INCREASING ROAD SAFETY BY SHARING ROAD SAFETY RELATED DATA IN PUBLIC AND PRIVATE COOPERATION

data for road safety

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CONTENTS

Acronyms

Acronym	Definition
API	Application Programming Interface
CEN	Comité Européen de Normalisation (European Committee for Standardization)
DFRS	Data For Road Safety
EU	European Union
HTTPS	Hypertext Transfer Protocol Secure
JSON	JavaScript Object Notation
L2	Level 2 Data
L2’	Level 2 Prime Data
L3	Level 3 Data
MDM	Mobility Data Marketplace
MPA	Multi-Party Agreement
NAP	National Access Point
OEM	Original Equipment Manufacturer
PoC	Proof of Concept
REST	Representational State Transfer
RRP	Recommended Reference Profile
SENSORIS	Sensor Interface Specification
SRTI	Safety Related Traffic Information
XML	Extensible Mark-up Language

Table 1: Acronyms

1 Introduction

The Data for Road Safety (DFRS) ecosystem has taken the first steps towards data sharing for Safety-Related Traffic Information (SRTI) in Europe.

This ecosystem is the first project in the European Union (EU) and the largest project in the world, focusing on improving road safety by means of the large-scale use of vehicle data and aiming to improve safety on European roads, on a mutual basis. The project is unique because of the profound public-private cooperation. A proof of concept (PoC) had been carried out in several European countries, in which vehicle data was shared for the purpose of Safety-Related Traffic Information. Industry leaders have agreed to cooperate and are willing to share relevant data.

In October 2020, partners of the PoC have signed a Multi-Party Agreement (MPA) to continue the activities initiated by the PoC. This document lays out the technical foundation for the SRTI ecosystem first laid out in the PoC and then continued via the MPA.

1.1 Project Aim

The aim of the PoC was to create an DFRS ecosystem where Original Equipment Manufacturers (OEMs), service providers and public authorities can share their safety related data. The DFRS ecosystem can be thought of as an area where all safety information from all participating parties can be found (something like an internet for vehicle safety messages). The Proof of Concept tested the sending and receiving of Safety Related Traffic Information between vehicles and road authorities. The collaboration effort between consortium members means that all data shared by each member can be utilised by others in the consortium. There are no obligations for parties to use the data that is available in the DFRS ecosystem.

The DFRS ecosystem supports the implementation of existing EU laws on access to safety data. By prioritising access to safety data and enabling collaboration between vehicle manufacturers and countries, the DFRS ecosystem aims to enhance traffic safety for all road users.

2 Data Categories

The data categories in **Table 2** have been identified by the Delegated Regulation (EU) 886/2013 to be cases that are deemed safety related.

Data Category No:	Road Safety-Related Events or Conditions	Corresponding Ecosystem Description
1	Temporary slippery road.	Activation events of the electronic driving dynamic stabilisation program of the vehicle (“lamp on”), absolute friction values as detected by the vehicle (“μ”).
2	Animal, people, obstacles, debris on the road.	Object recognition from rich sensors for outside situations <u>or</u> emergency call / breakdown call from ego-vehicle, where ego-vehicles are vehicles equipped with sensor technology.
3	Unprotected accident area.	Object recognition from rich sensors for outside situations <u>or</u> emergency call / breakdown call from ego-vehicle.
4	Short term road works.	Sign recognitions of road work signs.
5	Reduced visibility.	Activation events of the vehicle light (fog lights), rain sensor data, wiper activation.
6	Wrong way driver.	Object recognition from rich sensors for outside situations <u>or</u> ego-vehicle detection by sign-recognition.
7	Unmanaged blockage of a road.	Object recognition from rich sensors for outside situations.
8	Exceptional weather conditions.	Activation events of the vehicle light (fog lights), rain sensor data, wiper activation, activation events of the electronic driving dynamic stabilisation program of the vehicle (“lamp on”), absolute friction values as detected by the vehicle (“μ”).

