Green mobility data models and services for smart ecosystems

D2.1 Extended Smart Data Models v1.0

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List of Acronyms

Abbreviation / acronym	Description
AEMET	Spanish State Meteorological Agency
AGORA	Association for Air Quality Monitoring for the region Provence-Alpes-Côte d'Azur
ATMOSUD	Association for Air Quality Monitoring for the region Provence-Alpes-Côte d'Azur
AQI	Air quality index
EEA	European Commission European Environmental Agency
DCAT	An RDF vocabulary designed to facilitate interoperability between data catalogues published on the Web
DCAT-AP	An application profile of DCAT use in the European Data Portal
Dx.y	Deliverable number y belonging to Activity x
ETSI	European Telecommunications Standards Institute
GBFS	General Bikeshare Feed Specification from NABSA
GHG	Green House gases
hP	hectoPascal
IMS	Information Model Structure
INSPIRE	Infrastructure for Spatial Information in the European Community
IoT	Internet of Things
INSPIRE	Directive aimed to create a European Union spatial data infrastructure for the purposes of EU environmental policies and related policies or activities
ISA	Interoperability Solutions for European Public Administrations
ISG	Industry Specification Group
JSON-LD	JavaScript Object Notation for Linked Data) is a method of encoding linked data using JSON.
LDEN	Day Evening Night Sound Level
NABSA	North American Bikeshare & Scootershare Association
NGSI	Next Generation Service Interfaces, Open licensed-API specification by ETSI
NGSI-LD	Last version of NGSI protocol enabling the use of linked data principles
OGC	Open Geospatial Consortium
OSLO	Open Standards for Linked Organisations
RDF	Resource Description Framework. A general method for description and exchange of graph data.
SDM	Smart Data Models Program

Abbreviation / acronym	Description
URI	Uniform Resource Identifier is a unique sequence of characters that identifies a logical or physical resource used by web technologies
UML	Unified Modelling Language
URI	Uniform Resource Identifier
URL	Uniform Resource Locator
UV	Ultraviolete
W3C	World Wide Web Consortium

Executive Summary

This deliverable compiles the first version of the data models identified across the different uses cases of the GreenMov project. The reason for the creation of this deliverable during the project's life and beyond, is to be able to share the standardization required for a sustainable and green mobility. The data models were identified thanks to the interviews with the use cases and the collaboration with activity 5. The main challenge faced is the consolidation of the data models when the use cases are in a very early stage of implementation.

The identified data models have been classified in two groups. Those belonging to existing data models already available at the Smart Data Models Program[1], where only some additions were necessary, and those new ones that required their full creation and test across the use cases.

Additionally, in Flanders the OSLO process and method is used to evaluate OSLO core vocabularies and application profiles for the mobility domain. The OSLO Hoppin core vocabulary and application profile, currently being co-created in Flanders will be translated in English to be reusable in the project context of GreenMov and beyond in a shared mobility context.

The identified data models are in the process to be found into the European open data portal and other portals, however due to the preliminary situation of the data models, and the limited progress of the implementation of the pilots, the identified sources are a minimum.

The results presented are not final as long as the use cases have not completed their implementation. New versions are expected during the next 6 months. Eventually, some of these changes could affect to some of the data models presented in this document. These changes will be documented in the next version of this deliverable (deliverable 2.2).

As a summary, this deliverable has identified a reasonable amount of data models 11. Three of them brand new while the rest already available at the Smart Data Models Program. There has been detected a limited need for new data models and that many elements can be shared between the different use cases event taking into account the quite diverse location and use cases' goals.

1 https://smartdatamodels.org and its repository at https://github.com/smart-data-models

1 Introduction

This document is the first version of the data models identified for the GreenMov project. These data models are meant to be shared and to help other users to speed up the data interchange for sustainable mobility projects. The identified data models exceed the scope of mobility by including other terms related to the environment (including pollution) and crowd management, either of vehicles or people.

1.1 Purpose of the document

This deliverable provides the first set of extended data models from the Smart Data Models repository, including the conducted analysis of data sets, the implementation of the extension and the documentation to be used.

1.2 Relation to other project work

This is the first deliverable of the project. Consequently, there are no other deliverables related in the same activity or the others. With activity 5 there has been a natural relation as long as this activity compiled the requirements of the different use cases.

1.3 Structure of the document

After the introduction, the structure of this deliverable includes the description of the methodology for the selection, identification, filtering and consolidation of the different data models. After that, the list of the data models adopted or extended from the Smart Data Models Program is included. The next chapter describes those brand new data models defined across the project, and finally, the integration of OSLO vocabulary for the current use cases is explained. The conclusions remark the main achievements of the document.

2 Methodology

The objective of this document pursues the identification and a first draft definition of the data models and attributes used to map the data sources and data sets supporting the final mobility services and scenarios. This first round of data models will be evolved along with the activity 3 services and activity 5 scenarios' refinement, to result in the second version (M12) of the Extended Smart Data Models. According to this, the activities carried out to obtain the Smart Data Models are close related and involved in project's activity 5 actions for this first round and in both, activity 3 and activity 5 progresses for its second version.

Considering this dependence with activity 5 on this first stage (activity 3 is starting at the time of writing this first version), the methodology followed to derive the Smart Data Models involved in the scenarios is divided in five main steps:

1. Alignment with activity 5, by participating on the meetings intended to define and integrate the pilots on each city scenario. This will allow to identify the involved sources and possible extensions on each of them.
2. Organize specific meetings with pilots' responsible people to detail the identified data sets, map the attributes with the captured information and propose the valid data models that cover the pilots' requirements.
3. Compare the data models extracted from each pilot and merge them into common Smart Data Models' proposals and extensions, to be compliant with the Smart Data Models process.
4. Check (and evaluate) with pilots the common proposed Smart Data Models, to ensure that all requirements are covered according to pilots' particular objectives, so these can be adopted an integrated in their use cases implementations.
5. Maintain periodical meetings with activity 5 pilots to detect variations on requirements (new attributes/sources raising) and integrate them to obtain the Version 2 of this document.

The relevance, and the impact, of the Smart Data Models provide by Activity 2 is shown in Figure 1, where the relationship between the data sources and the Smart Data Models that homogenise the gathered information is depicted. This common language used to organise and describe the information guarantees later the portability of the services developed.

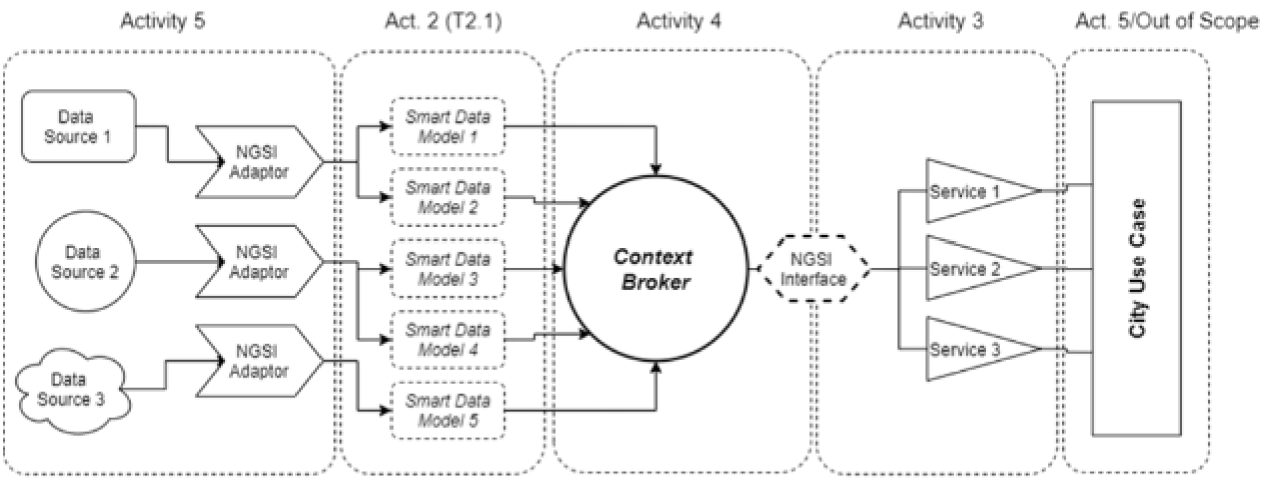

Figure 1. GreenMov Activities' relations

During the dedicated meetings with the pilots, the common process followed to derive the Smart Data Models started with: a) a high level definition of the expected use case that maps the needs of each city; b) identify the microservices that would support this final use case (these will be addressed to activity 3); and c) find the data sources, within the scope of the city, required to feed the corresponding microservices. These data sets would be translated into Smart Data Models, using the existing catalogue or proposing new ones.

By applying this process to each city scenario where the corresponding pilot is to be developed, the outcomes shown in the following subsections were obtained.

2.1 Murcia/Molina de Segura

The city councils of Murcia and Molina de Segura share a similar target in terms of mobility, due to their proximity and their common working and expansion areas. By merging efforts and data sources, they plan to develop within GreenMov scope a use case to **evaluate and predict the impact of the road traffic in the cities' air quality.**

Their use case will (initially) rely on a set of three main micro-services (to be developed and evolved in project's activity 3):

- Air Quality Index Calculation, which evaluates different air parameters to provide an Air Quality value.
- Traffic CO_2 Equivalent emissions calculation, that measures and classifies the traffic in the city to calculate and forecast the equivalent emissions due to vehicles.
- Shared bike's availability forecasting, as a complementary branch to help citizens to reduce pollution.

With this approach, and to support the micro-services and the final city use case, we have identified the following set of relevant data sources, either provided by the cities or available for Murcia and Molina de Segura, together with the proposed (existing or new) Smart Data Models:

- AirQualityObserved, to capture air parameters. These will be provided by the air quality sensors' network from Molina de Segura city and by the Murcia's region environmental monitoring network.
- NoiseLevelObserved, as noise can be also considered as pollution, the noise levels will be captured from the Molina's noise sensors network and from the Murcia's region environmental monitoring network.
- TrafficFlowObserved measures the traffic intensity using the traffic cams from Murcia and Molina de Segura.
- GBFS Models (station_status/station_information) to capture the data about location and availability of shared bikes provided by the Murcia's city bike's sharing company.
- WeatherObserved, still under evaluation, it captures periodically the general weather data related to the cities of Murcia and Molina de Segura provided by the Spanish State Meteorological Agency – AEMET.
- WeatherForecast, still under evaluation, it captures the weather forecast for the cities of Murcia and Molina de Segura provided by the Spanish State Meteorological Agency – AEMET.
- VehicleEmissionsLabel, as a new proposed Smart Data Model, its objective is to classify the vehicles according to their equivalent CO_2 emissions. This is to be defined and provided within GreenMov scope.

All these dependences are summarised in figure below.

