description	A short narrative description of the use case
Pre-condition	What are the pre-requisites? What input is required? What standard formats are used for the input?

Post-condition	What is the output from the use case? What are the anticipated next steps?
Flow of Events – Basic Path Describe the basic steps needed for executing the use case from the perspective of the primary actor. Describe, if relevant what type of overlap is encountered type 1: data model overlaps - semantically equivalent information type 2: data model overlaps - complementary information type 3: data provision overlaps - same information under same format from different providers type 4: data provision overlaps - same information under different formats	
Step 1 … Step n	
Scenario 1	Authorize overlapping publication
Recommendations Scenario 1	In most cases the recommendation will address NAP data consumers (possibly NAP data providers)
Scenario 2	Avoid overlapping publication
Recommendations Scenario 2	In most cases the recommendation will address NAP data providers (possibly NAP data consumers)

This study addresses overlaps of data models underpinning each data category. The following overlap types are possible:

- type 1 overlap: this overlap concerns two standard data models (underpinning a data category) which have a similar scope and represent semantically equivalent information;
- type 2 overlap: this overlap concerns two standard data models with similar scope (underpinning a data category) which have a similar scope and contain complementary information;
- type 3 overlap: this overlap concerns duplicate instances of published data using a standard format by different data providers. The description of the management of the overlap of type 3 is out of scope (concerns data quality) but has to be mentioned if relevant in a step. This overlap may occur for type 1 and 2 overlaps.
- type 4 overlap: this overlap concerns duplicate instances of published data using two different standard formats. The description of the management of the overlap of type 4 is out of scope (concerns data quality) but has to be mentioned if relevant in a step. However, in some cases recommendations to data providers may be addressed to help disambiguation of data (e.g. in the case of Access Nodes, usage of publicly known codes, e.g. IATA or UIC).

This project is mainly concerned by overlaps of type 1 and 2, i.e. it is considered that there is no overlap when the data models underpinning a data category do not have a similar scope (purpose). This is the case, for instance, for the data category Network Topology, for which INSPIRE is modelling the “infrastructure network” and Transmodel/NeTEx the “service network”.

5.3.3 Choice of Use Cases

The following specific Use Cases illustrate the publication overlaps:

- Use Case 1 - Find access nodes for Governmental Services in 2 regions;

- Use Case 2 - Retrieve location data (location search address, POI (Parking), Topographic place);
- Use Case 3 - Find nearest Access Node at a location;
- Use Case 4 - Compute a trip plan (between access nodes).

5.4 Use Case: Find Access Nodes for Governmental Services in 2 regions

5.4.1 Use Case summary

This Use Case concerns an application provider in charge of providing (to end users) a list of Stop Places in the neighbourhood (300m buffer) of administrative services for Region 1 & 2 together with their Postal Addresses (if available).

An application provider, i.e. a NAP data consumer, may face the following situation when searching for the relevant information on the NAP:

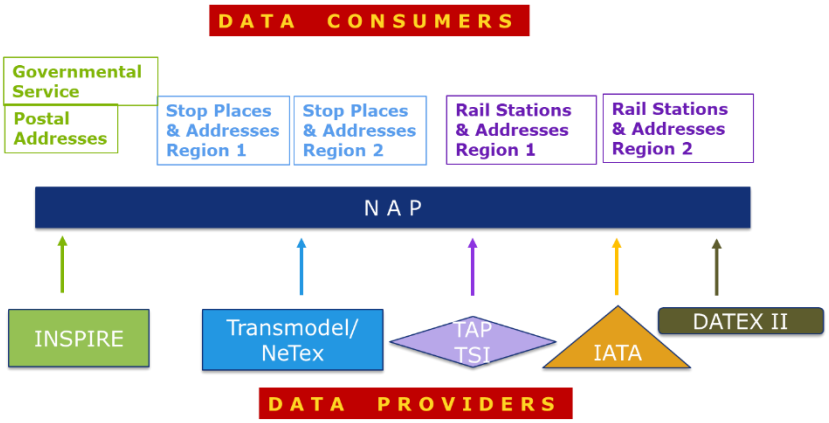
- Public Transport Stop Places for Region 1 & 2 are available in NeTEx format for Region 1 & 2;
- Rail stations are available using TAP-TSI EDIFACT format for Region 1 & 2;
- Governmental Services and Postal Addresses for Region 1 & 2 are published by INSPIRE.

This situation is the most likely to be found, as it respects the INSPIRE Directive and the Delegated Regulation 2017/1926. This corresponds to the scenario 1 (see § 4.3 above), i.e. NAP Data Consumers may find datasets with duplicated information.

This situation is schematically represented in the

Figure **10** below.

Figure 10. Illustration of the Use Case 'Find Access Nodes for Governmental Services'



However, in order to limit publication overlaps, knowing that a complete mapping TAP-TSI-NeTEx is available, the recommendation to NAP data providers may be formulated, proposing the publication of Rail Stations in NeTEx format as in scenario 2.

5.4.2 Use case description

Table 4. Description of Use Case 'Find Access Nodes for Governmental Services'

Use Case Description	
Name	Access nodes for Governmental Services in 2 regions
Functional Context	Location search (access nodes): • Identified access nodes (all scheduled modes)
UC Data provider	Standards: TAP-TSI, NeTEx, INSPIRE

Goal	to identify Stop Places in the neighbourhood (300m buffer) of administrative services for Region1&2 together with their Postal Addresses (if available).
Description	Data providers of Region 1 & 2 may publish Rail Stations (together with their postal Addresses) + Stop Places (together with their postal Addresses) according to TAP-TSI or NeTEx. INSPIRE provides Addresses and Governmental Services of Region 1 & 2. Data Consumers find partly overlapping publications, in particular as regards the Access Nodes (Stop Places and Rail Stations) and Addresses in formats which differ from the INSPIRE format.
Pre-condition	Input: • Access Nodes + Postal Addresses: published in TAP-TSI and NeTEx formats • Governmental Services + Postal Addresses: published using INSPIRE • Existence of a Mapping TAP-TSI → NeTEx for Access Nodes • Existence of Mapping NeTEx → INSPIRE for Postal Addresses • Existence of Mapping TAP-TSI → INSPIRE for Postal Addresses
Post-condition	Expected output: • List of Governmental Services in Region 1 & 2 • For each Governmental Service, in the neighborhood of 300 m, a list of Stop Places + their Postal Addresses.
Flow of Events – Basic Path Basic steps needed for executing the use case from the perspective of the primary actor	
Steps	1. Identify the set of Stop Places of Region 1 & 2 in a buffer of 300m around any Governmental Service 2. Identify the set of Rail Stations of Region 1 & 2 in a buffer of 300m around any Governmental Service 3. Compare the set of Rail Stations and the set of Stop Places and remove overlaps (of type 3 & 4) 4. Constitute the complete set of Access Nodes (without duplication): add to the set of Stop Places missing Rail Stations 5. For the Access Nodes with a Postal Address, convert the address to the INSPIRE format
Scenario 1	Data are published using TAP-TSI (EDIFACT), NeTEx and INSPIRE
Recommendations to NAP data consumer	Define data converters for Postal Addresses using the following mapping tables: • NeTEx Postal Address to INSPIRE Postal Address • TAP-TSI Postal Address to INSPIRE Postal Address
Scenario 2	Avoid duplication of publications: data are published using NeTEx (as the Reference Standard for the Access Nodes) and INSPIRE (as the Reference Standard for Postal Addresses and Governmental Services)
Recommendations to NAP data providers	Define a data converter for Rail Stations using the mapping table:

	• TAP-TSI Rail Stations to NeTEx Stop Places and publish Rail Stations using NeTEx

5.4.3 Use Case discussion

Scenario 1 allows for the publication of Access Nodes in 2 different formats for 2 regions.

This may provide, in general:

a. an overlap of type 1 between TAP-TSI and NeTEx (Rail Stations are representing Stop Places),

b. an overlap of type 3 for the NeTEx Stop Places, if 2 regions overlap and/or when several data providers are concerned,

c. an overlap of type 3 for the TAP-TSI Rail Stations, if 2 regions overlap and/or several data providers are concerned.

Scenario 2 recommends to NAP data providers the use of a converter (the design of which is done once) and to make Rail Stations systematically available through the NAP in NeTEx format.

As a consequence:

- the overlap as in "a" and "c" becomes not meaningful
- duplicated data instances may appear as described in "b": this problem may be solved by implementing efficient governance rules of the NAP.

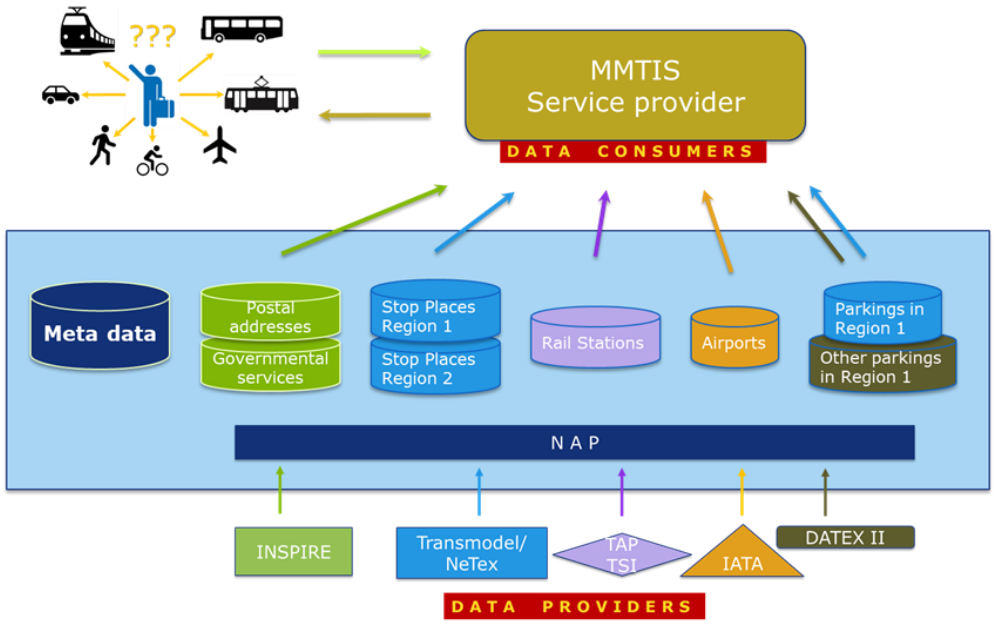
Conclusion: the application of the Delegated Regulation as is, leads in this Use Case to different overlaps (scenario 1) which may be solved building converters by NAP data consumers. The recommendation to NAP Data Providers of rail data to use NeTEx for data publication decreases the overlaps and if, additionally, efficient governance rules are implemented in the NAP, the NAP data consumers will find a coherent Access Node dataset without duplications.

5.5 Use Case: Retrieve location data (address, POI (Parking), Topographic place)

5.5.1 Introduction

This specific Use Case addresses the retrieval of location data in several datasets. In order to understand the functional architecture reflecting the scope of the standards involved, the Figure 11 below shows the application of the standards on the interfaces between the actors in the data chain from data provider → NAP → MMTIS Service Provider ('SP') → End user.

Figure 11. Illustration of the Use Case 'Retrieve Location Data'



It shows that the standards are in place to deliver the relevant data to an MMTIS Service Provider, who processes the datasets to accommodate his end users with valuable services. The official scope of the standards is not to support end-user applications directly.

For the Use Case "Retrieve location data" the basic steps of how the correspondence tables could be used are walked through.