Table 2: Data Categories identified by Delegated Regulation (EU) 886/2013

2.1 Data Types & Definitions

Level 2 Data / Data (L2)

Data (L2) is defined as the raw data made available to the SRTI Ecosystem that can be used for creating road safety related minimum universal traffic information. This data is collected via any private and/or public source, also referred to as ‘road safety related traffic data (as defined in article 2-m of Regulation 886), also referred to as “Level 2 Data”. L2 data is made available according to different standards, with SENSORIS being one amongst others.

2.2.1 Level 2’ Data / Data (L2’)

Data (L2’) is an enriched version of Data (L2) made available to the SRTI Ecosystem and created by cross referencing the Data (L2) across multiple L2 data sources and/or through data harmonization and cleansing of the Data (L2), also referred to as “Level 2 Prime Data”.

2.2.2 Level 3 Data / Data (L3)

Any extracted, aggregated and processed road safety related traffic information made available to the SRTI Ecosystem, offered by public and/or private road operators and/or service providers to End Users through any delivery channels, also referred to as "L3 Information" or "Road Safety Related Minimum Universal Traffic Information" or "SRTI" (as defined in article 2-n of Regulation 886); L3 data is generated by merging available data, including the fusion with L2/L2' data, to an event within the (a)-(h) categorization of the Regulation 886. L3 data can extend L2' substantially with information not contained in L2'.

2.3 Roles within the SRTI Ecosystem

At each stage of the data flow architecture, there are associated roles that are to be executed by specific parties. These roles are as follows:

2.3.1 Data Source

- A Party that generates Data (L2), Data (L2') and/or Data (L3);
- The Data Source is responsible for contributing original, new content into the ecosystem; and
- A typical L2 Data Source would be a vehicle OEM contributing L2 Data to the ecosystem.

2.3.2 Data Access Interface Provider (L2)

- Provides access to L2 data;
- For vehicle L2 data usually executed by an OEM or a delegated entity; and
- For public authority L2 data usually executed by road operator.

2.3.3 Aggregator (L2 to L2')

- A Party that uses Data (L2) to create Data (L2') e.g. by harmonizing and cleansing L2 data from L2 data sources.

2.3.4 Data Access Interface Provider (L2 Prime)

- Provides access to L2 prime data (Refer to Appendix 1 - L2' Data)

2.3.5 Creator (L3)

- A Party that creates Data (L3) from varying sources including Data (L2) and/or Data (L2') and/or Data (L3) acquired through the SRTI Ecosystem and/or external data sources.

2.3.6 Data Access Interface Provider (L3)

- Provides Access to L3 data

2.3.7 Service Provider

- A Party that renders and distributes Data (L3) acquired through the SRTI Ecosystem directly to an end user (i.e. driver in vehicles).

For further technical details regarding the data flow architecture, please refer to ***Appendix 1 – Stages for Data Flow.***