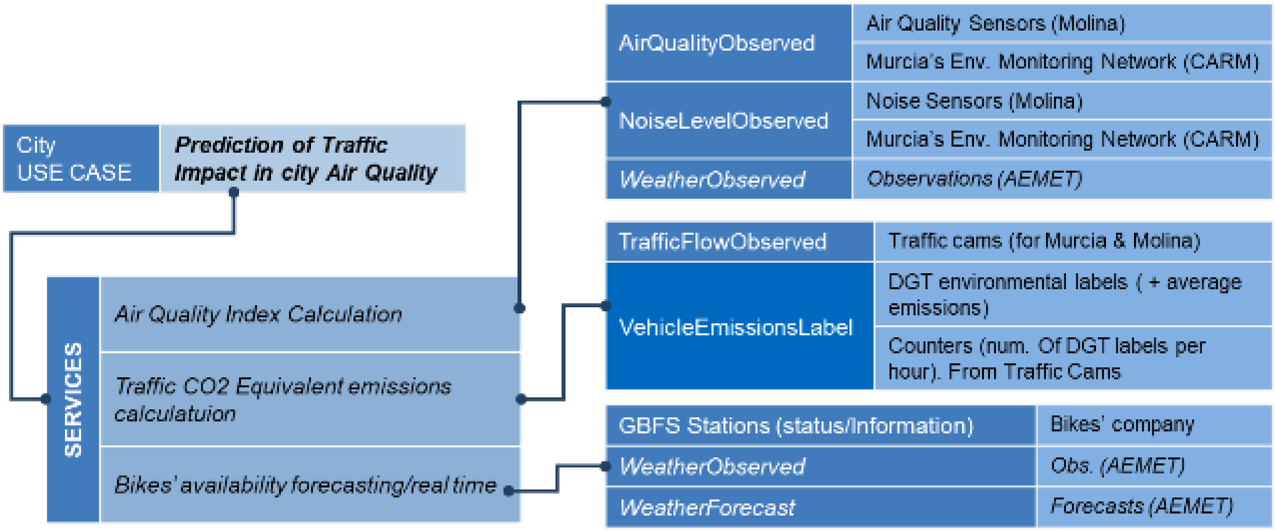

Figure 2. Murcia/Molina de Segura relationships between services and data sources

2.2 Flanders

By providing an **availability forecasting for shared bikes**, Flanders aim to improve the combined use of shared bike mobility and public transportation. In Flanders places of modality cross over are being branded as "Hoppin Points"[2]. To support the Hoppin Points a new OSLO-data-model "Hoppin Points" is being developed (in Dutch) and is near completion (see annex for the provisional "Hoppin Points" conceptual data model).

The focus of the use case are Hoppin Points at train stations with "Blue-Bikes"[3].If the availability forecasting works for Blue-Bikes it could also work for other bike sharing systems from other providers. The OSLO Hoppin-model will be translated from Dutch in English and will be extended if the business needs of GreenMov partners require so.

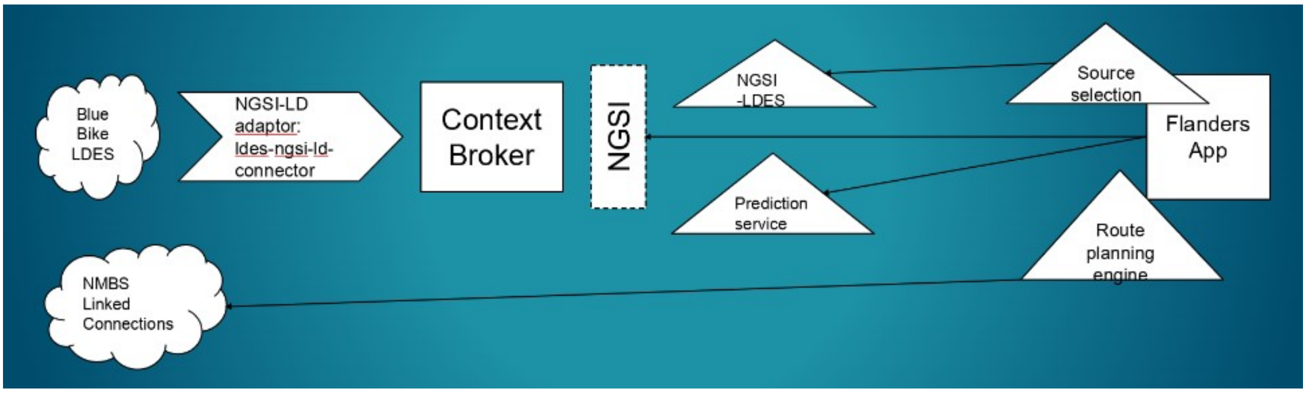

Figure 3. Flanders use case data sources

2 https://www.werkenaandering.be/en/working-on/hoppin-points

3 https://www.blue-bike.be/en

This use case will consume, within a first design, two main micro-services from Activity 3:

- Bikes' availability in real time, which provides location and current situation (available bikes to share and docks to release bikes) of the bikes' stations in the area.
- Bikes' availability forecasting, that indicates the expected number of available bikes or free docks of the selected bike station when I'm arriving there.

Based on the services and data provided by Blue-Bike for the region of Flanders, we have identified the following Smart Data Models to support the micro-services:

- GBFS (General Bikeshare Feed Specifications[4]) Model (station_status) to capture the data about location and availability of shared bikes provided by the Blue-Bike.
- GBFS Model (station_information) to capture extra data about the involved bikes' sharing stations, also provided by Blue-Bike.

All these dependences are summarised in Figure 4 below.

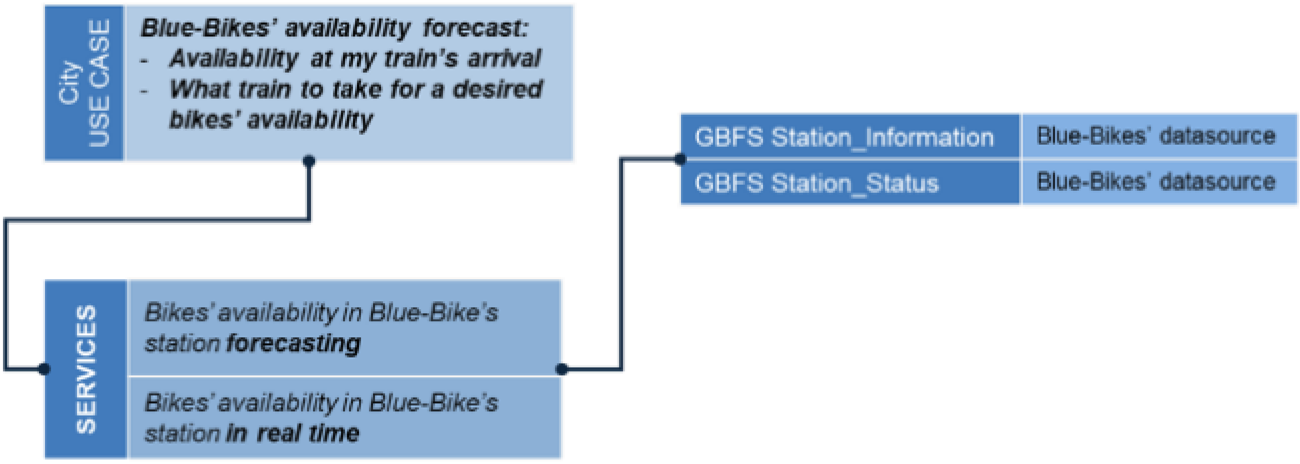

Figure 4. Flanders' region relationship between services and data sources

2.3 Nice

The City of Nice use case is also oriented to **reduce the impact of road traffic in city's pollution**. This is based on a mix between an optimized model of the car mix in the area, a predictive model of Noise and Air pollution, and potential scenarios for Public transportation availability. This mix aims to:

- Support the city's traffic managers decisions.
- Act on the behaviour of the citizens by proposing alternative green mobility services.
- Quantify and reduce the greenhouse gas emissions (GHG) and Noise emitted on the territory.

Within this use case, we identified the required data models from the different internal and external available inventories such as ATMOSUD, AGORA, MNCA or TomTom [7].

The data models identified are the following:

- Traffic Flow Observed: An observation of the traffic flow conditions at a certain place and time.

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4 https://github.com/NABSA/gbfs/blob/v2.2/gbfs.md

- Vehicle Emission Label: A classification of the vehicles according to their equivalent CO emissions.
- Air Quality Observed: Established data about air quality observations.
- Air Quality Monitoring: a continuous measurement of the air quality.
- Weather Observed: An observation of weather conditions at a certain place and time.
- Noise level observed: An observation of the acoustic parameters at a certain place and time.
- Noise Pollution: A detailed observation of the explicit acoustic parameters and what influences them at a certain place and time.

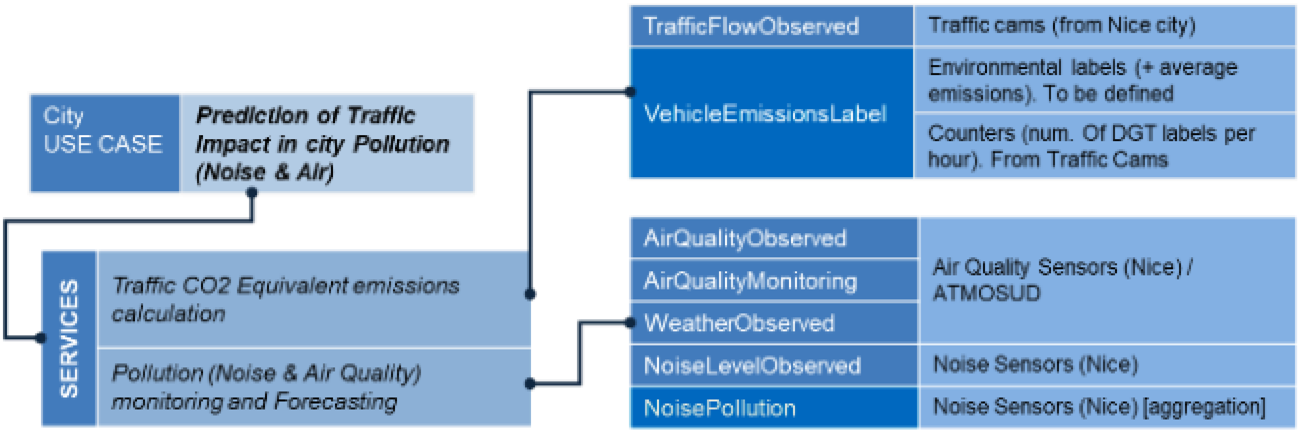

Figure 5. City of Nice relationships between services and data sources

2.4 OSLO vocabulary (Flanders) to re-use in project and European context

2.4.1 OSLO process and method

The focus of this section takes the process of raising and implementing semantic and technical agreements in the Open Standards for Linked Organisations (OSLO) program into account and is builds upon a peer reviewed method [1]. OSLO is an interoperability program in the region of Flanders, which brings together expertise from different business domains and governmental levels, independent of specific thematic use cases. The Flemish Government developed several domain models in line with international standards, including Interoperable Europe[5] (ISA²) and INSPIRE[6] enriched by data extensions to comply with the local (European) context [2]. The formal specification is published at data.vlaanderen.be[7] or purl.eu[8]. The thematic working groups, with over 500 authors from the public sector, private sector and academia, demonstrated that it is possible to raise the interoperability and foster the harmonization of data coming from different use cases.