5.5.2 Use case description

Table 5. Description of Use Case 'Retrieve Location Data'

Use Case Description	
Name	Retrieve location data
Functional Context	Location search (origin/destination): • Address identifiers (building number, street name, postcode) • Topographic places (city, town, village, suburb, administrative unit) • Points of interest (related to transport information) to which people may wish to travel
UC Data provider	Standards: TAP-TSI, NeTEx, INSPIRE, DATEX II
Goal	Provide the relevant location data to the end-user, by combining information from

	different datasets in an unambiguous way.
Description	In order to present information in the functional domain of location search to the end-users, the SP has to relate datasets in order to be able to find X,Y-coordinates corresponding with an address, or a bus stop in the vicinity of a museum (being a point of interest). The search can either start with an address, or a name of a point of interest, or the name of a geographical area. In this Use Case the reverse functionality (find an address, or POI etc., based on a X,Y coordinate) is not addressed, but makes use of the same principles.
Pre-condition	The availability at the MMTIS-SP's system of the following datasets in the indicated standard: • Postal Addresses: INSPIRE • Governmental Services with a Postal Addresses: INSPIRE • Rail stations with a Postal Address: TAP-TSI (or NeTEx and then part of stop places) • Stop places with a Postal Address: NeTEx • Parkings with a Postal Address: DATEX II Existence and availabilitye of Mapping/correspondence from: • NeTEx → INSPIRE for Postal Addresses • TAP-TSI → INSPIRE for Postal Addresses • DATEX II → INSPIRE for Postal Addresses • NeTEx → INSPIRE for Topographic Places • DATEX II → INSPIRE for Topographic Places • NeTEx → INSPIRE for Points of Interest
Post-condition	The result of this Use Case is a dataset in which the MMTIS Service Provider has linked all location data to further process them in trip calculations and/or presentation to the end user in text, or on a map.
Flow of Events – Basic Path	
This generic use-case is split in sub-use cases, each identified with this grey line Retrieve location data for Postal Addresses	
Step 1	Look for Postal Addresses in DATEX II dataset in the DATEX II format (this is only in the parking publication)
Step 2	Relate the DATEX II format to the INSPIRE format using the address mapping table
Step 3	Look for the corresponding Postal Address in INSPIRE
Step 4	Complement the address information of both datasets to the Actors dataset according to the business use case of the actor
Retrieve location data for Topographic Places	

Step 1	Look for Topographic Places in NeTEx dataset in the NeTEx format
Step 2	Relate the NeTEx format to the INSPIRE format using the Topographic Places mapping table
Step 3	Look for the corresponding Topographic Places in INSPIRE
Step 4	Complement the Topographic Places information of both datasets to the Actors dataset according to the business use case of the actor
Step 5	Remove functional duplicates (i.e. physically the same Topographic Place)
Retrieve location data for Points of Interest	
Step 1	Look for Points of Interest in the NeTEx dataset in the NeTEx format
Step 2	Relate the NeTEx format to the INSPIRE format using the Points of Interest mapping table
Step 3	Look for the corresponding Points of Interest in INSPIRE. The available POI's in INSPIRE are restricted to Governmental Buildings.
Step 4	Complement the Points of Interest information of both datasets to the Actors dataset according to the business use case of the actor.
Step 5	Remove functional duplicates (i.e. physically the same Point of Interest)
Scenario 1	Authorize overlapping publication
Recommendations to NAP data consumers (possibly providers)	In case of the data categories Points of Interest and Topographic Places, the information provided via the standards involved will be complementary, both in terms of the objects and the characteristics of the objects that are delivered. Merging and cleaning the resulting datasets is highly recommended.
Scenario 2	Avoid overlapping publication
Recommendations to NAP data providers (possibly consumers)	In order to make the data easier to use, it is recommended that the objects containing a: ● Postal Address ● Point of Interest or ● Topographic Place are provided with X,Y-coordinates as well. This makes the Location data retrieval process of the MMTIS Service Providers much more reliable and robust. It is recommended to the NAP to ensure that data providers provide their address data using the same source dataset.

5.6 Use Case: Retrieve parking data

5.6.1 Introduction

For Parkings a special situation is identified, as Parking information can be published in two formats. This causes the possibility that published parking information in a region can have all of the overlap types below.

Figure 12. Illustration of the Use Case 'Retrieve Parking Data'

type 1 overlap: this overlap concerns two standard data models (underpinning a data category) which represent semantically equivalent information. One set of parkings is published in NeTEx and one set is published in DATEX II. Note: This cannot be avoided, as DATEX II is mandatory in relation to regulation E: Safe and secure Truckparking.

type 2 overlap: this overlap concerns two standard data models (underpinning a data category) which represent complementary information. Information about a parking is more extensive in one dataset than the other. This situation may occur and may be addressed by an adequate data governance implemented by the NAP management.

type 3 overlap: this overlap concerns duplicate instances of published data using a standard format by different data providers. The description of the management of the overlap of type 3 is out of scope (concerns data quality) but has to be mentioned if relevant in a step. This overlap may occur for type 1 and 2 overlaps.

type 4 overlap: this overlap concerns duplicate instances of published data using two different standard formats. The description of the management of the overlap of type 4 is out of scope (concerns data quality) but has to be mentioned if relevant in a step. However, in some cases recommendations to data providers may be addressed to help disambiguation of data.

5.6.2 Use case description

Table 6. Description of the Use Case 'Retrieve Parking Data'

Use Case Description	
Name	Retrieve parking data
Functional Context	Location search (origin/destination): • Points of interest (related to transport information) to which people may wish to travel

UC Data provider	Standards: NeTEx, DATEX II
Goal	Merge the relevant parking data, combining information from different datasets in an unambiguous way in order to find the parking which is useful for a traveler, either as destination or waypoint for changing modality.
Description	Parking information is published in datasets carrying information about almost all characteristics (potentially) of the parking. Location, accessibility (both in terms of conditions on vehicles and on where and how persons can enter/leave a parking) and tariff and payment are provided in a single data publication. Some data providers in Region 1 may publish data about their Parking's according to DATEX II. Others provide the information about their Parking data according to NeTEx. Data Consumers need to combine both datasets, in order to have a complete information provision. Good data governance shall avoid the provision of information for the same parking in different data provisions.
Pre-condition	The availability at the MMTIS-SP's system of the following datasets in the indicated standard: Parking data: NeTEx Parking data: DATEX II Existence and availability of Mapping/correspondence from: DATEX II → NeTEx
Post-condition	The result of this Use Case is a dataset in which the MMTIS Service Provider has combined all parking data to further process them in trip calculations.
Flow of Events – Basic Path	
Step 1	Relate and convert the DATEX II format data to the NeTEx format using the Parking mapping table. Within the scope of this project the mapping table produced supports the functional domain location search[31]
Step 2	Add the DATEX II dataset to the NeTEx dataset
Step 3	Identify the duplicate parking's based on one (or a combination of) the following characteristics: — X,Y coordinates — Name of the parking — Address — Functional characteristics (if possible)

31 The functional scope of both NeTEx and DATEX II is very extensive and goes beyond the scope of this mapping/correspondence project. Work is ongoing in a different setting to complete this mapping in combination with an effort to align and harmonise the standards involved.

Step 4	Merge the data of the duplicate Parkings found
Step 5	Remove functional duplicates (i.e. physically the same Parking)
Scenario 1	Authorize overlapping publication
Recommendations to NAP data consumers (possibly providers)	In case of merging Parking data, be aware that dynamic datasets concerning real time availability, pricing, etc. might be (or become) available referring to a specific ID. Don't loose that ID in the merging phase. Try to avoid the inclusion of data about Parkings that are already published by the owner or competent authority managing the Parking. If complementary data is available and published, include a reference to the aforementioned datasource.
Scenario 2	Avoid overlapping publication
Recommendations to NAP data providers (possibly consumers)	

5.7 Use Case: Find nearest access node at a location

5.7.1 Use case description

Table 7. Description of the Use Case 'Find Nearest Access Node at a Location'

Use Case Description	
Name	Find nearest access node at a location
Functional Context	The Use Case applies where a user is looking for the nearest access points for a scheduled transport mode. Scheduled transport modes include rail, road based public transport modes and air. As input for this Use Case, the user has the address or the coordinates of the place from where he wants to discover the nearest access points for a scheduled transport mode. This comprises all available access nodes within a radius of 1000 meter[32]. The system shall be able to determine these based on the coordinates or the address of a location.
UC Data provider	The following standards shall be used for the data provision: - Public transport operators (NeTEx) - Airlines (IATA) - Railway undertakings (TAP-TSI timetable data in EDIFACT format)
Goal	The goal of this Use Case is to determine the nearest access points for scheduled transport modes. The location data of those access nodes may be provided in different datasets for the different transport modes (e.g. air, public transport, railway). The main question for this Use Case is: How to determine in the different datasets the access nodes to the public transport since they are available in different data formats?
Description	The data consumer shall be able to determine how to obtain the locations of the nearest access points. These access points shall be identifiable in different transport data subsets (public transport, air, rail).
Pre-condition	● The address or the coordinates of the starting point for the location search are available ● The transport datasets including the access nodes are available in one of the given formats: o CEN/TS 16614 (NeTEx) o technical documents defined in Regulation (EU) No 454/2011 o technical documents elaborated by IATA o any machine-readable format fully compatible and interoperable with those standards and technical specifications ● Availability of spatial datasets in INSPIRE format
Post-condition	The nearest access nodes can be discovered and are provided in the data format NeTEx.
Flow of Events – Basic Path Describe the basic steps needed for executing the use case from the	

32 See http://www.irpud.raumplanung.tu-dortmund.de/fileadmin/irpud/content/documents/publications/ap184.pdf, page 19

perspective of the primary actor.	
Step 1	Collect the data from the different data sources for scheduled transport modes
Step 2	Map the transport data for scheduled transport modes into a common dataset (NeTEx)
Step 3	If an address is provided, use the location data from INSPIRE to determine the coordinates of the location
Step 4	If the coordinates of the starting point are provided, use them as input for the starting point of the search
Step 5	Use the determined coordinates of the starting point and the coordinates of the stops from NeTEx to determine the closest access nodes
Scenario 1	Authorize overlapping publication
Recommendations to NAP data providers	- Publish the dataset in the format which is allowed by the Regulation. This comprises NeTEx for road based transport, TAP-TSI (EDIFACT) for rail services or IATA for airlines - Use identifiers which are used in common in the standards. For instance for railway access nodes the usage of the TAP-TSI location ID is recommended for the TAP-TSI datasets and as well for the datasets delivered by the public transport operators (e.g. in NeTEx); for airlines use the IATA code for the identification of an air access node; this code shall be used by railways as well, if the access node is used for air-rail combined tickets.
Recommendations to NAP data consumers	If overlapping publication is allowed, it is recommended for the data consumers: - To transform the input datasets from the different data sources into a common standard. For this purpose, it is recommended to use the NeTEx standard. The mapping of the files is described in the mapping tables corresponding to the data standards TAP-TSI and IATA - if a *"... machine-readable format fully compatible and interoperable with those standards ..."* (article 4, 1(b) (EU) 1926/2017) is used, those standards shall be mapped into NeTEx before use. - To use a common unique identification of the access nodes in the different datasets, e.g. for railway stations, it is recommended to use the TAP-TSI location code as unique identification for the station. This location code shall be used for datasets delivered by public transport operators as well (e.g. NeTEx). For datasets delivered according to IATA-standards, the IATA airport code shall be used in the datasets and included as well in other datasets (e.g. railway or public transport datasets).
Scenario 2	Avoid overlapping publication
Recommendations to NAP data providers	If overlapping publication has to be avoided, it is recommended for the data providers: - to transform the input datasets from the different data sources (e.g. air, rail) into a common standard. For this purpose, it is recommended to use the standard NeTEx. The mapping of the files is described in the mapping tables corresponding to the data

	standards TAP-TSI and IATA. - if a *"… machine-readable format fully compatible and interoperable with those standards …"* (article 4, 1(b) (EU) 1926/2017) is used, those standards shall be mapped into NeTEx before use.

5.8 Use Case: Compute a trip plan (between access nodes)

5.8.1 Introduction

Computer-aided travel tools assist potential travellers in preparing their trips, particularly in answering specific TRIP REQUESTs. Such a trip planning function identifies the origin and destination places (see previous Use Cases) of an intended trip and proposes one or several trip solutions. The proposition takes into account the user's constraints or preferences, such as minimal trip duration, minimal number of interchanges, cheapest fare, etc., and involves an optimisation process using such parameters.