3 DFRS Ecosystem Architecture

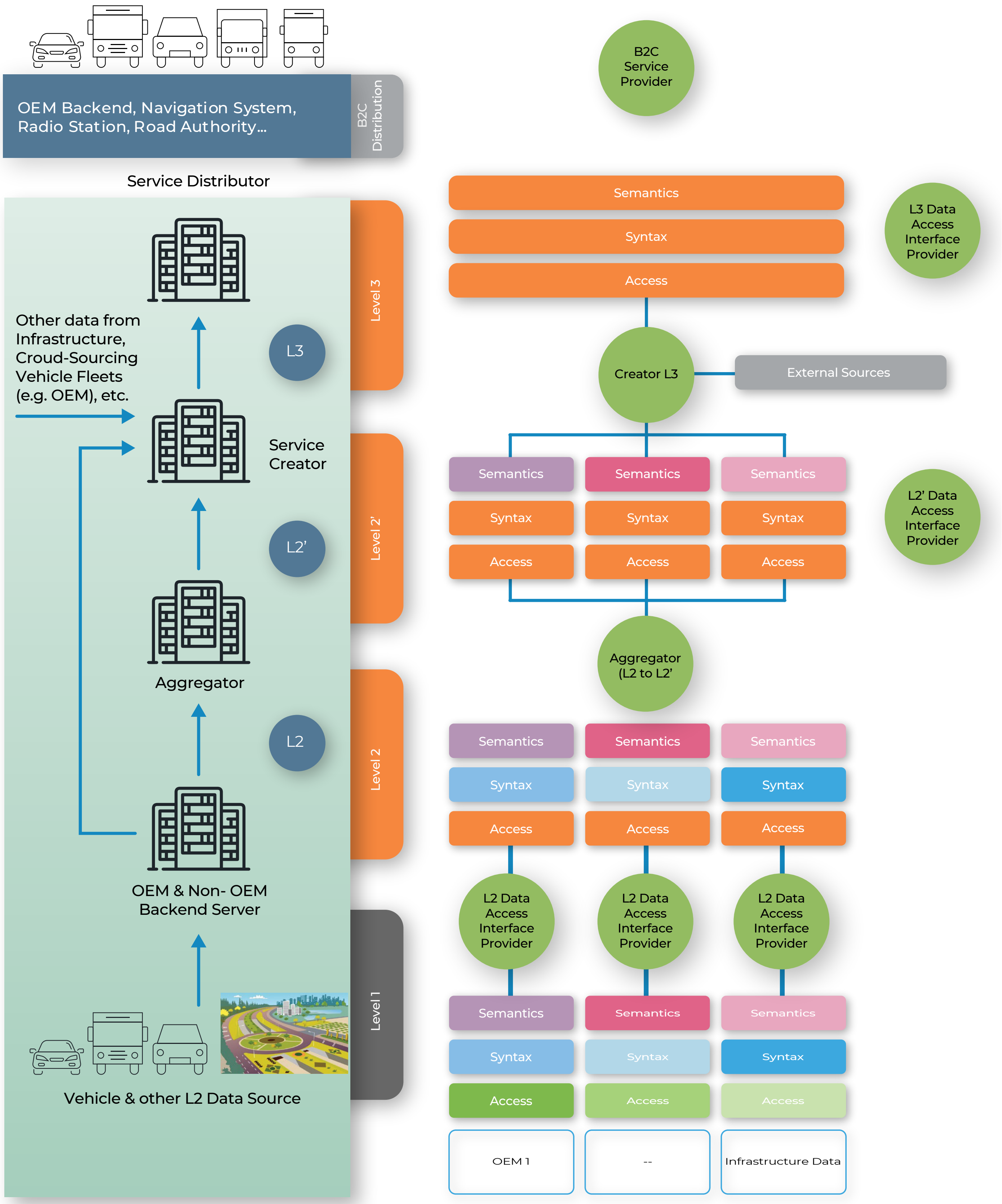

Figure 2: SRTI Ecosystem Overview Architecture

4 Members within the SRTI Ecosystem

This section will explain the types of members of the ecosystem and give some examples to provide more intuitive understanding. The examples reflect the situation as of 1 January 2022. As the membership of the ecosystem is changing dynamically, readers interested in this aspect are advised not to rely on the examples provided in this document, but to consult the ecosystem's metadata repository. As of 1st of January 2022, this is temporarily hosted on the German National Access Point *Mobility Data Marketplace*. Details how to access this repository can be found in Section 5.3.

4.1 Member types

Members are free to take the roles described above. Nevertheless, there are typical patterns, some of which are described below as informative information.

4.1.1 OEM Members

An OEM (car manufacturer) main task within the SRTI Ecosystem is to share SRTI data to all requesting parties, these data types are either L2 or L3 data types. Thus, they are a Data Source (L2 or L3).

Examples of OEM members within the SRTI Ecosystem as of 1st of January 2022 are:
BMW, Ford, Mercedes, Volkswagen, Volvo.

4.1.2 Members representing State Road Authorities

A member representing State Road Authorities has the commitment within the SRTI Ecosystem to share public authority L2 and L3 data to all requesting parties. These members are usually also associated with the respective National Access Point (NAP), as referred to in the EU Delegated Regulations in the scope of the ITS Directive.

Example of members representing State Road Authorities within the SRTI Ecosystem as of 1st of January 2022 are:
ASFINAG for AT, Danish Road Directorat for DK, National Highways for UK, TRAFICOM for FI, or the responsible Ministries for BE (Flanders), DE, ES, LU, NL.