The applied method to raise interoperability on the technical and semantic level is based on the principles of Linked Data [3]. The method includes an implementation framework that describes how to make authoritative data self-describing [3]. The semantic agreements are traceable and aligned to match the different stakeholders: policymakers, domain experts, analysts, and developers. The Resource Description Framework (RDF) can in particular facilitate the semantic agreements and JSON-LD allows developers to work with

[5] https://joinup.ec.europa.eu/collection/interoperable-europe/interoperable-europe
[6] http://inspire.ec.europa.eu/
[7] http://data.vlaanderen.be/ns/
[8] https://purl.eu/

Linked Data without a high entry barrier [3]. This facilitates the implementation of the semantic agreements across different use cases.

Our peer reviewed [1] approach to raising interoperability combines the process to reach technical and semantic agreements by broad consensus and an end-to-end method based on the principles of Linked Data to maintain the semantic agreements within an operational public sector context. This can be applied in four steps (Figure 6):

1. **Set up a formal governance** by anchoring the standardisation process at an existing governance body or initiating a new governance body. This step is crucial for the trust of the various stakeholders and supports the adoption of data standards.
2. **Agree on a transparent process** to reach semantic and technical agreements. The process outlines the roles of the different actors and specifies how consensus can be reached among stakeholders. Reference implementations of this process are applied and documented in Flanders[9] and on the Belgian interfederal level[10].
3. **Install an end-to-end method** based on the principles of Linked Data. This implies that all records of decisions, discussions and models are publicly accessible online; the latter is documented using a formal language based on RDF. The method must include an implementation framework that ensures semantic agreements are traceable and aligned to match the different stakeholders: policy makers, domain experts, analysts, and developers. Reference implementations of this process are applied and documented in Flanders[11] and on the Belgian interfederal level[12].
4. **Cocreate data standards:** starting from existing international standards, vocabularies and datasets in the European Data Portal, the semantic agreements are reached in open thematic working groups, consisting of domain experts from the public sector, private sector and academia. These working groups follow the process and method within a formal governance framework.

9 https://data.vlaanderen.be/standaarden/erkende-standaarden/proces-methode-ontwikkeling-standaarden/proces-methode-ontwikkeling.html (Dutch)

10 https://github.com/belgif/review/blob/master/Process/201906-ICEG%20-%20process%20and%20method.docx (English)

11 https://data.vlaanderen.be/standaarden/erkende-standaarden/proces-methode-ontwikkeling-standaarden/proces-methode-ontwikkeling.html (Dutch)

12 https://github.com/belgif/review/blob/master/Process/201906-ICEG%20-%20process%20and%20method.docx (English)

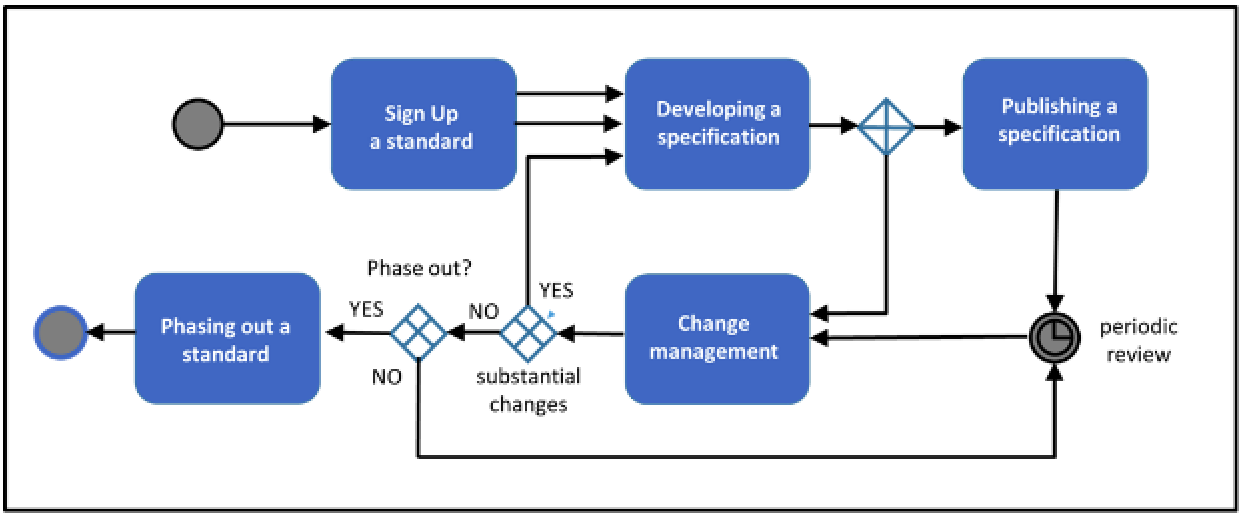

Figure 6. High-level overview of the different processes

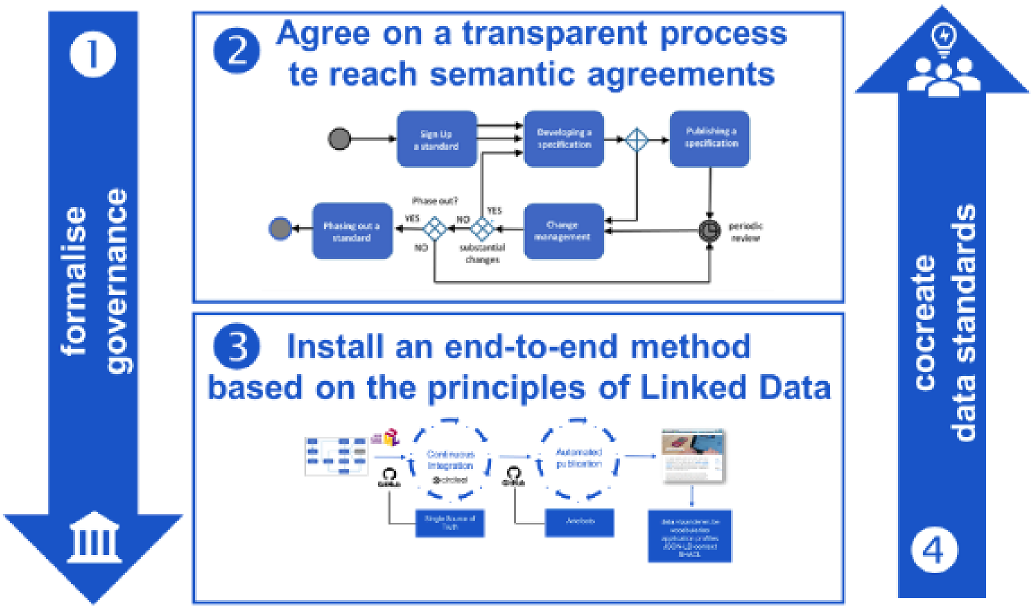

Figure 7. Raising interoperability in public sector

2.4.2 OSLO and Smart Data Models

This section outlines how the OSLO and the FIWARE Smart Data Models strengthen each other, which fits the main goal: "the definition of harmonized data models for green mobility". While the Smart Data models are fit for purpose in the context of advanced green mobility services, such as traffic flow management, smart management of free-floating mobility, shared mobility and environmental impact", OSLO also facilitates interoperability to other data spaces by linking to existing international standards. First, we provide context on FIWARE, Smart Data models and OSLO, based on a peer reviewed paper [4]. Next, we elaborate on the approach.

In 2016, the European Commission (EC) requested the European Telecommunications Standards Institute

(ETSI)[13] to create an Industry Specification Group (ISG) to define a standardised API for Context Information Management (CIM) with Future Internet Ware (FIWARE) Next Generation Service Interfaces (NGSI) as a nominee. FIWARE is an open-source platform, supported by the EC. NGSI is a protocol to manage Context Information. The ISG delivered the Next Generation Service Interfaces as Linked Data (NGSI-LD) standard [5], which enables nearly real-time access to information from different distributed data sources. The NGSI-LD Information Model Structure (IMS) consists of two layers: a core Meta-model and a Cross-Domain Ontology which can be extended with domain-specific logic. The core Meta-model defines a minimal set of constructs which are the basic building blocks of the Cross-Domain Ontology including Entity, Relationship, Property and Value [5, 6]. The Cross-Domain Ontology describes concepts and constraints which provide consistency between the different IoT domains and applications; these concepts include Geographical properties, Temporal properties and Time values [5, 6]. The domain-specific logic can be extended with ontologies for a specific domain[14]. NGSI-LD requires a reimplementation of existing Linked Data domain models to fit the semantics of NGSI. According the FIWARE Foundation[15]: "a smart data model includes three elements: The schema, or technical representation of the model defining the technical data types and structure, the specification of a written document for human readers, and the examples of the payloads for NGSIv2 and NGSI-LD versions".

The OSLO data standards result from a co-creation process, which has a share and reuse-first strategy. OSLO adopts existing data standards from data standardisation bodies such as ISO, OGC, W3C. The OSLO modelling guidelines ensure that this reuse is done in such a way that further reuse is facilitated. For instance, OSLO modelling guidelines consider the following reuse levels: (i) a vocabulary, (ii) an application profile and (iii) an implementation model. A vocabulary is a collection of terms having a persistent identifier and definitions, which an application profile describes the use of the terms in the context of a broad application area, and finally an implementation model describes the data used by one implementation. In the OSLO methodology, all reuse levels coexist, each with distinct life cycles, but together form one distributed connected knowledge graph. To establish that, the data technology cornerstone of OSLO data standards are persistent, dereferenceable URIs for all terms and documents. This approach builds a coherent Semantic Web where users (developers, business analysts) can find the semantics of the data by dereferencing the URI as a URL. Making the publishing coherent with browsing the Web increases the adoption.

The OSLO reuse first approach is powerful, but it still faces the usual data interoperability challenges when connecting with other data ecosystems that are not an intrinsic part of the OSLO knowledge graph. Then mapping approaches are to be applied.

In the case of FIWARE and OSLO a smart data model that is aligned with the vocabulary used in OSLO will be created. A smart data model JSON-LD context can be created using the "create external referenced context" service, which can refer to OSLO context files. Also, a specification needs to be created for an OSLO Application Profile, similar to the DCAT-AP data model. This approach makes a lossless data conversion possible between the OSLO and NGSI-LD ecosystems. The vocabulary terms are being reused and the rules of the application profile are still respected. With the smart data model specification, developers have better guidelines how to let OSLO data flow through the NGSI-LD ecosystem.