To process the trip request, and to fulfil the expectation of the European Regulation, the algorithm requires the following data categories;

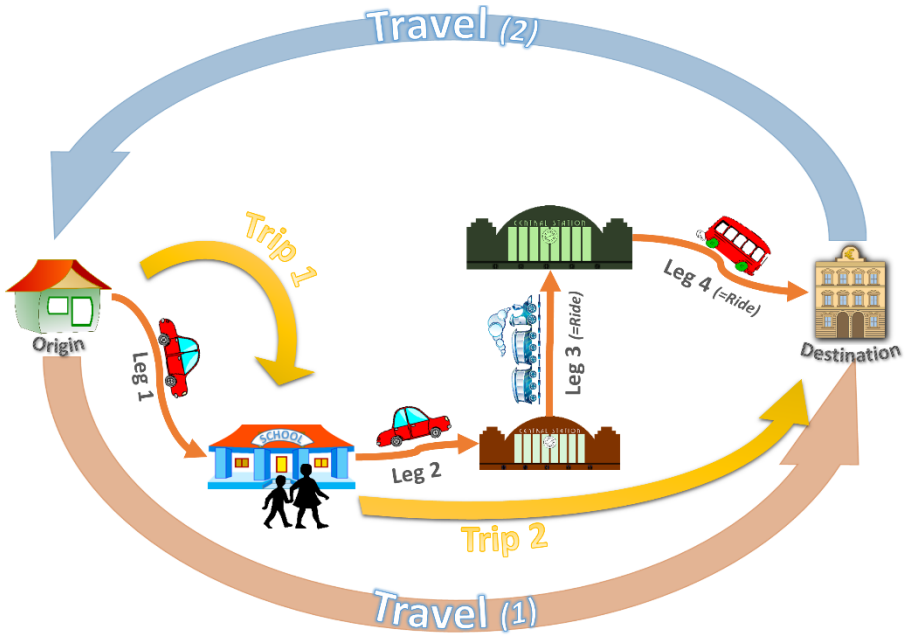
- As input Trip planning uses origin and destination, being results of Location Search (see previous chapter): geographic coordinates, access nodes, located address, topographical place
- Connection links where interchanges may be made, but also interchange – connection at a specific point between 2 identified journeys, when available *(even if not in the scope of this study)*
- Access nodes: as arrival/departure, within connections, to connect to other modes (walking, car, bike or any new mode) and for unplanned PT connections
- Network topology and routes/lines (topology) complemented with timing information *(even if not in the scope of this study)*
- Network description for all other supported modes:
  - > Road network
  - > Cycling network
  - > Walking Network (note that today's trip planners often use the road network as a walking network)
- Additional data may also be provided as input:
  - > Elevation map (especially for bikes and walking)
  - > Weather data
  - > Statistical information (traffic data, etc.)
  - > Etc.
- Stop facilities access nodes (including platform information, help desks/information points, ticket booths, lifts/stairs, entrances and exit locations)
- Note that in order to provide a real-time trip planning, all this data needs to be ready to be enhanced with availability update, real-time updates, traffic data, etc. *(even if not in the scope of this study).*

5.8.2 Transmodel TRIP

Transmodel defines a detailed structure describing a TRIP that can be used to describe one of the propositions from the TRIP calculation.

The following Figure 13 provides a functional overview of the main concepts to describe a TRIP. The TRIP itself is a journey (move) done for a unique identified reason (take the children to the school, go to the swimming pool, go to work, etc.). The TRIP can be subdivided in LEGs (on any mode of transport) which are a mono-modal journeys (unique transport mode: bus, train, bike, walk, private car, car-pooling, etc.): a part of a trip corresponding to the movement of a user on one and only one mode. TRIPs can be grouped in TRAVELs, a set of consecutive TRIPs (therefore grouping an origin, a destination, intermediate step-over, multiple TRIP reasons, multiple transport modes, etc.). An example could be to go to work, starting by dropping children to the school (by car) and then take the car, train and bus to go to the office (as in the following example).

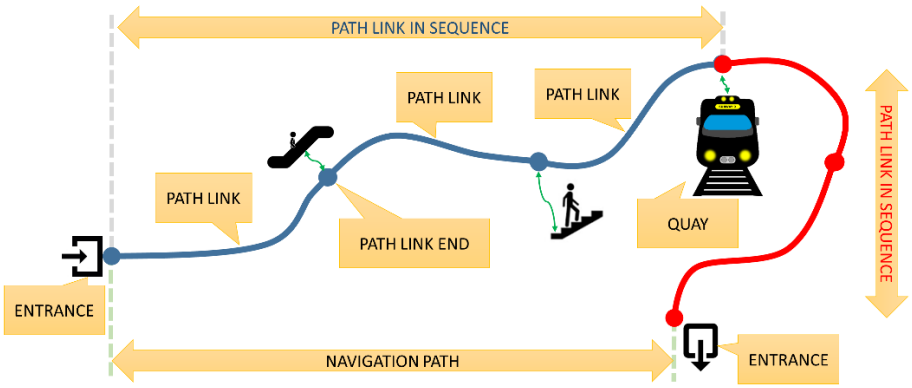
Figure 13. Example of Transmodel TRIP



5.8.3 Walking path

Transmodel also provides a more fine grained way of describing a walking path being part of the LEG (subdivisions of TRIPs). These are described through PATH LINKs grouped in NAVIGATION PATHs and provide information about all the EQUIPMENTs available on the way and all the needed accessibility information. The following Figure 14 provides a synthetic example of NAVIGATION PATHs within a STOP PLACE with 2 ENTRANCEs and walking paths from these ENTRANCEs to a QUAY. The blue NAVIGATION PATH features an escalator and a stair along the path.

Figure 14. Example of Transmodel Walking Path within a STOP PLACE



5.8.4 Principle of trip calculation

A Trip plan computation is most often done in several steps:

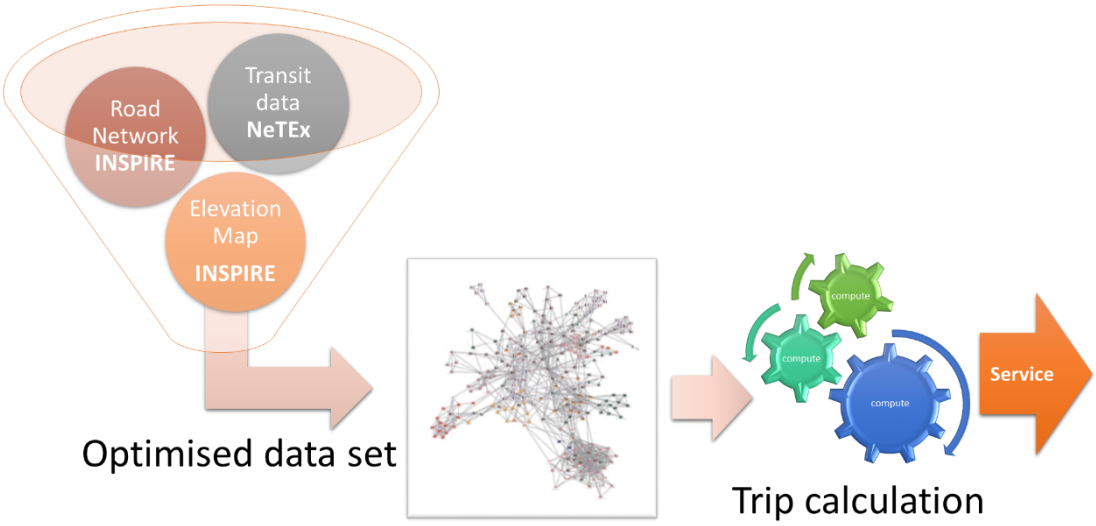
- Gathering all required information for the computation: this is where using standard is very important in order to be able to fully understand the semantic of the data and to avoid having one specific format for each provider (a single trip calculator can be fed by several PT operators, e.g. more than 100 in some big urban areas).
- "Compiling" all the gathered information in an optimised way for efficient and fast calculation: the optimised format is directly linked to the type of algorithm used (usually specific or

proprietary, most often based on Dijkstra, A*, Floyd-Warshall or Raptor algorithms) and is most often very specific.

- Providing the compiled data to the service algorithm.
- Give access to the algorithm to users (through web app, mobile app, etc.). Note that prior to accessing the trip calculation service, a location search (described in previous uses cases) has to be done in order to identify the departure and arrival locations, and additional information should be provided (date and time of travel, user preferences, etc.).

The following Figure 15 provides an overview of the trip calculation process.

Figure 15. Principle of trip computation



The main data possibly used to generate the optimised dataset, in the context of the European ITS Directive are presented in the following Table 8. The lines in blue show data out of the scope of the current study, but still in the scope of the regulation.

Table 8. Description of data needed for trip computation

Data	Provider	Comment
Origin and destination, being results of Location Search	Location search API based service, OJP recommended (standard from TC278/WG3/SG8)	The information can be: • ID of Access Nodes • ID of INSPIRE feature (Geographic location) • POI ID (OSM, etc.) • Geographic location
Connection links where interchanges may occur	NeTEx	Note that SITE CONNECTIONs may refer to external objects (INSPIRE, OSM, etc.)
Interchange	NeTEx	The interchanges are connections between 2 specific

		VEHICLE JOURNEYs (at a certain place and at a specific time).
Access nodes	NeTEx Some access nodes (or complementary information on access nodes) can be provided by TAP-TSI, IATA and INSPIRE (Aerodromes, etc.) but are expected to be converted to NeTEx	Needed for arrival/departure, within connections, to connect to other modes (walking, car, bike or any new mode) and for unplanned PT connections (not described as Connection Links)
Network Topology (Routes, Lines, etc.)	NeTEx Some information about the Network Topology (or complementary information) can be provided by TAP-TSI, IATA and INSPIRE but are expected to be converted to NeTEx	
Timing information	NeTEx Some information about the Timing Information can be provided by TAP-TSI for rail but are expected to be converted to NeTEx	
Network description for all other supported modes:		
Road network	INSPIRE	
Cycling network	Gap There is no standard format to describe a full cycling network (OSM may be used instead, GDF may also be used but is lacking cycling data source for now)	
Walking Network	Gap There is no standard format to describe a full walking network (OSM may be used instead, GDF may also be used but is lacking cycling data source for now)	Note that today's trip planners often use the road network as a walking network
Additional data		
Elevation map (especially for bikes and walking)	INSPIRE	
Weather data	DATEX II but not generic	Specially useful for cycling and

		outdoor walking
Statistical information (traffic data, etc.)	DATEX II	
Stop facilities access nodes (including platform information, help desks/information points, ticket booths, lifts/stairs, entrances and exit locations)	NeTEx	
Availability update, real-time updates, traffic data, etc.	SIRI for Public Transport and equipments DATEX II for Traffic	

The following Table 9 describes a possible simple Use Case based on Trip Computation. This example is deliberately simple: trip computation can easily become highly complicated and could by a large study on its own, which is not the scope of this document.