4.1.3 Private Sector Service Providers

There are many private sector members that provide services – either business-to-business or business-to-customer – that take roles in providing, handling and processing data in the ecosystem.

Examples of private sector service provider members within the SRTI Ecosystem as of 1st of January 2022 are:
Geotab, HERE, INRIX, TomTom.

4.1.4 Associations

Beyond members actively participating in data flows inside the ecosystem, associations interested in the objectives have joined the ecosystem.

Examples of association members within the SRTI Ecosystem as of 1st of January 2022 are:
ACEA

4.2 Examples of Existing Role Holders

The following is a list of examples of the existing role holders within the SRTI Ecosystem.

L2 Data Source

- OEMs (e.g. BMW. Ford, Mercedes...);
- Infrastructure Operators (e.g. ASFINAG, National Highways, Rijkswaterstaat...); and
- Automotive Suppliers (none yet).

L2 Data Access Interface Providers:

- OEMs/Infrastructure/Suppliers operating their own data feeds (e.g. Mercedes, ASFINAG, National Highways, NIRA Dynamics...); and
- Data access providers contracted/tasked by OEM/Infrastructure/Suppliers (e.g. HERE – for BMW and Ford; NDW – for Rijkswaterstaat...).

L2/L2' Aggregator:

- HERE;
- Geotab;
- NDW; and
- Post Luxembourg.

Service Creators:

- TomTom;
- NDW; and
- Post Luxembourg.

L3 Data Interface Providers:

- Volvo;
- HERE on behalf of NIRA Dynamics; and
- Public Authorities / Road Operators (ASFINAG, National Highways, NDW).

Service Providers:

- HERE;
- Volvo; and
- ASFINAG.

5 Data

In the context of incoming sensor data to the DFRS Ecosystem, within the previously mentioned 8 use cases various sensor signals can potentially be used. However, it must be accounted for the fact, that the sensor signals in the vehicle/infrastructure can be aggregated and processed in the data supplier backend before entering the DFRS Ecosystem.

Vehicle and Infrastructure data sets are classified into the following categories:

- L2 Data;
- L2' Data; and
- L3 Data.

For further technical details refer to **Appendix 1**.

5.1 Data Standards

Data standards are important, since they

- Need to be suited for the data to be modelled; and
- Need transparent for everybody who wants to access use the data.

However, data standard descriptions are not conveying the data quality aspects of the data modelled but limit themselves to the syntactical description of the data format.

In a complex ecosystem like the SRTI ecosystem, comprising of various participants in various roles, it was considered unfeasible to stick to "one standard fits all" approach.

Following the value creation flow from bottom to top on the right-hand side of Figure 2: SRTI Ecosystem Overview Architecture, it can be said, that the variety of used standards is higher on the L2 level and should be lower on the L3 level (ideally one, as it is the case now, being DATEX II).

This is due to the nature of the SRTI ecosystem, since the L2 data provide variety is very high consisting of various OEMs and infrastructure providers like road operators.

5.1.1 Standards currently in use on L3

DATEX II

DATEX II is a standard for modelling and encoding data regarding road traffic and travel information. It focuses on data that is relevant to traffic management and for planning and performing a journey, pre- and on-trip. This standard is formally covered by the multi-part CEN 16157 series. The current standard model that covers safety related information for drivers is CEN EN 16157-3:2018. The technical documentation for implementing the standard as well as further guidance can be obtained from the DATEX II website.

The DATEX II approach supports multiple different implementation platforms, where XML – with transfer syntax being validated by an XML Schema Definition – is the reference platform and is explicitly covered by the CEN standard document. New developments include alternative encoding platforms like JSON Schema and ASN.1 Encoding Rules, but these are not yet part of the standard.

The application of DATEX II is based on generating individual data profiles from the standardised models for publications. These profiles can be chosen to be compliant to Recommended Reference Profiles (RRP) that cover compliance with Delegated Regulations from the European Commission. The Data Task Force Technical Group has produced such a profile for SRTI information created from vehicle L2/L2' data, based on the RRP for Delegated Regulation (EU) 886/2013 regarding safety related traffic information. The profile uses a mechanism in DATEX II called "Level B extensions" that can extend data models in a backward compatible way to add some small features that were seen as useful by group members but not available in this form in the model from CEN EN 16157-3.