13 https://www.etsi.org/

14 https://github.com/FIWARE/data-models/blob/master/specs/ngsi-ld_howto.md

15 https://www.fiware.org/smart-data-models/

Applied OSLO vocabularies and application profiles

Following OSLO vocabularies and application profiles are re-used and contextualised for GreenMov:

- Hoppin points[16]: a place where you can easily transfer between one means of transport to another. Depending on the location, you will find bicycle parking spaces, tram and bus stops, shared vehicles, a Park & Ride[17].
- Application Profile Mobility: Trips and Offers[18].
- Vocabulary Mobility: Trips and Offers[19].
- Application Profiles Mobility: Timetable and Scheduling[20].
- Vocabulary : Timetable and Scheduling[21].

Within this project, the Hoppin points vocabulary and application profile will be translated into English together with the possibility of making extensions (e.g. GBFS). The co-creation approach, as mentioned in 2.4.1, will be applied. We will invite all project partners to join the workshops. The objective is to meet the deadline of version 2 of this deliverable (31/8/2022).

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16 https://www.werkenaandering.be/en/working-on/hoppin-points

17 https://data.vlaanderen.be/standaarden/standaard-in-ontwikkeling/vocabularia-en-applicatieprofielen-hoppinpunten.html

18 https://data.vlaanderen.be/standaarden/erkende-standaard/applicatieprofiel-mobiliteit-trips-en-aanbod.html

19 https://data.vlaanderen.be/standaarden/erkende-standaard/vocabularium-mobiliteit-trips-en-aanbod.html

20 https://data.vlaanderen.be/standaarden/standaard-in-ontwikkeling/applicatieprofielen-mobiliteit-dienstregeling-en-planning.html

21 https://data.vlaanderen.be/standaarden/standaard-in-ontwikkeling/vocabularium-mobiliteit-dienstregeling-en-planning.html

3 Datasets identified in European open data portals

3.1 In the European Data Portal

Data published through the official European Data Portal[22], managed by the Publication Office of the European Union.

3.1.1 Murcia/Molina Use Case

Datasets for the use case were found at the European data portals (February 2022) as a federation of other data portals (see section 3.2.1).

3.1.2 Nice Uxe Case

- Hourly air quality measurements in the Metropolis of Nice Cote D'Azur dated from 2016, these measurements were carried out by Approved Associations for Air Quality Monitoring and they include the following pollutants: O_3, NO, NO_2, SO_2, PM2.5, PM10, CO, C_6H_6:
    - Hourly air quality measurements for pollutants – 2016[23].
- A dataset that locates the sectors exposed to sound levels from the noise of major roads in the Metropolitan area of Nice according to the Lden index for the year 2017:
    - Lden noise level of major roads in France - Report 2017[24].
- Historical weather alerts for the level of risk of floods occurring on the main rivers monitored by the State during the year 2021:
    - Flood monitoring – VIC[25].
- Historical data on the average annual daily traffic of all types of vehicles on the Metropolitan road network from 2019:
    - Average annual daily traffic[26].

3.1.3 Flanders Use Case

- Data about the real-time availability of Blue Bikes. Currently, only data in the greater city area of Ghent is documented. This is done for each train station, with one or more Blue Bike facilities.
    - Blue Bike sharing bikes Ghent Sint-Pieters (M. Hendrikaplein)[27]

22 https://data.europa.eu

23 https://data.europa.eu/data/datasets/http-www-lcsqa-org-referentiel-surveillance-qualite-air-france?locale=en

24 https://data.europa.eu/data/datasets/http-www-lcsqa-org-referentiel-surveillance-qualite-air-france?locale=en

25 https://data.europa.eu/data/datasets/7de06fcf-ef53-4976-b772-30aaa3aeb4e2?locale=en

26 https://data.europa.eu/data/datasets/fr-120066022-jdd-6729872d-ec98-4b80-88ae-da7a3e59fce8?locale=en

27 https://data.europa.eu/data/datasets/1cff1bfd-7c47-38ab-a4d2-5ca9aa753d0c?locale=en

- Blue Bike sharing bikes Ghent Sint-Pieters (St. Denijslaan)[28]
- Blue Bike sharing bikes Ghent Dampoort[29]
- Blue Bike sharing bikes Merelbeke — Drongen — Wondelgem[30]

- Data about the planned and actual timetable of trains:
  - SNCB GFTS - scheduled timetable and real-time data[31]

3.2 In other European data portals

3.2.1 Murcia/Molina Use Case

- European Air Quality Portal[32]: is an open source dedicated to the Air Quality e-Reporting system established by the European Commission (EC[33]) and run by the European Environmental Agency (EEA). It contains technical details and services that facilitate the reporting of official air quality data from EU Member States and other EEA member and co-operating countries. It also provides access to different tools which allow to visualize the collected data and statistics as well as to download them.
- AEMET: that is the meteorological data reported by the Spanish "Agencia Estatal de Meteorología", This data is pulled into the European Open Data Portal. Aemet Open Data portal[34].

3.2.2 Nice Use Case

For the Nice Use case, some of the datasets to be used are available on other European data portals:

- Weather forecast and Air quality observation and weather forecast available via Copernicus European portal: Air quality observation – Copernicus[35].
- Historical weather conditions report from Meteo France platform: Historical weather data - Meteo France[36] .
- Historical Noise data from 2017 available via European Environment Agency: Historical noise pollution - EEA[37].

3.2.3 Flanders Use Case

Datasets for the use case were not found in other European data portals (February 2022).

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28 https://data.europa.eu/data/datasets/blue-bike-deelfietsen-gent-sint-pieters-st-denijslaan?locale=nl

29 https://data.europa.eu/data/datasets/blue-bike-deelfietsen-gent-dampoort?locale=nl

30 https://data.europa.eu/data/datasets/34da56c8-80ad-3d12-9e5c-1d24391775d2?locale=nl

31 https://data.europa.eu/data/datasets/ef98f1a2-4a77-4327-bc5a-99a3c66bed80?locale=en

32 https://aqportal.discomap.eea.europa.eu/

33 https://www.eea.europa.eu/themes/air

34 https://opendata.aemet.es/

35 https://cds.climate.copernicus.eu/#!/home no direct link possible, it has to be searched

36 https://meteofrance.fr/actualite/publications/les-publications-de-meteo-france/2021-les-bilans-climatiques

37 https://www.eea.europa.eu/data-and-maps/data/data-on-noise-exposure-8

3.3 Not present in any European Data Portals

3.3.1 Murcia/Molina Use Case

- Molina Smart City: data generated by IoT devices belonging to Molina Town Council, related to air quality and noise monitoring.
- Murcia Bike Stations: data about bike availability in the different stations in Murcia.
- HOPU Parking Sensors: data collected by sensors produced by HOPU, that are installed in electric car parking places, and measure if the place is free or not.
- Traffic Cameras: data about vehicle count and traffic intensity collected by the cameras installed by Murcia and Molina municipalities.

3.3.2 Nice Use Case

- Real time and historical traffic data collected by the different sensors in the city and provided through and API of the Metropolitan area of Nice.
- Real time and historical detailed noise pollution data: Lden, Lnight, LMax, LAaeq ... available on an internal platform (AGORA/ATMOSUD) as well as the API's of the Metropolitan area of Nice.
- Real time, historical and prediction for meteorological conditions in the Metropolitan area of Nice available on an internal platforms (AGORA/ATMOSUD) as well as the API's of the Metropolitan area of Nice.
- GTFS and NeTEx (Network Timetable Exchange files) with data about the public transportation stops, routes, timetable …
- Traffic data - Traffic flow observation API's available on TomTom's developers platform: Traffic flow observation – TomTom[38].
- Traffic Data scrapped from the Waze and Google Maps API's: Waze PartnerHub[39].

3.3.3 Flanders Use Case

All source datasets that are needed were identified through the official European Data Portal.

[38] https://developer.tomtom.com/traffic-api/documentation/traffic-flow/flow-segment-data

[39] https://www.waze.com/partnerhub

4 Data Models for GreenMov use cases

From the outcomes derived from the methodology described in section 2 and applied to the scenarios in Murcia and Molina de Segura, Flanders and City of Nice pilots, this subsection lists the current existing Smart Data models (within the Smart Data Models Program) identified and the attributes used to map the provided data. For all these data models, there exist a set of common attributes that must be present to guarantee Smart Data Models and FIWARE compliance. These are listed in Table 1.

Table 1. Common attributes for all Smart Data Models

Attribute Name	Data type	NGSI type	Description
id	id	Property	UNIQUE identifier of the entity (same attribute for all entities' models).
type	string	Property	TYPE of the reporting entity (AirQualityObserved, NoiseLevelObserved …).
location	Geopoint	Geoproperty	Location (Lat/Long) of the sensor reporting data (Location of the measurement).
dateModified	date	Property	Date of the last entity modification (timestamp).
dateObserved	date	Property	Date of the observation (timestamp).

4.1 AirQualityMonitoring

Air Quality Monitoring (AQM) Data Model. Subject Environment[40].

Table 2. Attributes of Air Quality Monitoring

Attribute Name	Data type	NGSI type	Description
airQualityIndexx	number	Property	Number used to report air quality.
airQualityLevel	string	Property	Overall qualitative level of health concern corresponding to the observed air quality.
feelLikesTemperature	number	Property	Felt temperature.

40 https://github.com/smart-data-models/dataModel.Environment

Attribute Name	Data type	NGSI type	Description
dewPoint	number	Property	The dew point coded as a number. Observed temperature to which air must be cooled to become saturated with water vapour.
aqiMajorPollutant	number	Property	Major air quality index (AQI) pollutant.
atmosphericPressure	number	Property	Observed atmospheric pressure measured in Hecto Pascals.
solarRadiation	number	Property	Observed solar radiation measured in Watts per square meter.
visibility	number	Property	Visibility categories.
illuminance	number	Property	Observed instantaneous ambient light intensity.
UVIndexMax	number	Property	The maximum UV Index for the period, based on the World Health Organization's UV Index measurement.
weatherType	string	Property	Text description of the weather.

New attributes identified to complement AirQualityMonitoring Smart Data Model.

Table 3. New attributes of Air Quality Monitoring

Attribute Name	Data type	NGSI type	Description
airTemperatureAVG	number	Property	Average temperature measured on a datum.
windType	string	Property	Wind type dominate during the last 24 hours.

4.2 AirQualityObserved

An observation of air quality conditions at a certain place and time. Subject Environment.

Table 4. Attributes of Air Quality Observed

Attribute Name	Data type	NGSI type	Description
validFrom	date	Property	The start of the validity period for this forecast as a ISO8601 format.
validTo	date	Property	The end of the validity period for this forecast as a ISO8601 format.
dataProvider	string	Property	A sequence of characters identifying the provider of the harmonised data entity.
airTemperature	number	Property	Instantaneous temperature of the measured air.
relativeHumidity	number	Property	Relative Humidity of the air (a number between 0 and 1 representing the range of 0% to 100%).
windSpeed	number	Property	Intensity of the wind.
windDirection	number	Property	Direction of the weathervane.
precipitation	number	Property	Amount of rainwater recorded.
as	number	Property	Arsenic detected.
c6h6	number	Property	Benzene detected.
cd	number	Property	Cadmium detected.
co	number	Property	Carbon Monoxide detected.
co2	number	Property	Carbon Dioxide detected.
ni	number	Property	Nickel detected.
no	number	Property	Nitrogen monoxide detected.
no2	number	Property	Nitrogen dioxide detected.
o3	number	Property	Ozone detected.
nox	number	Property	Other Nitrogen oxides detected.