Table 9. Description of a Use Case for Trip Plan Computation

Use Case Description	
Name	Provide a trip calculation on a simple bus network providing an access to an airport
Functional Context	Trip Plan Computation — compute a trip from a bus stop to an airport across a single bus network. Origin bus Stop Place and destination Airport are expected to be provided by a previous location search.
UC Data provider	Standards: IATA, NeTEx, INSPIRE
Goal	To identify a trip across the bus network from a Stop Place to an airport at a specific starting date and time.
Description	Use the data from a bus operator describing a bus network, together with information from INSPIRE and IATA on the area covered by the bus network to compute an optimal trip to the airport (as short as possible, but with sufficient margin to secure any connection or walking to access stops). The request for the trip is done by an end user through a web site. Data Consumers (organization in charge of the trip calculator) may find partly overlapping publications, in particular as regards the information about airports
Pre-condition	Input: Bus network topology from the bus operator (may be obtained through National Access Point): NeTEx Access nodes on the bus Network (NeTEx), may be provided by the bus operator or by a national or regional stop database registry Connections (and possibly interchanges) on the bus Network Bus services (timing information, out of the scope of this study, but obviously necessary): NeTEx Aerodrome information from INSPIRE Airport information from IATA In this example, walking paths are calculated on a 'bird fly' base (no pedestrian network available) Existence of a relation (through IATA code) to link airport data between IATA and INSPIRE
Post-condition	Expected output: A detailed description of the trip (lines, boarding and alighting access nodes and associated timing information, directions, intermediate stops, connections and associated durations, estimated walking times).
Flow of Events – Basic Path Basic steps needed for executing the use case from the perspective of the primary actor	
Steps	Preparation of the trip calculator:

	• Gathering all required information for the computation: bus network including access nodes, timing information, INSPIRE and IATA data for the area covered by the bus network • "Compiling" all the gathered information in an optimised way for efficient and fast calculation • Provision of the compiled data to the service algorithm on the web site Trip computation: • Acquisition of the Id of the starting bus access node and of the destination airport (through another service). The airport's Id is expected to be a IATA code and the bus access node's Id a NeTEx Id. • Identification of the bus access nodes located within the airport (based on the geometry of the airport provided by INSPIRE and the location of the bus access nodes). Note that this may be refined if terminal's information (in case of multiple terminals) is also provided. Also note that this information may have been pre-computed during the "compiling" phase (can be pre-computed on all major Points of Interest). • Calculation of the optimal trip. • Provision of the detailed trip (prefer Transmodel based description, as described above) to the user interface part of the system. • Presentation of the proposed trip(s) to the user (text and possibly map).
Scenario 1	Airport data are published using INSPIRE and IATA
Recommendations to NAP data consumer (trip calculator)	Use the IATA code to link INSPIRE and IATA information Use INSPIRE for a detailed geographic description of the airport (named Aerodrome in INSPIRE) Connect this location to the bus network based on the inclusion or proximity of the geographic locations
Scenario 2	Airport data are published using NeTEx (as the Reference Standard for the Access Nodes)
Recommendations to NAP data providers and to NAP data consumer (trip calculator)	For NeTEx data provider: use IATA code in access node (Stop Place) description when relevant For data consumer (trip calculator): calculate the trip only based on NeTEx information, and display the associated map based on INSPIRE information

6 Recommendations

6.1 Introduction

This chapter presents the following types of recommendations:

Recommendations for NAP data consumers: concern mainly the scenario in which all standard formats specified in the Delegated Regulation 2017/1926 are used (scenario 1 described in section 5).

Scenario 1 is fully in line with the Regulation.

Recommendations for NAP data providers: concern the scenario if overlaps intend to be avoided (scenario 2 described in section 5).

Note: the Regulation 2017/1926 does not prescribe the scenario 2. The native formats as mentioned in the Regulation are allowed for data publication by NAP data providers. The recommendations formulated represent a guidance in the case when NAP data providers choose to avoid duplication in data publication.

Recommendations to the Member States and/or the Commission intend to identify further areas of work.

The following template is used to present the synthesis of the Data Category description and associated recommendations:

Table 10. Recommendations Summary Template

Data Category Number	Data Category Name	Description
A	Context	Functional context taken from the MMTIS regulation (location search, trip plan computation, information provision)
B	Definition	Definition as agreed in §2
C	Reference standard	The standard marked as R in the overlap table
D	Further description based on standard xxx	Description of the contribution of standard xxx to this data category Reference to documentation in Appendix 1
E	Note by standard xxx	**Comment related to the identified overlap** of xxx explaining the reasons why the mapping is relevant or not. This corresponds in most cases to the "note" in the overlap table.
F	Mapping Status	Mapping is meant as the comparison of a Contributing Standard xxx to the Reference Standard done/not relevant done: mapping table completed not relevant: no semantic equivalence with the Reference Standard
G	Recommendations	Recommendations concern the overlap handling Recommendations for NAP data consumers concern mainly the scenario in which all standard formats specified in the Delegated Regulation 2017/1926 are used (scenario 1 described in §4) Recommendations for NAP data providers concern the scenario if overlaps intend to be avoided (scenario 2 described in §4).
H	Comments and	Observations concerning (in most cases) either

	further recommendations	- the mapping or - situations where either no Reference Standard is identified or a gap in standardisation is identified. Recommendations/comments to the Member States and/or the Commission identify the need for further developments.

6.2 Data Categories for which INSPIRE is the reference standard

6.2.1 Overview

Table 11. Data categories for which INSPIRE is the reference standard

Static Spatial Data Category		TRM/NTX	INSPIRE	TAP-TSI	IATA	DATEX
Level of service 1						
Address identifiers	1	C	R	C		C
Topographic Places	2	C	R			C
Points of Interest	3	C	R[33]			
Road network	9	note	R			note

33 for a limited number of typologies of POIs

6.2.2 Address identifiers

1	Data Category: Address identifiers	Description
A	Context	Location search
B	Definition	Locations of properties based on address identifiers, usually by road name, house number, postal code (INS: Addresses)
C	Reference standard	INSPIRE
D	Further description based on INSPIRE	An address is an identification of the fixed location of a property. The full address is a hierarchy consisting of components such as geographic names, with an increasing level of detail, e.g.: town, then street name, then house number or name. It may also include a post code or other postal descriptors. The address may include a path of access but this depends on the function of the address. Documentation: see Appendix 1, Part A.
	Further description based on TRM/NTX	Transmodel provides a data model for ADDRESSES with two specialisations POSTAL ADDRESS and ROAD ADDRESS. NeTEx implements both as a description of Addressable Places. The ROAD ADDRESS is used for all location where no POSTAL ADDRESS is available (not associated to any specific number, etc.), which is the case of most bus stop, for example. ROAD ADDRESS are not entirely covered by INSPIRE. Documentation: see Appendix 1, Part B.
	Further description based on TAP-TSI	TAP- TSI provides postal addresses of rail stations. The postal addresses provided by TAP-TSI are the addresses of locations for railway services (e.g. rail stations, bus stations or ferry terminals). The address contains the postal address of those locations, determined by the city name, the post code and the street address as unstructured address. The provision of the address for railway locations is optional. Documentation: see Appendix 1, Part C.
	Further description based on DATEX	DATEX II provides postal addresses related to parkings and related administrative services in the parking Documentation: see Appendix 1, part D, § 1.5.2
E	Note by INSPIRE	Overlap with: TRM/NTX, TAP-TSI, DATEX All the Contributing standards for Addresses (NeTEx, TAP-TSI and DATEX) feature a large semantic overlap with the Reference standard INSPIRE. Addresses are described using the INSPIRE Address (AD) data theme, whose data model (*fully described in the INSPIRE Technical Guidelines, available at https://inspire.ec.europa.eu/id/document/tg/ad*) is designed to represent all possible address representations at the European level and is more comprehensive and complex than the data models of NeTEx, TAP-TSI and DATEX, except for few attributes of the ROAD ADDRESS Transmodel/NeTEx class not present in the ThoroughfareName INSPIRE class, such as BearingCompass and BearingDegrees. A 1:1 semantic overlap between classes and elements in the data models of each Contributing standard and INSPIRE happens only in few cases, while in most cases one class or attribute of each Contributing standard corresponds to a set of INSPIRE classes and attributes (see the mapping tables provided in Appendix 2).

	Note by TRM/NTX	Transmodel/NeTEx consider several attributes, in particular of ROAD ADDRESS, of specific interest for the transportation domain and not considered by INSPIRE (see mapping tables provided in Appendix 2).
F	Mapping Status	Mapping NeTEx → INSPIRE: provided in Appendix 2 Mapping TAP-TSI → INSPIRE: provided in Appendix 2 Mapping DATEX → INSPIRE: provided in Appendix 2
G	Recommendations	For NAP data providers: NeTEx, TAP-TSI and DATEX datasets where Postal Addresses are needed, should use the INSPIRE data format, by taking guidance from the mapping tables provided in Appendix 2. Wherever Road Addresses are needed the original format should be used. For NAP data consumers: INSPIRE is the only standard providing a comprehensive Postal Address dataset and therefore whenever a Postal Address is needed the INSPIRE dataset should be considered; NeTEx, TAP-TSI and/or DATEX datasets containing a Postal Address should be transformed into the INSPIRE Addresses data format, based on the mapping tables provided in Appendix 2. NeTEx datasets containing a Road Address should be used without transformation. DATEX datasets containing a Road Address should be used without transformation. When a transformation of Road Addresses NeTEx/DATEX is needed, coordinates should be used.
H	Comments and further recommendations	Member States should ensure that the INSPIRE Addresses datasets are discoverable through the NAPs. There is no correspondence between the INSPIRE Addresses IDs and the IDs of Addresses used in the other standards. Recommendation to the MS and the Commission: In order to increase data interoperability across the different standards, MS are encouraged to implement a national strategy related to the reuse of persistent identifiers for spatial objects. This would allow to build lookup tables of Address IDs at national levels.

6.2.3 Topographic Places

2	Data Category: Topographic Places	Description
A	Context	Location search
B	Definition	Names of areas, regions, localities, cities, suburbs, towns or settlements, or any geographical or topographical feature of public or historical interest. (INS: Geographical Names)

C	Reference standard	INSPIRE
D	Further description based on INSPIRE	A geographical name is a proper noun applied to a natural, man-made or cultural feature on Earth. Documentation: see Appendix 1, Part A.
	Further description based on TRM/NTX	Transmodel/NeTEx use the concept of TOPOGRAPHIC PLACE to represent the named settlements and other places to which Public Transport data may be related. A TOPOGRAPHIC PLACE can be located within a COUNTRY. TOPOGRAPHIC PLACEs may overlap. They may also be contained inside another TOPOGRAPHIC PLACE. The purpose of NeTEx is not to publish Topographic Places per se as a dataset. Documentation: see Appendix 1, Part B.
	Further description based on DATEX	DATEX II uses the concept of AreaLocation to represent a location that is an area instead of a point or line, and which is relevant in the context of Road Traffic and Travel Information. An AreaLocation can be a NamedArea, which is conceptually overlapping with the definition of TOPOGRAPHIC PLACE. Documentation: see Appendix 1, part D, paragraph 1.5.3
E	Note by INSPIRE	Overlap with: TRM/NTX, DATEX Due to the different scopes of the specifications, there is a limited overlap between the two Contributing standards for Topographic places (NeTEx and DATEX) with the Reference standard INSPIRE, in particular there are very few cases where a 1:1 semantic overlap between classes and elements was found (see the mapping tables provided in Appendix 2).
F	Mapping Status	Mapping NeTEx → INSPIRE: provided in Appendix 2 Mapping DATEX → INSPIRE: provided in Appendix 2
G	Recommendations	For NAP data providers: INSPIRE should be used to publish Topographic Places; NeTEx and DATEX datasets where Topographic Places are needed, should use the INSPIRE data format and associate it with complementary information possibly present in these datasets, by taking guidance from the mapping tables provided in Appendix 2. For NAP data consumers: INSPIRE is the only standard providing a comprehensive Topographic Place dataset and therefore whenever a Topographic Place is needed the INSPIRE dataset should be considered; NeTEx and/or DATEX datasets containing a Topographic Place should be transformed into the INSPIRE Geographical Names data format, based on the mapping tables provided in Appendix 2.
H	Comments and further recommendations	There is no correspondence between the INSPIRE Geographical Names IDs and the IDs of the Topographic Places used in the other standards. Recommendation to MS and the Commission: In order to increase data interoperability across the different standards,

		MS are encouraged to implement a national strategy related to the reuse of Persistent Identifiers for spatial objects. This would allow to build lookup tables of Topographic Places IDs at national levels.