Note that another part of the DATEX II standard series (CEN EN 16157-5:2020) is commonly used by road operators to share road sensor data (à non-vehicle L2(') data).

5.1.2 Standards currently in use on L2

SENSORIS

The Sensor Interface Specification (SENSORIS) defines an interface for requesting and sending vehicle sensor data from vehicles to clouds and across clouds. The specification and its standardisation focus on the content and encoding of the interface.

SENSORIS differentiates between the following three actor roles:

- Service Cloud;
- Vehicle Cloud; and
- Vehicle Fleet.

A vehicle is part of a vehicle fleet. The vehicles of a vehicle fleet communicate with a vehicle cloud. A vehicle cloud can also communicate with a service cloud. A cloud instance can have both the role of a vehicle cloud and a service cloud. However, if a cloud instance has only the role of a service cloud, then it cannot communicate with a vehicle fleet. An example setup could be that vehicles of an OEM vehicle fleet communicate with their OEM vehicle cloud. The OEM vehicle cloud in turn communicates also to the service cloud of a map maker.

The interface of SENSORIS defines content and encoding of the messages that are communicated between the actor roles. Data messages contain vehicle sensor data. Data messages communicated from one vehicle of a vehicle fleet to its vehicle cloud contain sensor data from the one vehicle. Data messages communicated from a vehicle cloud to a service cloud contain data from individual vehicles or aggregated data from several vehicles of a vehicle fleet. Job request messages contain jobs defining which vehicle sensor data is requested under which conditions and when the data shall be communicated to the requesting cloud. Job status messages contain information about termination of jobs. Job status messages communicated from a vehicle of a vehicle fleet to its vehicle cloud or from a vehicle cloud to a service cloud contain the reason of the termination of the job in the vehicle or vehicle cloud. Job status messages communicated from a service cloud to a vehicle cloud or from a vehicle cloud to a vehicle of a vehicle fleet request the termination of the job. Detailed description of SENSORIS and further technical information can be found in **Appendix 2 - SENSORIS Data Format.**

NB: At time of writing this document SENSORIS version 1.2 is the encouraged standard to be used.

SDII (Sensor Data Ingestion Interface)

This standard can be considered to be the precursor of SENSORIS, which historically was the first data format being used for ingesting vehicle data into the cloud for generating traffic related information. Its documentation can be found Here:

Note on access technology and message encoding:

It needs to be distinguished between the data format of the actual content (i.e. how are the messages encoded) and the access technology.

Throughout the ecosystem, there are various access paradigms being used, ranging from request/reply REST like access schemes (e.g. Daimler) towards streaming like access schemes like HERE's Open Location Platform (for providing Ford and BMW data).

This being said, additionally there are also various encoding schemes being used. REST interfaces typically offer ASCII-JSON and binary protobuf as message encoding, whereas streaming like access schemes often provide binary protobuf only.

5.2 Data Harmonisation

5.2.1 Level 2

For L2/L2' data from vehicles, it has been decided that the basic elements possible to structure such data would be agreed by all signatories. In addition, a simple set of additional attributes to describe these elements (e.g. location) were also agreed.

No specific standard of format has been prescribed, however it has been identified that the requirements for the DFRS ecosystem data are similar to that of SENSORIS standards, therefore the DFRS ecosystem has worked closely with SENSORIS to influence their latest release to include the requirements for data flow within the DFRS ecosystem. SENSORIS is used by all OEM L2 providers and is strongly recommended for new OEM L2 data sources.

There is no common specification of the actual access technology used, but all data feeds are requested to use open standards only for this purpose, and to accompany their data feed with clear guidance and documentation that is sufficiently detailed to allow system developers to implement a client against this data feed.