Attribute Name	Data type	NGSI type	Description
pb	number	Property	Lead detected.
sh2	number	Property	Hydrogen sulphide detected.
so2	number	Property	Sulphur dioxide detected.
pm10	number	Property	Particulate matter 10 micrometres or less in diameter.
pm25	number	Property	Particulate matter 2.5 micrometres or less in diameter.
volatileOrganicCompoundsTotal	string	Property	Alkanes <C10, ketones <C6, aldehydes <C10, carboxylic acids <C5, aspirits<C7, Alkenes <C8, Aromatics.

New attributes identified to complement AirQualityObserved Smart Data Model.

Table 5. New Attributes of Air Quality Observed

Attribute Name	Data type	NGSI type	Description
pm1	number	Property	Particulate matter 1 micrometers or less in diameter.
h2s	number	Property	Hydrogen sulphide detected (olfactory pollution).
hc	number	Property	Unburnt hydrocarbons detected.
chci	number	Property	1,2-Dichloroethene detected.
c4h6	number	Property	1,3-Butadiene detected.
nh3	number	Property	Ammonia detected.
c6h2	number	Property	Cyclohexane.

4.3 NoiseLevelObserved

An observation of those acoustic parameters that estimate noise pressure levels at a certain place and time. Subject Environment.

Table 6. Attributes identified to complement NoiseLevelObserved

Attribute Name	Data type	NGSI type	Description
dataProvider	property	Property	A sequence of characters identifying the provider of the data entity.
dateObservedFrom	value	Property	Observation period start date and time.
dateObservedTo	value	Property	End date and time of the observation period.
refWeatherObserved	string	Relationship	link to the Weather observed entity representing atmospheric conditions.
sonometerClass	string	Property	Sound level meter class.
LAeq	number	Property	Average sound level (equivalent) recorded during the measuring time.
LAeq_d	number	Property	Average sound level during the day (8h).
Lamax	number	Property	Maximum sound level recorded during the measuring time.

Table 7. New attributes identified to complement NoiseLevelObserved

Attribute Name	Data type	NGSI type	Description
frequency	number	Property	Measurement frequency of the used sensor.
heightAVR	number	Property	Sensor height above ground.
distanceAVG	number	Property	Average distance between sensor and potential noise sources.
obstacles	string	Property	Type of potential obstacles between the sensor and the noise source.

4.4 ParkingSpot

A parking spot (or parking lot) entity identifies the delimited area where a given vehicle can be parked. Subject Parking[41].

[41] https://github.com/smart-data-models/dataModel.Parking

Table 8. Attributes identified to complement ParkingSpot

Attribute Name	Data type	NGSI type	Description
status	Enum	Property	Status of the parking spot from the point of view of occupancy. Enum:'closed, free, occupied, unknown'.

Table 9. New attributes identified to complement ParkingSpot

Attribute Name	Data type	NGSI type	Description
parkingTime	number	Property	The time in seconds that the place is occupied.

4.5 Station_information

Details including system operator, system location, year implemented, URL, contact info, time zone. According to the Standard GBFS 2.2. Subject GBFS. This model has been analysed to be included within the GreenMov use cases to complement GBFS Station_Status.

4.6 Station_status

Describes the capacity and rental availability of the station According to the Standard GBFS 2.2. Subject GBFS[42].

Table 10. Attributes of GBFS Station_status

Attribute Name	Data type	NGSI type	Description
num_docks_available	number	Property	num of current AVAILABLE docks in the station.
num_bikes_available	number	Property	num of current AVAILABLE bikes in the station.

4.7 TrafficFlowObserved

An observation of traffic flow conditions at a certain place and time. Subject Transportation[43].

Table 11. Attributes of TrafficFlowObserved

Attribute Name	Data type	NGSI type	Description
Intensity	number	Property	Total number of vehicles detected during this observation period.

42 https://github.com/smart-data-models/dataModel.GBFS

43 https://github.com/smart-data-models/dataModel.Transportation/

Attribute Name	Data type	NGSI type	Description
Occupancy	number	Property	Fraction of the observation time where a vehicle has been occupying the observed lane.
averageVehicleSpeed	number	Property	The mean speed of the vehicles.

Table 12. New attributes for TrafficFlowObserved model

Attribute Name	Data type	NGSI type	Description
Fluency	string	Property	A string describing the fluency of the traffic.

4.8 WeatherObserved

An observation of weather conditions at a certain place and time. This data model has been developed in cooperation with mobile operators and the GSMA. Subject Weather[44]

Table 13. Attributes of WeatherObserved

Attribute Name	Data type	NGSI type	Description
airTemperature	number	Property	Instantaneous temperature of the measured air.
referenceTemperature	number	Property	Reference temperature of the measured air.
atmosphericPressure	number	Property	Observed atmospheric pressure (hP).
relativeHumidity	number	Property	Humidity in the air. Observed instantaneous relative humidity (water vapour in the air).
windSpeed	number	Property	Wind intensity.
windDirection	number	Property	Wind direction.
precipitation	number	Property	Amount of rainwater measured.
solarRadiation	number	Property	Observed solar radiation measured in Watts per square meter..

44 https://github.com/smart-data-models/dataModel.Weather/

5 New Data Models documented

This section presents the new data models within the Smart Data Models framework identified in this first round analysis for the three use cases. These models can be modified or extended due to the fact that some of the use cases have not completed their deployment (Feb 2022).

5.1 NoisePollution

NoisePollution Smart Data Model proposal is intended to merge specific and punctual noise measurements (coming, e.g. from NoiseLevelObservation entities) into average parameters referred to city areas, providing a more city-related data about noise pollution status and evolution.

Table 14. Attributes of new NoisePollution Smart Data Model proposal

Attribute Name	Data type	NGSI type	Description	Units
riskType	number	Property	Health risk index (1 to 10) according to noise level.	Without unit
Lanight	number	Property	Average sound level recorded during the night (8h).	dB
Laf	number	Property	Average sound level recorded for a certain frequency range (e.g. La50hz, La100hz).	dB
acousticPressure	number	Property	Noise sound pressure.	Pa
nnEvents	number	Property	Number of noise events during the measurement period.	Without unit
miMask	number	Property	Percentage of time for which the noise level exceeded a certain threshold (e.g. 65dB for 12h/24h).	%
noiseType	string	Property	Recorded noise type.	Without unit
noiseOrigin	string	Property	Main origin (source) of the recorded noise.	Without unit
exposureType	string	Property	Exposure time.	Without unit
pressure	number	Property	Noise pressure level measured.	Pa

Attribute Name	Data type	NGSI type	Description	Units
intensity	number	Property	Intensity noise level measured.	W/m²
buildingsType	string	Property	Type of predominant buildings within the measurement area.	Without unit
groundType	string	Property	Type of predominant ground in the measurement area.	Without unit
wallsType	string	Property	Facade material types dominant in the measurement area.	Without unit
Lamax24	number	Property	Maximum sound level recorded for 24 hours.	dB
LAeq24	number	Property	Average sound level over 24 hours.	dB
LAeq_d	number	Property	Average sound level during the day (8h).	dB

5.2 VehicleEmissionsLabel

VehicleEmissionLabel proposal characterises the road traffic within the city (or a given area) by enabling the calculation of gases emissions due to vehicles. The first set of attributes to define this model are shown below. The data model is to be defined in the subject Transportation.

Table 15. Attributes of new VehicleEmissionsLabel Smart Data Model proposal

Attribute Name	Data type	NGSI type	Description
EmissionRange	string	Property	Specifies the Category of emission range.
Intensity	number	Property	Total number of vehicle per category of emission range.
averageVehicleSpeed	number	Property	The mean speed of the vehicles in the considered category.

5.3 PublicTransportation

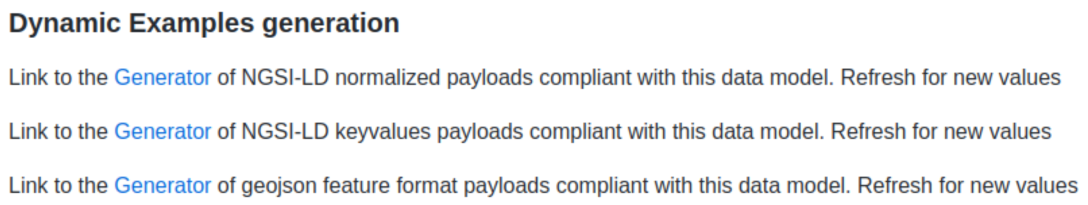
PublicTransportation model provides information about the public transport service of the city, to support the applications that requires inter-modal and commuting functionalities. This is related to UrbanMobility scenarios.

Table 16. Attributes of new PublicTransport Smart Data Model proposal

Attribute Name	Data type	NGSI type	Description
contractingAuthority	string	Property	Name of the contracting authority of the public transportation.
contractingCompany	string	Property	Name of the contracting company responsible for the exploitation of the service.
installationMode	string	Property	Location relative to the ground reference.
locationGTFS	string	Property	Location of all stations from a GTFS file.
locationType	number	Property	Type of location of the public transportation stations.
frequency	number	Property	Frequency of public transportation per hour.
serviceHours	number	Property	Number of hours of service per day.
serviceStart	date	Property	Service start time.
serviceEnd	date	Property	Service end time.
wheelChairAccessible	boolean	Property	PMR accessible or not.
webSite	string	Property	Website of the contracting company.
phonenumber	string	Property	Contracting company phone number.
pricingAVG	string	Property	Average price of public transportation.
numberTrips	string	Property	Number of daily public transportation trips.
numberStations	string	Property	Number of public stations.
stopCode	string	Property	Identifier/code of the public transport stops.
typestransportation	string	Property	List of public transportation available.
routes	string	Property	List of routes covered with public transportation.

6 Generation of examples of the data models

For those data models published in the Smart Data Models Program the generation of examples is a service always linked from the README.md file. It is automatic for official data models.



Dynamic Examples generation

Link to the Generator of NGSI-LD normalized payloads compliant with this data model. Refresh for new values

Link to the Generator of NGSI-LD keyvalues payloads compliant with this data model. Refresh for new values

Link to the Generator of geojson feature format payloads compliant with this data model. Refresh for new values

Figure 8. Screenshot pointing to examples' generator

Data Models name	URL	comments
AirQualityObserved	https://github.com/smart-data-models/dataModel.Environment/blob/master/AirQualityObserved/README.md	IMREDD use case.
AirQualityMonitoring	https://github.com/smart-data-models/dataModel.Environment/blob/master/AirQualityMonitoring/README.md	
NoiseLevelObserved	https://github.com/smart-data-models/dataModel.Environment/blob/master/NoiseLevelObserved/README.md	IMREDD use case.
NoisePollution		Under definition.
ParkingSpot	https://github.com/smart-data-models/dataModel.Parking/blob/master/ParkingSpot/README.md	IMREDD use case.
PublicTransportation		Under definition.
Station_information	https://github.com/smart-data-models/dataModel.GBFS/tree/master/station_information/README.md	From GBFS.
Station_status	https://github.com/smart-data-models/dataModel.GBFS/blob/master/station_status/README.md	From GBFS.