6.2.4 Points of Interest

3	Data Category: Points of Interest	Description
A	Context	Location search
B	Definition	Types of places to or through which passengers may wish to navigate as part of their journey (TRM/NTX: POINT OF INTEREST)
C	Reference standard	INSPIRE
D	Further description based on INSPIRE	Even though INSPIRE has been identified as Reference standard for Points of Interest data category, there is neither a single reference INSPIRE data theme for this data category nor a set of data themes containing all the categories of Points of Interest comprehensively representing all the possible origins/destinations in Location search services. Rather, INSPIRE offers some data themes whose data models contain spatial objects fitting for purpose with the Points of Interest data category, namely: Utilities and Governmental Services (US), Buildings (BU), and Protected Sites (PS). Documentation: see Appendix 1, Part A.
	Further description based on TRM/NTX	Transmodel provides a data model for POINTs OF INTEREST and describes a POINT OF INTEREST as a type of place to or through which passengers may wish to navigate as part of their journey and which is modelled in detail by journey planners. This means in particular, that a POINT OF INTEREST needs to be recognised by journey planners as an origin/destination of a trip but that this is the main purpose when it is present in a dataset. Although Transmodel allows for a classification of POINTs OF INTEREST, NeTEx does not implement specific standard typology, However, in principle, POIs may be published using NeTEx. Documentation: see Appendix 1, Part B.
E	Note by INSPIRE	INSPIRE can be considered as Reference standard only for a limited set of POIs categories (Utilities and Governmental Services (US), Buildings (BU), and Protected Sites (PS)), each of which has its own specific data model. Given these limitations as well as those outlined above for TRM/NTX, the overlap analysis with Transmodel was not carried out.
	Note by TRM/NTX	Although a classification of POIs is taken into account in Transmodel, NeTEx does not prescribe any typology of POIs and thus the correspondence to INSPIRE is not straightforward. The fact that there is no predefined typology in NeTEx makes it difficult to map to existing INSPIRE data models for POIs but also allows to describe POIs that could not be described by INSPIRE (e.g. leisure, entertainment, etc).
F	Mapping Status	Mapping NeTEx → INSPIRE: not relevant
G	Recommendations	For NAP data providers: INSPIRE should be used to publish POIs for the types present in INSPIRE (Buildings, Protected Sites, Utilities and Governmental Services); however, different levels of completeness (level of detail and scope) of these three types of POIs should be considered; NeTEx should be used to publish POIs for the types not present in INSPIRE (in particular leisure, entertainment, historic monuments, etc.)

		For NAP data consumers: The consumers should use coordinates (if available) to identify any correspondence between the INSPIRE POIs and NeTEx POIs.
H	Comments and further recommendations	INSPIRE is chosen as the reference standard for Points of Interest only for a limited number of categories: Utilities and Governmental Services (US)[34], Buildings (BU)[35] and Protected Sites (PS)[36]. Recommendation to the Commission: 1. The overall typology of Points of Interest should be standardised[37]. 2. Parking may be considered as a POI. The functional scope of both NeTEx and DATEX II is very extensive with regard to Parking and goes beyond the scope of this project. Work is ongoing in a different form to complete the mapping in combination with an effort to align and harmonise the standards involved. In addition, a reference standard should be appointed at least as regards the Parking layout structure for personal vehicles in order to avoid double publication. This work should be brought to a satisfactory outcome within a well defined framework.

34 INSPIRE US data specifications are available at https://inspire.ec.europa.eu/id/document/tg/us
35 INSPIRE BU data specifications are available at https://inspire.ec.europa.eu/id/document/tg/bu
36 INSPIRE PS data specifications are available at https://inspire.ec.europa.eu/id/document/tg/ps
37 Investigation of the OSM typology should be considered.

6.2.5 Road network

9	Data Category: Road network	Description
A	Context	Trip plan computation
B	Definition	Link and node structure to represent a road system used for the transportation of vehicles in the form of a linear network (INS: Road Transport Network)
C	Reference standard	INSPIRE
D	Further description based on INSPIRE	The primary aspects modelled for road network elements are: - Spatial. Geometric (point, line and area (topographic)) representation of various elements that are parts of a network. Typically, the network is handled as a network of connected linear elements (links) with points (nodes) at the ends of the lines (at junctions, road ends, etc). Also real objects with a function in a network may be represented in the dataset. Network connectivity within the roads network is essential but between elements in the other networks is an optional spatial aspect. - Temporal. All elements in a network may have a temporal validity (i.e. description of when the network element exists in the real world) and also optional information on when data was entered, modified or deleted in the dataset. - Thematic. The road schema can be thematically displayed via several of the attributes defined within the specification. The three aspects are relevant to the physical infrastructure representing the road network. Documentation: see Appendix 1, Part A.
	Further description based on TRM/NTX	Transmodel takes the road network explicitly into account only as far as this impacts the operation of Public Transport vehicles (e.g. meeting or overtaking restrictions on a ROAD ELEMENT). Transmodel does not cover the road network as such. The Transmodel public transport network has to be understood as the service network, i.e. determined by points and links dedicated to public transport services (stopping, timing registration, etc.). However, the link with infrastructure (rail-, road- and wire-network) is represented through the definition of the projection mechanism: a correspondence between objects from a service layer to the infrastructure layer (e.g. correspondence (called projection) of a stop point with a point on a road element). Documentation: See Transmodel Part 2, chapter 5.3.2 - Infrastructure Network - Conceptual Model.
	Further description based on DATEX	DATEX II enables the provision of information about traffic situations, traffic status and traffic affecting events. To define the location of these road traffic related information elements, several location referencing standards are supported (Alert-C location referencing (RDS-TMC), TPEG, OpenLR, Linear referencing, GML, and x,y,(z) coordinates). The ones operationally used are determined by the operational requirements of the data provider. In operation three operational use cases for location information are identified:

		- human readable textual location information - "easy" display on a digital map - processable in automated routing/navigation algorithms (in combination with the impact of the provided information on the trip) in more advanced ITS systems. The use of DATEX II assumes both the data provider and the data consumer to have (access to a maintained) a digital administration of the road network that is able to fulfil the requirements from one of the above use cases. Documentation: • CEN ISO/TS 18234-6:2006, Traffic and Travel Information (TTI) — TTI via Transport Protocol Expert Group (TPEG) data-streams — Part 6: Location referencing application (ISO/TS 18234-6:2006) • CEN ISO/TS 24530-2:2006, Traffic and Travel Information (TTI) — TTI via Transport Protocol Experts Group (TPEG) Extensible Markup Language (XML) — Part 2: tpeg-locML (ISO/TS 24530-2:2006) • EN ISO 14819-3:2013, Intelligent transport systems — Traffic and travel information messages via traffic message coding — Part 3: Location referencing for Radio Data System – Traffic Message Channel (RDS-TMC) using ALERT-C (ISO 14819-3:2013) • EN ISO 19148:2012, Geographic information — Linear referencing (ISO 19148:2012) • ISO/TS 21219-22, Intelligent transport systems — Traffic and travel information (TTI) via transport protocol expert group, generation 2 (TPEG2) —- Part 22: OpenLR location referencing (TPEG2-OLR):**[1]** • EN ISO 19136:2009, Geographic information — Geography Markup Language (GML) (ISO 19136:2007) ● EN 16803-1:2016, Space - Use of GNSS-based positioning for road Intelligent Transport Systems (ITS) – Part 1: Definitions and system engineering procedures for the establishment and assessment of performances ● ETSI TS 102 894-2, Intelligent Transport Systems (ITS); Users and applications requirements; Part 2: Applications and facilities layer common data dictionary (v.1.2.1 – 2014-09) ● ISO 3166-2:2013, Codes for the representation of names of countries and their subdivisions – Part 2: Country subdivision code --- [1] Note: this standard is closely related to OpenLR dynamic location referencing method which enables reliable data exchange and cross-referencing using digital maps of different vendors and versions. See https://openlr.org
E	Note by INSPIRE	There is a very limited semantic overlap with NeTEx and DATEX; thus, mapping is not relevant.
	Note by TRM/NTX	A global link between the public transport service network layer and the infrastructure (e.g. road) layer is described through a generic correspondence between spatial data layers, without modelling this correspondence to the INSPIRE road network. The physical mapping is not elaborated within this project.

	Note by DATEX	The class LocationReference in DATEX II is the only concept linking objects to be located in space to a possible road network. However, a direct link to the INSPIRE road network is not modelled by DATEX II and thus there is no overlap identified. Linking the datasets is the responsibility of the data consumers.
F	Mapping Status	Mapping NeTEx → INSPIRE: not relevant Mapping DATEX → INSPIRE: not relevant
G	Recommendations	**For data NAP providers/consumers:** INSPIRE Road network datasets should be used.
H	Comments and further recommendations	The explicit link between the Transmodel/NeTEx service network model and the INSPIRE infrastructure network model is missing. Recommendation to the Commission: The link between the Transmodel/NeTEx service network and the INSPIRE infrastructure network should be modelled[38].

38 potentially in a similar manner to the link Transmodel/GDF. GDF is an ISO standard initiated by CEN covering the overall road description and its usage.

6.3 Data Categories for which Transmodel/NeTEx is the reference standard

6.3.1 Overview

Table 12. Data categories for which NeTEx is the reference publication standard

Static Spatial Data Category		TRM/NTX	INSPIRE	TAP-TSI	IATA	DATEX
Level of service 1						
Identified access nodes	4	R	C[39]	C	C	
Geometry/map layout-structure of access nodes	5	R				
Connection links	6	R	note	C	note	
Netw. Topology & Routes/Lines (topology) [40]	7	R	note	C[41] note	C	
Stop facilities access nodes	8	R		note		
Level of service 2						
Park & Ride stops	12	R[42]		C[43] note		C
Bike sharing stations	13	R[44]				
Car-sharing stations	14	R[45]				C
Secure bike parking (such as locked bike garages)	16	R[46]				
Where to buy tickets	17	R		C note	note	C[47] note
Fare network data (fare zones/stops and fare stages)	18	R		C[48] note		

39 for air/rail only
40 this data category concerns the transport service network, the transport infrastructure network is provided by INSPIRE
41 Contributing standard only for Service Patterns (no Routes, Lines)
42 Transmodel extension carried out in CEN TC278 WG17, submitted to Formal Vote.
43 Parking&station accessibility
44 Transmodel extension carried out in Reference data model provided in "Urban ITS - Models and definitions for new modes", CEN TC278 WG17, submitted to Formal Vote
45 Transmodel extension carried out in Reference data model provided in "Urban ITS - Models and definitions for new modes", CEN TC278 WG17, submitted to Formal Vote
46 Transmodel extension carried out in Reference data model provided in "Urban ITS - Models and definitions for new modes", CEN TC278 WG17, submitted to Formal Vote
47 only for parking
48 Refuelling Infrastructure Publication not published standard

6.3.2 Identified Access Nodes

4	Data Category: Identified Access Nodes	Description
A	Context	Location search
B	Definition	Topological aspect: Zero-dimensional nodes of the network (that may be located by coordinates in a particular Coordinate Reference System) used for the spatial description of the network, where passengers can board or alight from vehicles (TRM/NTX: SCHEDULED STOP POINT) Geographical aspect: Places comprising one or more locations where vehicles may stop and where passengers may board or leave vehicles or prepare their trip (TRM/NTX: STOP PLACE)
C	Reference standard	Conceptual Model: Transmodel Publication format: NeTEx
D	Further description based on TRM/NTX	Transmodel describes on one hand the SCHEDULED STOP POINTs, on the other hand the detailed structure and components of STOP PLACEs. The model describes also the link between both aspects: a SCHEDULED STOP POINT may be assigned to a whole STOP PLACE or to particular components of a STOP PLACE (quay, boarding position). A STOP PLACE may be multimodal (e.g. for the air MODE it represents an airport). The NeTEx European profile provides datasets of Stop Places which may be related to Scheduled Stop Points. Documentation: see Appendix 1, Part B.
	Further description based on TAP-TSI	The TAP-TSI EDIFACT exchange protocol allows the description and exchange of a very basic structure of access nodes. Documentation: see Appendix 1, Part C
	Further description based on IATA AIDM	The AIDM data model provides the description of a very basic structure of access nodes.
E	Note by TRM/NTX	TRM/NTX overlaps with INSPIRE, TAP-TSI and IATA Mapping INSPIRE → NeTEx: not relevant because of difference of scope Mapping TAP-TSI → NeTEx: limited to name, identifier and location Mapping IATA→ NeTEx : because of a different granularity of the data models only a high level (class level) comparison is possible.
	Note by TAP-TSI	Additional information about the accessibility of access nodes may be given in the future by the implementation of the Inventory of assets, a database required by the revised regulation (EU) 1300/2014 (PRM TSI) to provide data about the accessibility of railway stations. The proposed data format is NeTEx. The revised regulation for this is still in draft status, therefore not applicable for the time being. TAP-TSI and IATA Access Node publication provides only a limited information concerning this data category useful for traveller information. The information given is limited to location name (if available in several languages), identifier and location coordinates.