Further details can be found in **Appendix 3.**

5.2.2 Level 3

For Level 3 data it has been agreed to follow the recommendation of Delegated Regulation 886/2013 to provide the data encoded in DATEX II according to the CEN 161517 series of standards. The Technical group identified that the DATEX II organisation had published a Recommended Reference Profile (RRP) on the DATEX II website. This mechanism allows for the creation of data profiles that have a proven compatibility with the requirements of the Delegated Regulations. Since such RRPs are not complete data profiles, the group agreed to develop a dedicated DATEX II profile – compliant with the RRP – that would be suited for L3 data feeds created out of vehicle based L2/L2' data.

This profile has been published for direct references on the DATEX II website.

Further details can be found in **Appendix 3 DATEX II Data format**.

5.3 Metadata Repository - Mobility Data Marketplace (MDM)

For partners to know which data is available where and in what format, metadata for the data access interfaces needs to be made available to all partners. Since not all data access interfaces are public, a protected, SRTI Ecosystem partner internal metadata repository is required.

For now, all metadata is to be made available at the MDM (Mobility Data Marketplace) repository. This is the German NAP and currently acts as an intermediate solution.

The following is the step-by-step instruction for creating so-called "data publications" (metadata for one data access interface) within the MDM.

5.3.1 User certificates

In order to be able to enter and edit metadata in the MDM, a user certificate is required. The MDM operates with authentication via X.509 certificates (as opposed to username, password).

Follow the following steps to set this up:

1. Send an email to Timo Hoffmann at hoffmannt@bast.de,CC to mdm@bast.de with your affiliation/organization name, email address and mobile phone number (the mobile phone number is used to send the password for the certificate);
2. You will receive (usually the next working day at the latest) an email with a verification link. Click on the link to activate your account;
3. You will receive (usually the next working day at the latest) a X.509 certificate to your email address and the password to the mobile number you provided via text message;
4. Install the certificate to your operating system and/or browser; and
5. In case you need any help with the certificate, send an email to orga@mdm-portal.de for further help.

5.3.2 Create contact person

For each data publication, there needs to be a contact person. In order to be able to select yourself (or your organisation's) contact person for the data access interface to the Data Task Force, it is required that you create a contact person, if you have not done so already.

1. Go to https://service.mdm-portal.de;
2. Switch to English language;
3. "Log-in" (only works with installed certificate);
4. Go to "My organization";
5. "Add new contact" and add your contact details (deselect system notifications); and
6. Save.

5.3.3 Create data publication

For every data access interface that your organization is making available to the DFRS ecosystem, you must do the following:

1. Go to https://service.mdm-portal.de;
2. Switch to English language;
3. "Log-in" (only works with installed certificate);
4. Go to "Publications", "Create publication";
5. "Yes" if your publication is in DATEX II format and you want to use MDM brokering. In all other cases choose "No". In Step 2 in all relevant fields as detailed as possible:
   - Choose the right contact person (you);
   - Make it non searchable to keep the info amongst our group (for now);
   - Leave "Valid from" and "Valid to" empty;
   - Data category "Unexpected road events and conditions" (category detail empty);
   - Transport modes "Car" and "Truck" (leave at this even though data might apply for more); and
   - Conditions of use "License and free of charge".
6. In Step 3 fill in all relevant fields as detailed as possible:
   - Geographical coverage: "NUTS 0: Deutschland" (this is a known limitation of the system);
   - Road network coverage choose all "Motorways", "Federal and state roads" and "Urban roads"; and
   - Reference file could be further documentation of the data.
7. In Step 4 fill in all relevant fields for access information as detailed as possible:
   - Data format e.g. "Protocol buffers", "other", "SENSORIS".
8. In Step 5 (Confirmation) choose "no" to not submit your self-declaration to the German national body and verify your submitted information; and
9. Save publication.

6 Implementation

The following gives a simplified, more hands-on explanation of the various data levels and involved actors defined in chapters 2 and 3. Included are examples of the development work and methodologies that are required for sharing and receiving data. The examples are indicative and therefore members are under no obligations to adopt any of the approaches that have been listed below.