Data Models name	URL	comments
TrafficFlowObserved	https://github.com/smart-data-models/dataModel.Transportation/blob/master/TrafficFlowObserved/README.md	IMREDD use case.
VehicleEmissionsLabel		Under definition.
WeatherObserved	https://github.com/smart-data-models/dataModel.Weather/blob/master/WeatherObserved/README.md	IMREDD use case.
WeatherForecast	https://github.com/smart-data-models/dataModel.Weather/blob/master/WeatherForecast/README.md	Available, but still to be considered.

7 Conclusions

A first identification of the data models is carried out in this document. However, the correlation of these data models with the European open data portal is limited (few of them are available there). And their possible availability in other portals is also under exploration. By the time of the finalization of the document (February 2022) the use cases are in the process of finishing their definitions, so some of the attributes identified could not be completely updated or to vary in next version of the document.

A minimum of **four new data models will be defined**, NoisePollution, PublicTransportation, VehicleEmissionsLabel, and Hoppin Points.

Additionally, **seven existing data models available at the Smart Data Models Program will be extended** with new attributes in order to deal with all the needs of the use cases. Once published the resources for the generation of examples are automatically created. The possibility of sharing the same data models, together with the use a common API system will allow the easy interoperability and the reuse of new solutions between pilots. Additionally, their publication in the Smart Data Models Program's repository will allow other projects and use cases of the Mobility to apply sustainability principles.

8 References

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[4] Buyle, R., Van de Vyvere, B., Rojas Melendez, J. A., Van Lancker, D., Vlassenroot, E., Van Compernolle, M., … Mannens, E. (2021). A sustainable method for publishing interoperable open data on the web. DATA, 6(8). https://doi.org/10.3390/data6080093

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[6] Abbas, A.; Privat, G. Bridging Property Graphs and RDF for IoT Information Management. In Proceedings of the SSWS@ ISWC; 2018; pp. 77–92.

[7] TomTom , T*omTom Developer Portal*, https://developer.tomtom.com/, retrieved 2022-02-14 .

Annex: OSLO-datamodel “Hoppin points” (Dutch version)

The UML-schema of the provisional application profile is cut up over the next 9 pages.