	Note by INSPIRE	Road & Cable & Water: INSPIRE is NOT considered as Contributing Standard Air: There is an overlap between INSPIRE and IATA: The INSPIRE class TransportNode has a meaningful Subtype AerodromeNode representing the whole airport and has an IATA and ICAO code. Rail: A possible overlap between INSPIRE and TAP-TSI/NeTEx is related to the INSPIRE attribute RailwayStationCode (more details are provided in Appendix 1).
E	Note by IATA	The IATA Station is not a geospatial concept, so the inclusion of the IATA code in INSPIRE provides a useful correlation between this logical location of a Station (or airport) and the INSPIRE geospatial equivalent. It should be noted that where there is insufficient commercial activity, an airport may not have an IATA code. In these cases an ICAO code will likely exist.
F	Mapping Status	Mapping INSPIRE → NeTEx: not relevant Mapping TAP-TSI → NeTEx: provided in Appendix 2 Mapping IATA → NeTEx: only an initial comparison is available in Appendix 2
G	Recommendations	**For NAP data providers** **(Road & Cable & Water):** NeTEx Access Nodes datasets should be used as there is no semantic overlap with other standards. **(Air):** For NeTEx data providers: STOP PLACE code should have the value of the IATA code for the air MODE. For TAP-TSI data providers: « Rail Location Codes » (former UIC) should be completed with a IATA code where commercial agreements between the involved parties exists. This is usually the case where a rail station is attributed with an additional IATA code (e.g. Brussels-Midi with the IATA code ZYR) for air-rail products. **Caveat:** the conversion of IATA Access Nodes to NeTEx following an IATA approved conversion of the initial comparison of "AIDM to NeTEx" to an agreed mapping specification is necessary. **Under these conditions, NeTEx publication of STOP PLACEs (for the air MODE) should be used.** **For NAP data providers & for data consumers*:*** The IATA code should be used to link the Access nodes for air. INSPIRE should be used for complementary information[49] of the airport **(Rail)** - "Railway Location - primary Code" (as specified in TAP-TSI technical document B.9, known as UIC location code) should be used to relate the

49 related to the physical infrastructure of the airport

		Access Nodes for rail as a link provided it is used by the other standards. - INSPIRE should introduce the « Railway Location - primary Code » in the RailwayStationCode - Transmodel/NeTEx should introduce the « Railway Location - primary Code » in the STOP PLACE code - TAP-TSI should convert Access Nodes to NeTEx (using the "TAP-TSI to NeTEx" mapping) to get a NeTEx representation. A publication in the TAP-TSI data formats (TAP-TSI technical document B.4) is allowed as well by the regulation. If not done by the provider, the mapping can be done at the NAP level. Note that this conversion should be done together with the timetables conversion in order to avoid any merging need with existing data. **NeTEx should be used for the publication under the conditions above.** **For NAP data consumers** Converters (to the NeTEx format) based on the mapping tables (Appendix 2) and coordinates should be built.
H	Comments and further recommendations	**Recommendation to the MS:** The ID coding rule for the Access Nodes as defined in the NeTex Passenger Information European Profile should be adopted. **Comment to IATA and the Commission:** As regards the IATA model, further work is required to get a comprehensive model and mapping to the Reference standard.

6.3.3 Geometry/map layout structure of access nodes

5	Data Category: Geometry/map layout structure of access nodes (Schematic Map)	Description
A	Context	Location search
B	Definition	A map representing schematically the layout of the topographic structure of places or the public transport network (e.g. a set of lines). (TRM/NTX: SCHEMATIC MAP)
C	Reference standard	Conceptual Model: Transmodel Publication format: NeTEx
D	Further description based on TRM/NTX	Schematic Maps provide an "easy to read" overview of Access Nodes and Network Topology. Documentation: see Appendix 1, part B.
E	Note by TRM/NTX	No overlaps with considered standards.
F	Mapping Status	not relevant (see above)
G	Recommendations	**For NAP data providers**: NeTEx shall be used for the publication of "Geometry/map layout structure of access nodes". **For NAP data consumers**: none, as a unique standard is used for publication.
H	Comments and further recommendations	See the recommendation for the Network Topology and Road Network data categories.

6.3.4 Connection links where interchanges may be made

6	Data Category: Connection Links	Description
A	Context	Trip plan computation
B	Definition	topological aspect: Couples of places located sufficiently near that it may represent for a passenger a possibility to reach one of these points when starting at the other one in a timescale which is realistic when carrying out a trip. (TRM/NTX: TRANSFER and its specialisations CONNECTION, SITE CONNECTION, DEFAULT CONNECTION) geographical aspect: Designated paths between two places, which may include an ordered sequence of links within a place or between two places that represents a step in a possible route for pedestrians, cyclists or other out-of-vehicle passengers (TRM/NTX: NAVIGATION PATH)
C	Reference standard	Conceptual Model: Transmodel Physical Model: NeTEx
D	Further description based on TRM/NTX	Transmodel/NeTEx represent the multimodal service network and thus, a connection is considered from the point of view of a passenger, allowing the travellers a transfer either between two different modes or between two different vehicles in order to carry out a trip within a realistic timescale. Note that TRANSFER (and thus CONNECTION) is actually not a purely space-related concept as its attributes contain time characteristics. Documentation: see Appendix 1, Part B.
	Further description based on TAP-TSI	The TAP-TSI contains descriptions for connections between rail locations and connections with time characteristics between railway services (e.g. specific trains). The connections can be defined as default minimum connection times within a station and as connection times between different locations (e.g. two railway stations or platforms). Documentation: see Appendix 1, Part C
	Further description based on IATA	The concept of Minimum Connection Times ('MCT') is supported by IATA. MCTs are observed by all ticketing and reservations outlets and are used by automated reservation systems. Thus MCTs are correctly established, updated, uniformly quoted and used at all times. In a passenger context, MCT is defined as the shortest time interval required in order to transfer a passenger and their luggage from one flight to a connecting flight, in a specific location or metropolitan area. MCTs are not currently modelled in AIDM but will be included at a later date. It is important to note that an MCT only exists in the context of an offer of a commercial ticket that connects one or more flights.
E	Note by TRM/NTX	There is an overlap with TAP-TSI - see Appendix 1 data model documentation. (TAP-TSI connection is considered there as comparable to an interchange)

	Note by INSPIRE	INSPIRE allows to model Network Connections as 'logical connections between two or more network elements in different networks', which represent connections between infrastructure networks. The overlap with NeTEx is therefore not present because of the different scope of INSPIRE (more details are provided in Appendix 1).
	Note by IATA	The mapping is not provided: the corresponding AIDM model part is under development.
F	Mapping Status	Mapping TAP-TSI → NeTEx: provided in Appendix 2
G	Recommendations	**For NAP data providers**: use NeTEx for publication of Connection Links **For NAP data providers/consumers**: the mapping TAP-TSI → NeTEx provides guidance to build a converter.
H	Comments and further recommendations	_

6.3.5 Network Topology & Routes/Lines (topology)

7	Data Category: Network Topology	Description
A	Context	Trip plan computation
B	Definition	Service topology determined by routes, lines and service patterns (TRM/NTX: ROUTE, LINE, SERVICE PATTERN)
C	Reference standard	Conceptual Model: Transmodel Physical Model: NeTEx
D	Further description based on TRM/NTX	Transmodel and NeTEx provide a comprehensive description of the Network Topology which represents the service (see NeTEx Part 1 and Transmodel Part 1&2 for a full description). Documentation extract: see Appendix 1, Part B.
	Further description based on TAP-TSI	TAP-TSI provides the service network of Service Patterns only. The service pattern covers the public timetable of a given service (train, bus) and services offered in this service. Only the stations served by the service and the corresponding timing is indicated.
	Further description based on IATA	IATA AIDM provides the network of Operating Segments composed of Operating Legs with their associated timing (Detailed in Transport Departure/Transport Arrival).
E	Note by TRM/NTX	Overlap with TAP-TSI and IATA TAP-TSI network topology has been fully mapped to NeTEx: any single TAP-TSI concept can be hosted by NeTEx (the reverse is not true). Overlap with IATA: a mapping is not provided, a preliminary comparison is started (Appendix 2) There is no overlap with INSPIRE: INSPIRE supports the **topology of the infrastructure network**. Transmodel/NeTEx support the topology of the service network. The purpose/scope of the 2 specifications is different and thus there is no semantic equivalence.
	Note by INSPIRE	INSPIRE provides a comprehensive description of the network infrastructure (road, rail, water, air) but not of the service network which is how the PT network uses the infrastructure to provide a service. INSPIRE can complement the projection of the Transmodel/NeTEx Network Topology (service network) on the infrastructure. Moreover, INSPIRE may allow to provide network functional representations, in which symbolic straight lines connect nodes corresponding to physical locations. Further details are provided in Appendix 1.
F	Mapping Status	Mapping TAP-TSI → NeTEx: done (see Appendix 2) Mapping IATA→ NeTEx: only an initial comparison provided (see Appendix 2)

G	Recommendations	For NAP data providers: NeTEx Network Topology publication should be used. For TAP-TSI: a converter should be built taking guidance from the mapping table provided in Appendix 2. For IATA: the data model and publication format is under development. For NAP data consumers: NeTEx, TAP-TSI may use their standards for publication. The IATA model and publication format is under development The mapping TAP-TSI→ NeTEx provides guidance to build a converter.
H	Comments and further recommendations	Recommendation to the Commission/data providers: the link between Network Topology (i.e. "service network") and the "infrastructure network" (as published by INSPIRE) should be carried out using the Transmodel/NeTEx projection mechanism (additional processing effort), described in Transmodel Part 1- Chapter 5.5.7 . This recommendation is symmetrical to the one provided for the Road Network. See also Road Network Data category. Comment to IATA and the Commission: As regards the IATA model, further work is required to get a comprehensive model and mapping to the Reference standard.

6.3.6 Stop facilities access nodes (including platform information, help desks/information points, ticket booths, lifts/stairs, entrances and exit locations)

8	Data Category: Stop Facilities	Description
A	Context	Location search
B	Definition	Types and locations of fixed equipment or facilities related to access nodes (TRM/NTX: FACILITY, EQUIPMENT, EQUIPMENT PLACE)
C	Reference standard	Conceptual Model: Transmodel Publication format: NeTEx
D	Further description based on TRM/NTX	Transmodel describes the equipment related to Sites and equipment location within the Site. A set of facilities (without a precise location within the Site itself) is also related to a Site. NeTEx: Facilities are already included in the Passenger Information Profile but the equipment will be part of the future profile dedicated to Stop Place and Accessibility. Documentation; see Appendix 1, Part B
E	Note by TRM/NTX	No overlapping standard
	Note by TAP-TSI	TAP-TSI is currently providing only a limited set of additional information concerning the stop facilities (e.g. opening hours, ticketing services). For information concerning the accessibility of a station, the revised Commission Regulation (EU) No 1300/2014 (PRM TSI) requires the set-up of a so called inventory of assets, containing more detailed information about the accessibility of railway stations. This inventory will be set-up in the next years and is based on NeTEx.
F	Mapping Status	Mapping not relevant
G	Recommendation	For NAP data providers/consumers: NeTEx Passenger Information Profile should be used.
H	Comments and further recommendations	The Stop Place and Accessibility profile is missing (planned) **Recommendation for the Commission:** the development of the Stop Place and Accessibility profile should be confirmed taking into account the deadlines of the Regulation.