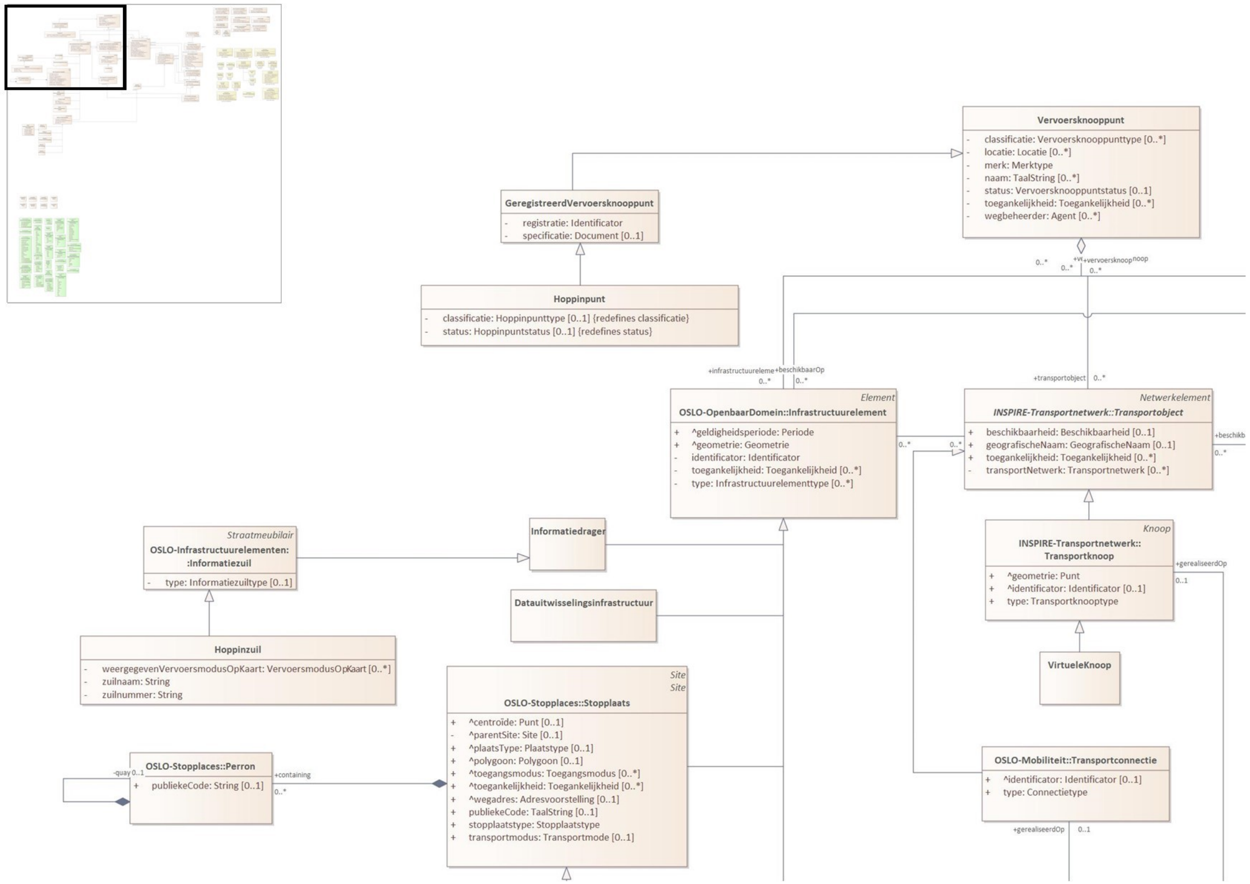

Figure 9. UML-schema of the provisional application profile 1/9

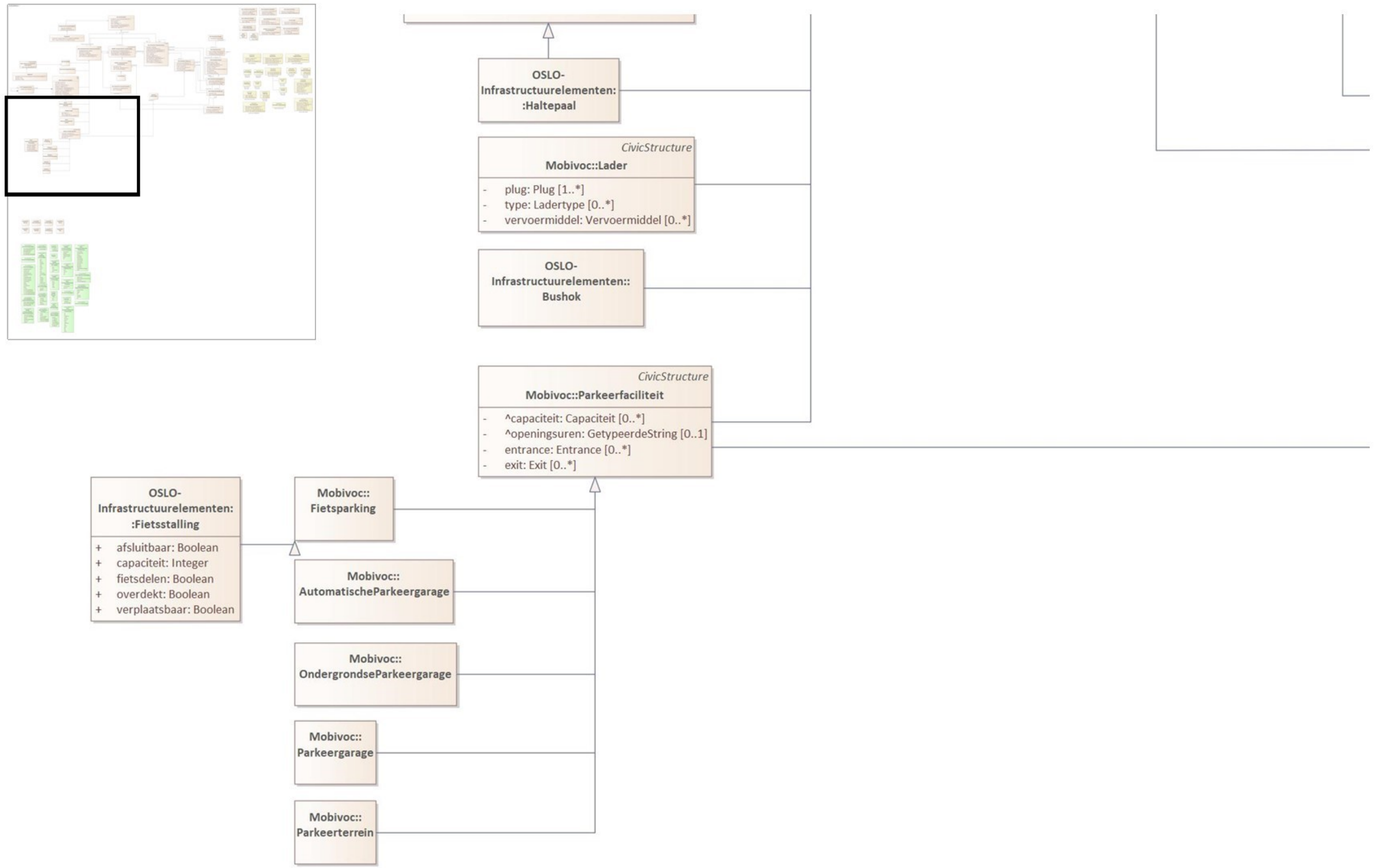

Figure 10. UML-schema of the provisional application profile 2/9

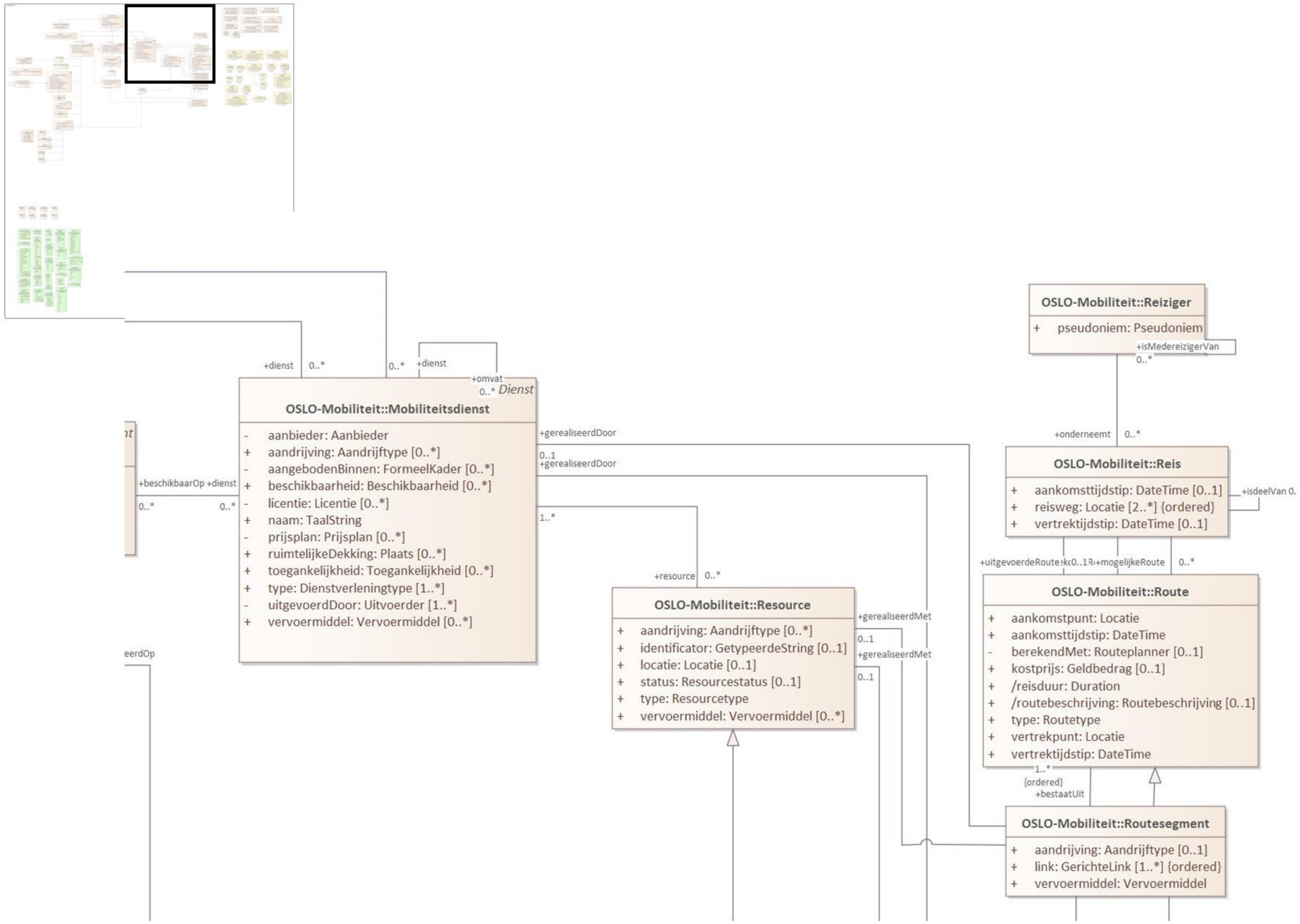

Figure 11. UML-schema of the provisional application profile 3/9

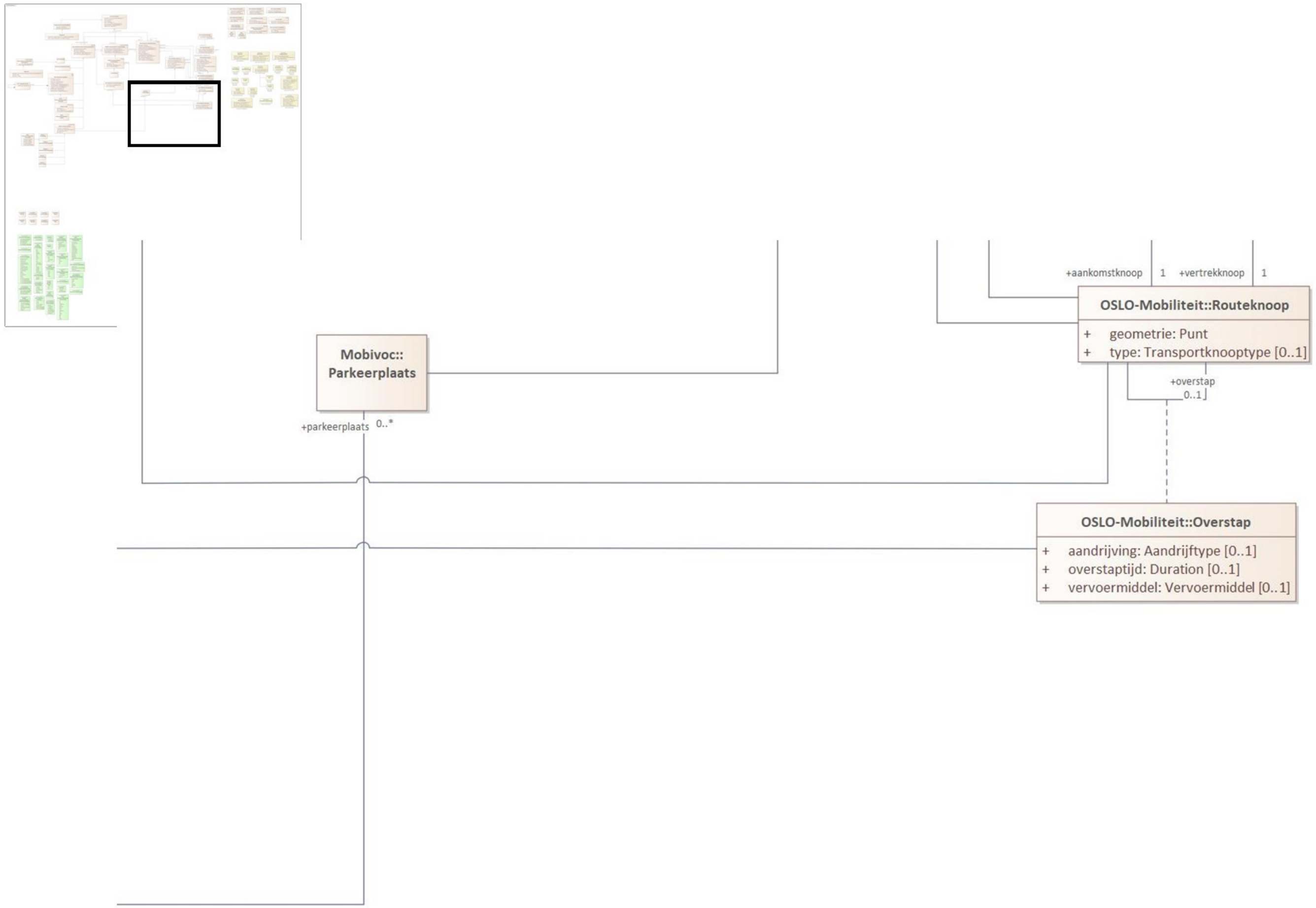

Figure 12.UML-schema of the provisional application profile 4/9

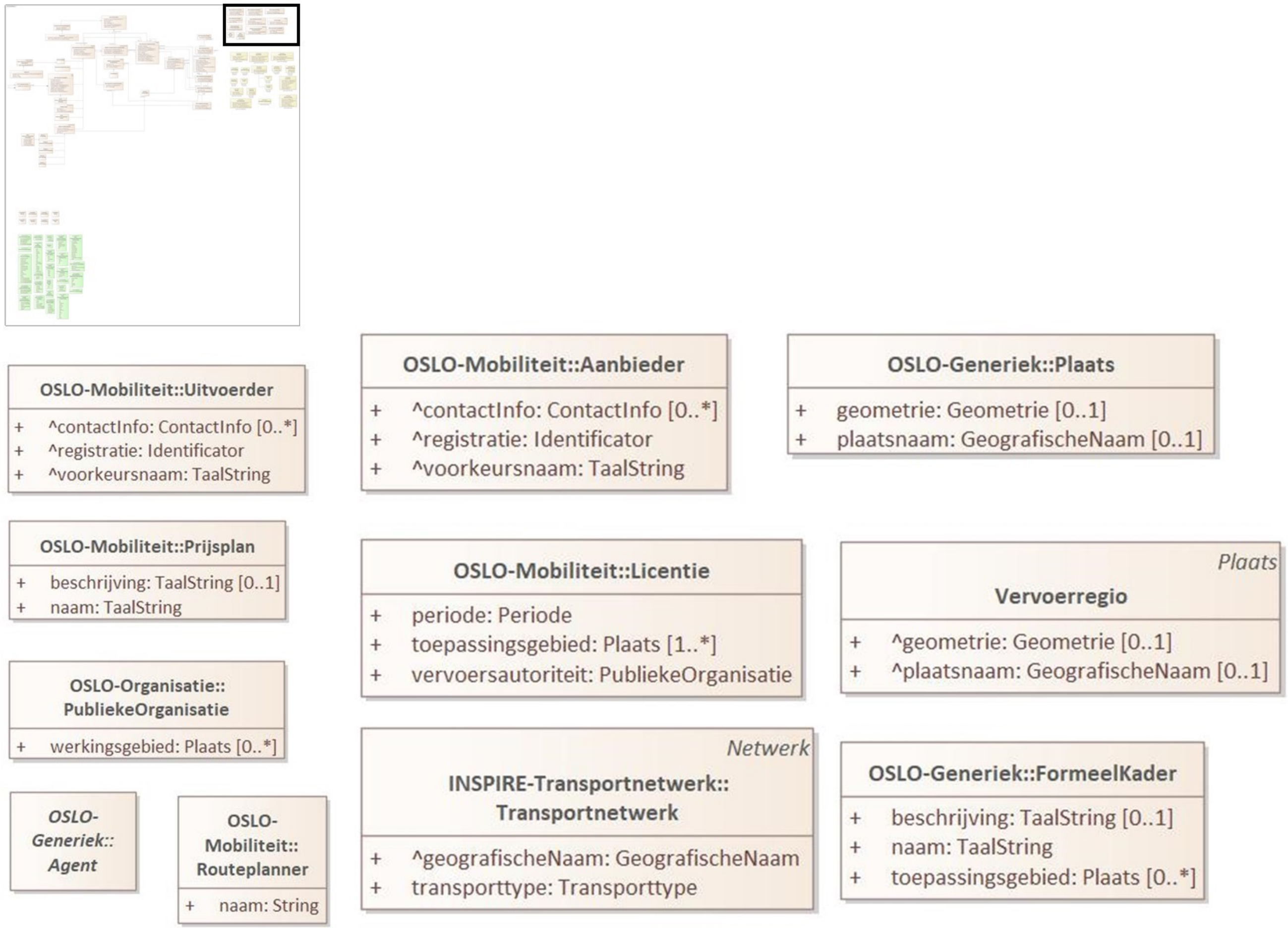

Figure 13. UML-schema of the provisional application profile 5/9

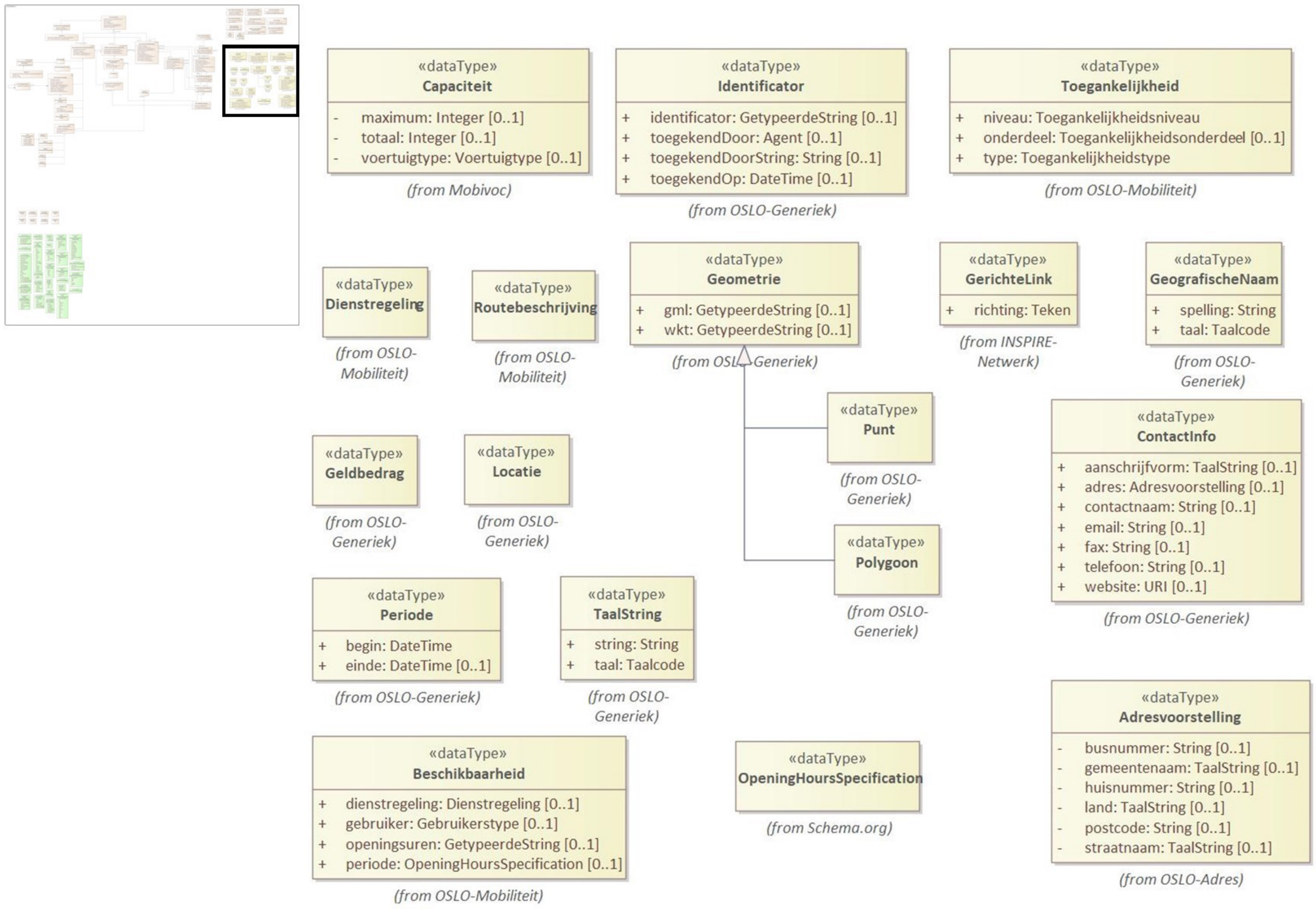

Figure 14. UML-schema of the provisional application profile 6/9

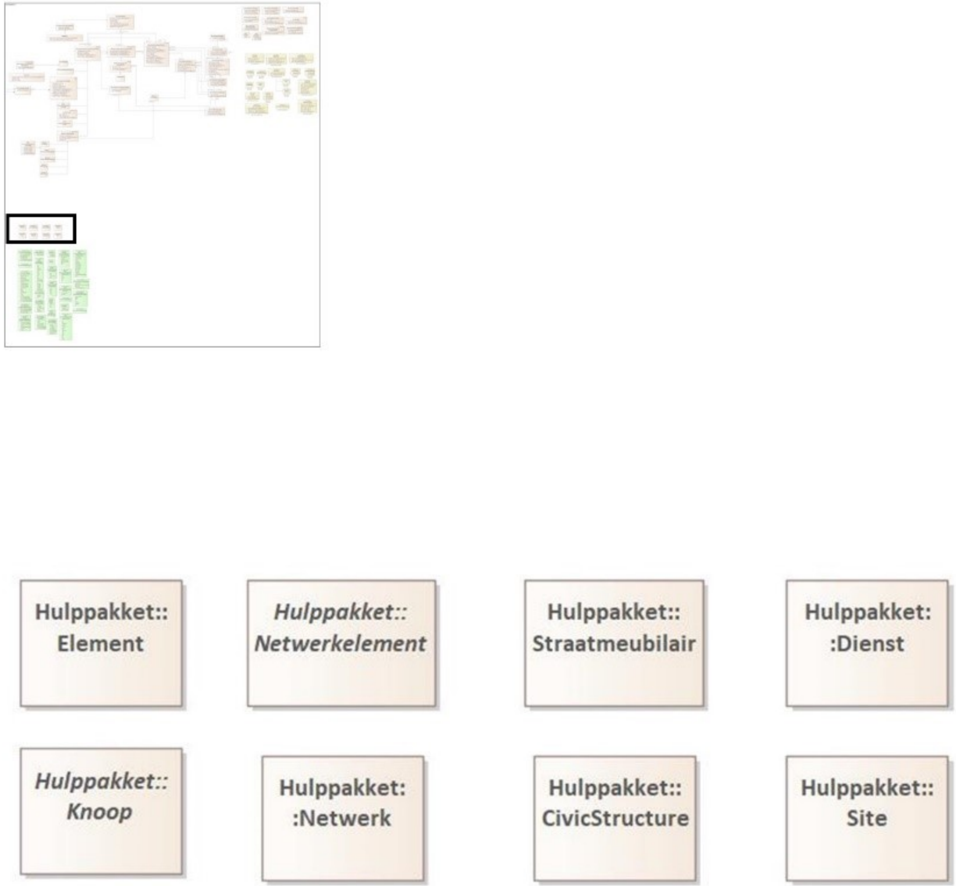

Figure 15. UML-schema of the provisional application profile 7/9

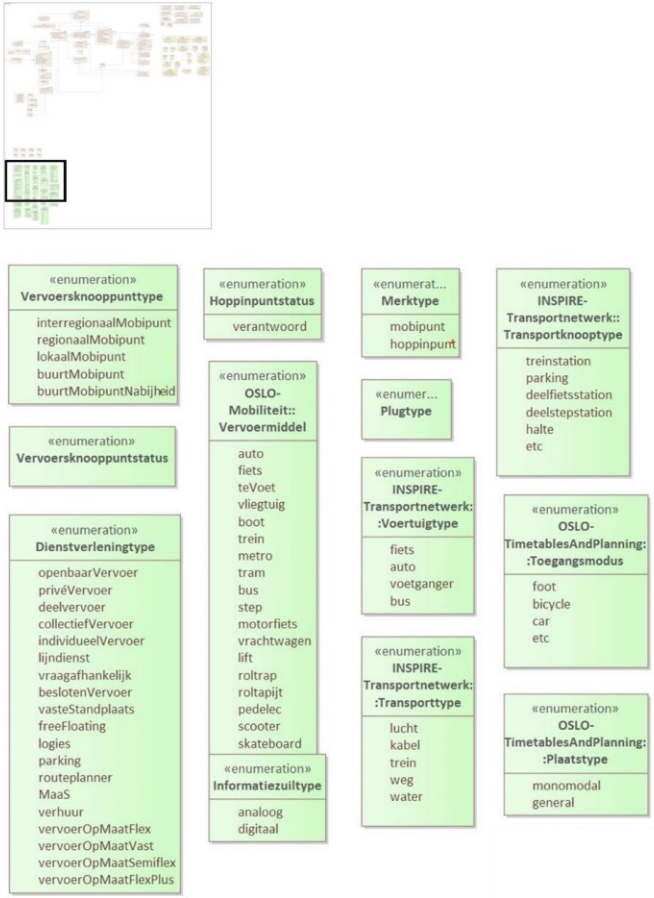

Figure 16. UML-schema of the provisional application profile 8/9

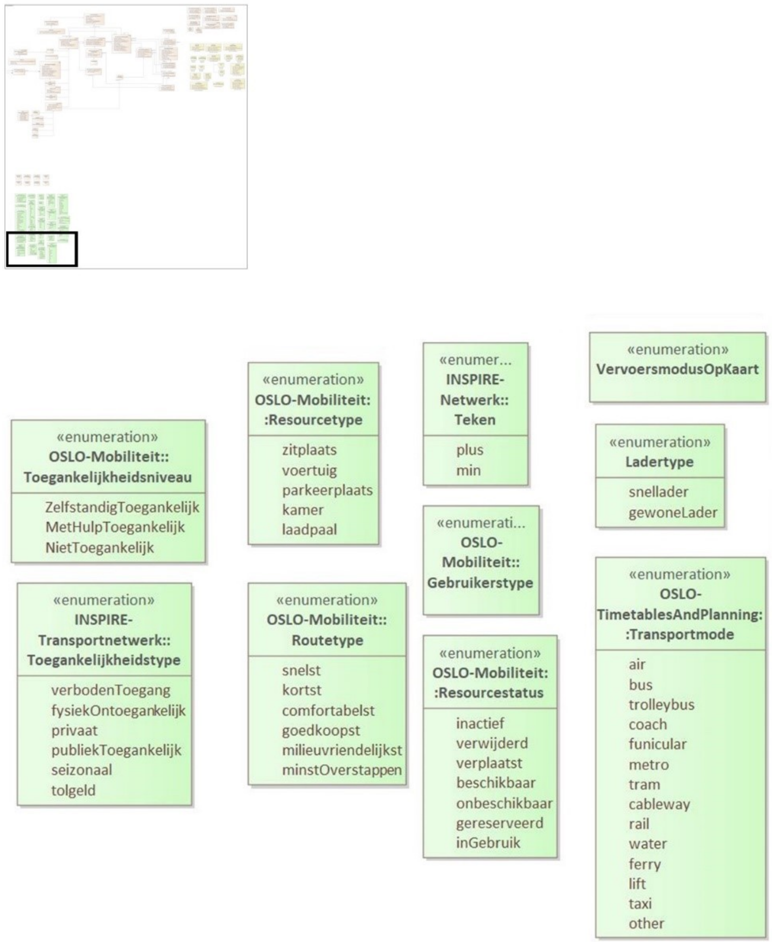

Figure 17. UML-schema of the provisional application profile 9/9