6.3.7 Park & Ride stops

12	Data Category: Park & Ride stops	Description
A	Context	Location search
B	Definition	Location dedicated to travellers allowing them a dedicated modal transfer, in particular to leave/pick up their vehicles before/after a trip on public transport (URBAN ITS - Models and Definitions for New Modes)
C	Reference standard	Conceptual Model: extension of Transmodel provided by CEN TC278 WG17 Publication format: in development
D	Further description based on TRM/NTX	Description provided in "URBAN ITS- Models and Definitions for New Modes" Standardisation effort ongoing[50]. In order to describe the park & ride activity, the concept of SITE CONNECTION is used of which one end is the PARKING (of the type dedicated to the park and ride activity, i.e. a PARKING organised to ease the modal transfer to public transport) and the other end is a STOP PLACE. Documentation: "URBAN ITS - Models and Definitions for New Modes", 2019, CEN TC278 WG17.
	Further description based on DATEX	In DATEX II a Park&Ride stop is a possible parking usage scenario of a ParkingSite. It is characterised by 1 value of an attribute called parkingUsageScenario in the ParkingTable Publication of DATEX II (CEN TS16157 part 6). Part 6 is in the process of systematic review and is voted to become an EN in 2019 after processing the received comments. Documentation: see Appendix 1, part D, paragraph 1.5.5
	Further description based on TAP-TSI	TAP-TSI identifies rail stations with the P&R facility. This information can be provided once the inventory of assets for the accessibility information is available. The dataset will be based on NeTEx.
E	Note by TRM/NTX and DATEX	The extension of Transmodel dedicated to "park & ride" is based on the Transmodel/NeTEx parking model, in particular the parking layout structure. This model is not harmonised with DATEX for the time being, although the scope of this part of the model is similar in both standards. The models are both rather extensive with a substantial semantical equivalence for a big part of the model, e.g. Parking Layout Structure. Mapping of the complete models does not fit in the scope of the work of this project. Nevertheless it is identified by both stakeholder communities of DATEX II and Transmodel that it is worthwhile to harmonise the overlapping parts of the standard (or at least to carry out the mapping). Therefore the mapping of the Parking Layout Structure between Transmodel and DATEX

50 Data model developed and an extension of Transmodel (currently under formal vote). Project submitted to develop the publication format as an extension of NeTEx.

		is under way in a different joint setting, with contributions of the parking industry. The result of this work will be extensive mapping between the standards and recommendations to the editors of the standards for modifications to achieve harmonised (parts of) models, enabling documented interoperability
	Note by TAP-TSI	This information may be provided, once the inventory of assets for the accessibility information is available. The dataset will be based on NeTEx.
F	Mapping Status	Started for the Parking Layout Structure
G	Recommendation	The situation of the 2 competing data models should be considered and a decision should be taken for harmonisation or mapping - see below.
H	Comments and further recommendations	The presence of 3 data models (Transmodel, DATEX and a data model developed by the Parking Industry ADPS) generates overlaps. Recommendation to the Commission: 1. The situation of the 2 (or 3) competing data models should be considered and a decision should be taken for harmonisation or mapping. 2. The harmonisation of Parking Layout Structure should be provided to allow for a common representation of the Park & Ride Stops and other topological elements related to alternative modes operation. 3. The implementation of the data model for the "New Modes" shall be developed (project Alternative Modes API submitted to the EC through CEN TC278 WG17) according to the CEN. Rolling Plan 2019 and the recommendation of the Mandate 456.

6.3.8 Bike sharing stations

13	Data Category: Bike sharing stations	Description
A	Context	Location search
B	Definition	A dedicated location (part of a parking) for short term cycle rental (cycle sharing) where the cycle can be taken from and parked and which is composed of one or more places to park an individual cycle. (based on Urban ITS- Definitions and Models for New Modes)
C	Reference standard	Conceptual Model: extension of Transmodel provided by CEN TC278 WG17 Publication format: in development
D	Further description	Standardisation effort ongoing[51]This data category is modelled as a dedicated part of a parking area for cycle sharing, composed of one or more parking spots. Description provided in "URBAN ITS - Models and Definitions for New Modes", 2019, CEN TC278 WG17.
E	Note	No overlapping standard publication
F	Mapping Status	Not relevant
G	Recommendations	For data providers/consumers: Publication format shall be used based upon the Conceptual Model developed as an extension of Transmodel This format is planned to be provided by CEN TC278 WG17 (mid 2020)
H	Comments and further recommendations	

51 Data model developed and an extension of Transmodel (currently under formal vote). Project submitted to develop the publication format as an extension of NeTEx.

6.3.9 Car-sharing stations

14	Data Category: Car sharing stations	Description
A	Context	Location search
B	Definition	A dedicated location (part of a parking) for short term car rental (car sharing) where the car can be taken from and parked and which is composed of one or more places to park an individual car (based on Urban ITS- Definitions and Models for New Modes).
C	Reference standard	Conceptual Model: extension of Transmodel provided by CEN TC278 WG17 Publication format: in development
D	Further description based on TRM/NTX	Standardisation effort ongoing[52] Description provided in "Models and Definitions for new Modes". This data category is modelled as a dedicated part of a parking area for cycle sharing, composed of one or more parking spots. Description provided in "URBAN ITS- Models and Definitions for New Modes", 2019, CEN TC278 WG17.
	Further description based on DATEX	In DATEX II a Park&Ride stop is a possible parking usage scenario of a ParkingSite. It is characterised by 1 value of an attribute called parkingUsageScenario in the ParkingTable Publication of DATEX II (CEN TS16157 part 6). Part 6 is in the process of systematic review and is voted to become an EN in 2019 after processing the received comments. Documentation: see Appendix 1, part D, paragraph 1.5.5
E	Note	Overlap with DATEX: this overlap is a consequence of the overlapping data models for Parking.
F	Mapping Status	Ongoing
G	Recommendations	The situation of the 2 competing data models should be considered and a decision should be taken for harmonisation or mapping - see below.
H	Comments and further recommendations	See recommendation for the Park & Ride Stops.

6.3.10 Secure bike parking (such as locked bike garages)

16	Data Category: Secure bike parking	Description
A	Context	Location search
B	Definition	A parking location for cycles including specific facilities and/or services

52 Data model developed and an extension of Transmodel (currently under formal vote). Project submitted to develop the publication format as an extension of NeTEx.

		providing safety to cycles. (based on TRM/NTX: EQUIPMENT PLACE of CYCLE STORAGE EQUIPMENT)
C	Reference standard	Conceptual Model: Transmodel Publication format: NeTEx
D	Further description based on TRM/NTX	This information is considered as a fixed equipment with a location. Documentation: see Appendix 1, Part B
E	Note	No overlapping standard publication
F	Mapping Status	Not relevant
G	Recommendations	-
H	Comments and further recommendations	Recommendation to the Commission: The Work Item "Alternative Modes API" as the implementation of the "Urban ITS – Models and definitions for New Modes" model should be considered and started (cf. Rolling Plan 2019 and Mandate 546). At this occasion the facility code list should be extended to enable the consideration of this data category as a facility linked to parking areas.

6.3.11 Where to buy tickets

17	Data Category: Where to buy tickets	Description
A	Context	Information service
B	Definition	Locations (physical or on-line) of ticketing service. (TRM/NTX: EQUIPMENT PLACE related to TICKETING EQUIPMENT)
C	Reference standard	Conceptual Model: Transmodel Publication format: NeTEx
D	Further description based on TRM/NTX	Considered as equipment (Ticketing Equipment) and its location. Documentation: see Appendix 1, Part B.
	Further description based on DATEX II	For DATEX II this data category limits to Where to buy tickets for parking. In the DATEX II ParkingTable publication, the class parking equipment or service facilities is defined, specialising in Equipment, having the attribute equipmentType, in which paydesk and the payment machine are possible literal values. Such an equipment or facility may have a location, specific to that object. Documentation: see Appendix 1, part D, paragraph 1.5.6
E	Note by TRM/NTX	Overlap with TAP-TSI, DATEX
	Note by TAP-TSI	TAP-TSI may provide information about ticket offices and travel agencies. They are identified by their location code.
	Note by IATA	IATA AIDM may provide the IATA Airport Code or City code of the travel agency issuing the ticket, however no geospatial data is provided.
F	Mapping Status	Not provided within the timescale of the project
G	Recommendation	**For data providers/consumers**: NeTEx should be used
H	Comments and further recommendations	Observation: there is no EU NeTEx Fares Profile available **Recommendation to the Commission:** the development of the EU NeTEx Fares Profile should be considered. **Recommendation to the Commission:** the Work Item "Alternative Modes API" as the implementation of the model "Urban ITS – Models and Definitions for New Modes" should be considered and started (cf. Rolling Plan 2019 and Mandate 546). **Recommendation to the Commission/Member States:** The mapping between the overlapping standards (NeTEX and TAP-TSI, DATEX) should possibly be considered and clarified.

6.3.12 Fare network data (fare zones/stops and fare stages)

18	Data Category: Fare network data	Description

A	Context	Trip plans, auxiliary information, availability check
B	Definition	Tariff zones used to define a zonal fare structure in a zone-counting or zone-matrix system and/or if applicable, fare zones composed of fare sections built of consecutive points used to define elements of the fare structure (TRM/NTX: TARIFF ZONE, FARE ZONE, FARE SECTION)
C	Reference standard	Conceptual Model: Transmodel Publication format: NeTEx
D	Further description	See Appendix 1 & documentation in Transmodel Part 1&5 and NeTEx Part 3
E	Note by NeTEx	Overlap with TAP-TSI
	Note by TAP-TSI	A mapping between TAP-TSI and NeTEx is available.
F	Mapping Status	Mapping TAP-TSI → NeTEx described
G	Recommendations	For data providers/consumers: Use NeTEx for Fare Network Data publication
H	Comments and further recommendations	Recommendation to the Commission: The development of the EU NeTEx Fare Profile should be considered.

6.4 Data Categories without reference standard

6.4.1 Gaps in standardisation

Two types of gaps in standardisation have been identified:

a. Addressed gaps: the standard is elaborated but not yet published (e.g. in the commenting/formal vote period) or planned to be developed.

This is the case of the following data categories:

- Park and Ride Stops
- Bike sharing Stations
- Car sharing stations

b. Non-addressed gaps: the Project Team is not aware of a plan to develop the standard for:

- Points of Interest for types different than those foreseen by INSPIRE
- Points of Interest typology: OSM may be a source for the categorisation of POIs for the implementation within NeTEx. Then a mapping/complementarity with INSPIRE should be investigated
- Cycle network with the required characteristics
- Pedestrian network with accessibility facilities
- Link of the service network (Transmodel) with the infrastructure network (INSPIRE)
- Link of the schematic map (Transmodel) with the infrastructure network (INSPIRE).

6.4.2 Absence of a reference standard

The absence of a Reference Standard is the case when two or more standards are efficiently contributing to a particular Data Category. This is the case for the following Data Categories:

- Parking (considered as particular Points of Interest): Transmodel/NeTEx is proposed as a potential reference for spatial information. However, no formal agreement is met with neither DATEX nor the Parking Alliance (both providing models).

For detailed information of the parking model in DATEX II see Appendix 1, part D, paragraph 1.5.4.

- Publicly accessible refuelling stations & charging stations for electric vehicles

In DATEX II this is work in progress, to be published as CEN standard in 2019.

The available draft documentation: see Appendix 1, part D, paragraph 1.5.7

- Where (and how) to pay for car parking, public charging stations for electric vehicles and refuelling points.

In DATEX II the parking part is in the regular model.

The available draft documentation: see Appendix 1, part D, paragraph 1.5.4

For public charging stations for electric vehicles and refuelling points:

this is work in progress, to be published as CEN standard in 2019.

The available draft documentation: see Appendix 1, part D, paragraph 1.5.7

7 Conclusions

Three workshops have been held to present to the Member States and the Commission the progress of this study (April 2018, November 2018 and March 2019). At the last workshop (Brussels, 27 March 2019) the project team presented the following conclusions:

- Current standards are sufficient to start implementation of the Delegated Regulation EU 2017/1926,
- Several recommendations show that further work is necessary (gaps in standardisation, need for European profiles and for conversion tools),
- The establishment of the link between actions proposed by the experts' group and the EC workplan may be of benefit,
- Similar investigations may be led for data categories not considered in this project (e.g. time-related information, dynamic information).

References

INSPIRE

INSPIRE Directive

DIRECTIVE 2007/2/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE)

https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32007L0002&from=EN

As regards Transport Networks data models:

D2.10.1: INSPIRE Data Specifications – Base Models – Generic Network Model, Version 1.0rc3 https://inspire.ec.europa.eu/documents/inspire-data-specifications-%E2%80%93-base-models-%E2%80%93-generic-network-model

D2.5: Generic Conceptual Model, Version 3.4

https://inspire.ec.europa.eu/documents/inspire-generic-conceptual-model

D2.8.I.7 Data Specification on Transport Networks – Technical Guidelines

https://inspire.ec.europa.eu/id/document/tg/tn

Agreed changes to the INSPIRE Technical Documentation for "D2.8.I.7 Data Specification on Transport Networks – Technical Guidelines" version 3.2

https://inspire.ec.europa.eu/id/document/tg/tn

Links to UML data models, gml application schemas (xsd), matching tables of the Transport networks theme

https://inspire.ec.europa.eu/Themes/115/2892

As regards metadata:

COMMISSION REGULATION (EC) No 1205/2008 of 3 December 2008 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards metadata

http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008R1205&from=EN

Technical Guidelines for implementing dataset and service metadata based on ISO/TS 19139:2007

https://inspire.ec.europa.eu/id/document/tg/metadata-iso19139

As regards network services:

COMMISSION REGULATION (EC) No 976/2009 of 19 October 2009 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards the Network Services, amended by Commission Regulation (EU) No 1088/2010 of 23 November 2010

http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02009R0976-20101228&from=EN

Technical Guidance for the implementation of INSPIRE Download Services

https://inspire.ec.europa.eu/documents/technical-guidance-implementation-inspire-download-services

Technical Guidance for the implementation of INSPIRE Discovery Services

https://inspire.ec.europa.eu/documents/technical-guidance-implementation-inspire-discovery-services-0

Technical Guidance for the implementation of INSPIRE View Services

https://inspire.ec.europa.eu/documents/technical-guidance-implementation-inspire-view-services-1

Transmodel

Transmodel V6.0 (http://www.transmodel-cen.eu/), the Public Transport Reference Data Model, splits into 8 parts:

Part 1: Common Concepts,

Part 2: Public Transport Network,

Part 3: Timing Information/Vehicle Scheduling,

Part 4 : Operations Monitoring & Control,

Part 5 : Fare Management,

Part 6 : Passenger Information,

Part 7 : Driver Management,

Part 8: Management Information & Statistics.

Relevant for this study are in particular the following documents:

EN12896-1:2016, Public Transport Reference Data Model - Part 1: Common Concepts,

EN12896-2:2016, Public Transport Reference Data Model - Part 2: Public Transport Network,

EN12896-2:2016, Public Transport Reference Data Model - Part 3: Timing Information and Vehicle Scheduling,

EN12896-5 (under publication in 2019), Public Transport Reference Data Model - Part 5: Fare Management.

NeTEx

NeTEx (http://netex-cen.eu/) is data exchange standard for public transport network, timetables and fares (static information) based on Transmodel. NeTEx is divided into three parts:

TS 16614-1, Network and Timetable Exchange — Part 1: Public transport network topology exchange format,

TS 16614-2, Network and Timetable Exchange — Part 2: Public transport scheduled timetables exchange format,

Network and Timetable Exchange (NeTEx) — Part 3: Public transport fares exchange format.

Datex II

Datex II (https://www.datex2.eu/) relevant specifications are provided in the following documents:

EN 16157-1: 2019 Intelligent transport systems — DATEX II data exchange specifications for traffic management and information — Part 1: Context and framework (DATEX II version 3),

EN 16157-2: 2019 Intelligent transport systems — DATEX II data exchange specifications for traffic management and information — Part 2: Location Referencing (DATEX II version 3), where the following documents are mentioned:

- CEN ISO/TS 18234-6:2006, Traffic and Travel Information (TTI) — TTI via Transport Protocol Expert Group (TPEG) data-streams — Part 6: Location referencing application (ISO/TS 18234-6:2006),
- CEN ISO/TS 24530-2:2006, Traffic and Travel Information (TTI) — TTI via Transport Protocol Experts Group (TPEG) Extensible Markup Language (XML) — Part 2: tpeg-locML (ISO/TS 24530-2:2006),
- EN ISO 14819-3:2013, Intelligent transport systems — Traffic and travel information messages via traffic message coding — Part 3: Location referencing for Radio Data System – Traffic Message Channel (RDS-TMC) using ALERT-C (ISO 14819-3:2013),
- EN ISO 19148:2012, Geographic information — Linear referencing (ISO 19148:2012),
- ISO/TS 21219-22, Intelligent transport systems — Traffic and travel information (TTI) via transport protocol expert group, generation 2 (TPEG2) —- Part 22: OpenLR location referencing (TPEG2-OLR),
- EN ISO 19136:2009, Geographic information — Geography Markup Language (GML) (ISO 19136:2007),
- EN 16803-1:2016, Space - Use of GNSS-based positioning for road Intelligent Transport Systems (ITS) – Part 1: Definitions and system engineering procedures for the establishment and assessment of performances,

- ETSI TS 102 894-2, Intelligent Transport Systems (ITS); Users and applications requirements; Part 2: Applications and facilities layer common data dictionary (v.1.2.1 – 2014-09),
- ISO 3166-2:2013, Codes for the representation of names of countries and their subdivisions – Part 2: Country subdivision code.

EN 16157-3: 2019 Intelligent transport systems — DATEX II data exchange specifications for traffic management and information — Part 3: Situation Publication (DATEX II version 3),

TS 16157-4: 2014 Intelligent transport systems — DATEX II data exchange specifications for traffic management and information — Part 4: VMS Publication (DATEX II version 2),

TS 16157-5: 2014 Intelligent transport systems — DATEX II data exchange specifications for traffic management and information — Part 5: Measured and elaborated data publications (DATEX II version 2),

TS 16157-6: 2015 Intelligent transport systems — DATEX II data exchange specifications for traffic management and information — Part 6: Parking Publications (DATEX II version 2),

EN 16157-7: 2019 Intelligent transport systems — DATEX II data exchange specifications for traffic management and information — Part 7: Common data elements (DATEX II version 3).

TAP-TSI

The Regulation (EU) 454/2011 (TAP-TSI) specifies the data exchange for rail within EU (https://tap-tsi.uic.org/). The relevant standards for the data exchange are attached to the Regulation as legally binding technical documents.

The Technical Specification for Interoperability on "Telematics Applications for Passengers" (TAP-TSI) prescribes protocols for the data exchange of

- timetables,
- tariffs,
- reservations,
- ticketing,
- information to passengers in station and vehicle area

For this study the focus is on the models for timetable data and tariffs, described in the technical documents:

TAP-TSI tariff data:

TAP-TSI Technical Document B.1 - Computer generation and exchange of tariff data meant for international or foreign sales – non reservation tickets,

TAP-TSI timetable data:

TAP-TSI Technical Document B.4 – Implementation guide for EDIFACT messages covering timetable data exchange,

TAP-TSI reference data:

TAP-TSI Technical Document B.8: Standard numerical coding for railway undertakings, infrastructure managers and others companies involved in rail transport chains,

TAP-TSI Technical Document B.9: Standard numerical coding of locations.

IATA

SSIM: Standards Schedules Information Manual http://www.iata.org/publications/store/Pages/standard-schedules-information.aspx,

PADIS: Passenger and Airport Data Interchange Standards http://www.iata.org/whatwedo/workgroups/Pages/padis.aspx,

AIDX: Aviation Information Data Exchange http://www.iata.org/publications/Pages/info-data-exchange.aspx,

SIDX: Schedules Information Data Exchange (Part of SSIM) http://www.iata.org/publications/store/Pages/standard-schedules-information.aspx,

SXSG: Slot Exchange Schemas (Part of SSIM) http://www.iata.org/publications/store/Pages/standard-schedules-information.aspx,

AIDM: Airline Industry Data Model http://www.iata.org/whatwedo/passenger/Pages/industry-data-model.aspx,

NDC: New Distribution Capability https://airtechzone.iata.org/industry-programs/ndc/#about.

List of abbreviations and definitions

Abbreviations:

AIDM	IATA Airline Industry Data Model
DTX	DATEX II
ELISE	European Location Interoperability Solutions for e-Government
IATA	International Air Transport Association
INSPIRE	Infrastructure for Spatial Information in Europe
INS	INSPIRE
ISA^2	Interoperability Solutions for European Public Administrations, Business and Citizens
JRC	Joint Research Centre
NAP	National Access Point
NTX	NeTEx (Network and Timetable EXchange)
TRM	Transmodel
OSM	OpenStreetMap
TAP-TSI	Commission regulation (EU) 454/2011 on the Technical Specification for Interoperability relating to the subsystem 'Telematics Applications for Passenger services' of the trans-European rail system
UML	Unified Modeling Language
XML	eXtensible Markup Language

Definitions:

Complementary models	Two or more data models with a similar scope and representing complementary information (*overlap* of type 2 - see Overlap Type definition).
Contributing Standard	For each *data category*: a specification of which the scope is such that this standard only refers to (uses) this data category to better describe other concepts. See also *Reference Standard.*
Data Category	Named set of data mentioned in the Annex of the *Regulation 2017/1926.*
Level of service	Term used by the *Regulation 2017/1926* indicating the deadline for the availability of certain *data categories* dedicated to particular travel information services.
Mapping Table	For a *data category*, a table representing the correspondence between the *Contributing Standard* data model underpinning the data category and the corresponding *Reference Standard*. A mapping table is defined only in the

	case of semantic equivalence of data models.
Overlap of data models	For each *data category*, the situation in which two or more data models underpinning a data category have a similar scope as regards this data category (is also called overlap). In this case the data models are *semantically equivalent models or complementary models*.
Overlap of Datasets	Situation in which same data instances are present in two or more datasets.
Overlap Table	Table in which the rows represent *data categories* (classes and attributes), the columns the standard specifications mentioned in the *Regulation 2017/1926* and the cells the *overlap type*.
Overlap Type	Categorisation of overlaps into: ● Overlap of data models: ○ Type 1: overlap which represents similar information ○ Type 2: overlap which represents complementary information ● Overlap of datasets ○ Type 3: duplicate instances of published data using the same standard format by different data providers. ○ Type 4: duplicate instances of published data using two different standard formats.
Reference Standard	For each *data category*: a specification of which the scope covers that particular data category in the most comprehensive way. See also *Contributing Standard*.
Regulation 2017/1926	COMMISSION DELEGATED REGULATION (EU) 2017/1926 of 31 May 2017 supplementing Directive 2010/40/EU of the European Parliament and of the Council with regard to the provision of EU-wide multimodal travel information services.
Semantically equivalent models	Two or more data models with a similar scope and representing the same information (*overlap* of type 1 - see *Overlap Type* definition).

List of figures

List of tables

Annexes

Annex 1. Submodels and definitions

Annex 2. Mapping tables

GETTING IN TOUCH WITH THE EU

In person

All over the European Union there are hundreds of Europe Direct information centres. You can find the address of the centre nearest you at: https://europa.eu/european-union/contact_en

On the phone or by email

Europe Direct is a service that answers your questions about the European Union. You can contact this service:

- by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),

- at the following standard number: +32 22999696, or

- by electronic mail via: https://europa.eu/european-union/contact_en

FINDING INFORMATION ABOUT THE EU

Online

Information about the European Union in all the official languages of the EU is available on the Europa website at: https://europa.eu/european-union/index_en

EU publications

You can download or order free and priced EU publications from EU Bookshop at: https://publications.europa.eu/en/publications. Multiple copies of free publications may be obtained by contacting Europe Direct or your local information centre (see https://europa.eu/european-union/contact_en).

KJ-NA-29975-EN-N

The European Commission's science and knowledge service

Joint Research Centre

JRC Mission

As the science and knowledge service of the European Commission, the Joint Research Centre's mission is to support EU policies with independent evidence throughout the whole policy cycle.

EU Science Hub

ec.europa.eu/jrc

@EU_ScienceHub

EU Science Hub - Joint Research Centre

EU Science, Research and Innovation

EU Science Hub

Publications Office of the European Union

doi:10.2760/404745

ISBN 978-92-76-13046-8