6.1 Data Source L2

L2 Data is collected via vehicles, infrastructure and other sources and provided to the ecosystem. The provider of such data to the ecosystem is termed "Data Source of L2 Data". L2 Data is usually an aggregation of data from several vehicles of the same OEM, aggregated by the OEM Backend. For some data types just a single vehicle provides the data. Note that any data leaving the vehicle will be the result of an internal aggregation of the vehicle's raw data. Data input from infrastructure sensors is normally deemed as L2 data as it is provided by single sensors or by an aggregation of a number of sensors of the same type. Vehicle data usually comes from the OEMs and infrastructure data from the member states. Examples of L2 Data are

- Road Weather Condition Hydroplaning (provided by OEM, normally aggregated over multiple vehicles);
- Accident (provided by OEM, from single vehicle); and
- Road Weather Condition (provided by member state infrastructure, normally aggregated over multiple sensors).

6.2 Data Aggregator

Data aggregated from different L2 Data sources is called L2 Prime Data or, in short form, L2' Data. L2' Data is usually an aggregation of the L2 Data feeds of several OEMs. The provider of such data is termed "Data Aggregator". Aggregations happen all along the data transmission chain, but as the individual sources are indiscernible only after this aggregation step, it is seen as the main aggregation. Going purely by theory the transformation of L2 to L2' is a syntactic aggregation. Data input from infrastructure sensors can be deemed L2' Data if several types of sources are aggregated.

As an example NDW acting as Data Aggregator collects and aggregates the L2-feeds of different Data Sources of L2 Data, including BMW, Daimler and Ford, and in the case of Ford has to cater for a different input format.

6.3 Creator (L3)

Data aggregated from different L2 Data, L2' Data and even other L3 Data is called L3 Data. The provider of such data is termed "Creator (L3)". Purely on the basis of definition there is no difference to L2' Data. The Difference lies in the perspective of the consumer. L3 Data is formulated as a requirement: This data holds the desired information in its most exact and timely form and no reference to how it was assembled is included. In L2' Data the exact sources are also excluded, but the mere fact that it is titled "L2'" holds the information that this data was formed in an aggregation chain from raw data via L2 Data to L2' Data. Because L3 Data can also input sources from outside of the ecosystem it has on one hand a greater verification level and on the other hand a greater susceptibility to longer latency. It might make perfect sense to process L2' Data instead of the final L3 Data when in search of lower latency. It might also make sense for a member state to provide the same data as L2 Data and as L3 Data, in order to benefit acquisitors of L2' Data and L3 Data alike.

As an example, Post Luxembourg acting as a Creator (L3) creates L3 Data from varying sources including L2 Data, L2' Data and/or L3 Data. This data is acquired through the SRTI Ecosystem and/or external data sources. The following steps were performed to fulfil this role:

1. Set up a technical architecture to get real time L2, L2' and L3 data to be combined with cold data:
   - Message queue mechanism e.g. Kafka and MQTT;
   - Specific Data Storage for high velocity data retrieval (key-value system like HBase); and
   - API implementation and exposition for data sharing.
2. Subscribe to the dedicated provider to get OEM/non-OEM L2, L2' and L3 data, implement the interfaces and data parsers;
3. Implement a L3 creation process:
   - Filter, cleanse and aggregate input data; and
   - Data quality rules.
4. Implement an API to share generated L3 data in real time in DATEX II; and
5. Expose the API through your internal API Manager and/or through the German MDM.

6.4 Data Access Interface Provider (L3)

6.4.1 OEM

As an OEM and Creator (L3) and Data Access Interface Provider (L3), Volvo holds the responsibility of providing access to L3 Data. The list below demonstrates the requirements of a Data Access Interface Provider (L3) from the perspective of an OEM. The Integration to NDW (see 6.2) interchange node work items as follows:

1. Obtaining security credentials for all environments (test + production);
2. Implementation of transformation from internal data representation format to the SRTI DATEX profile;
3. Implementation of integration adaptor to interchange node;
4. Deployment and verification in test environment; and
5. Deployment to production environment.

Table 3 summarises the different difficulty levels for each of the above steps.

Difficulty	Step
Low	1, 4, 5
Medium	3
High	2

Table 3: Difficulty levels of steps required for integration to NDW interchange node

6.4.2 Member State Road Authority

Implementation requirements

As a Creator (L3) and Data Access Interface Provider (L3), ASFINAG provides a data interface for the streaming of all of its traffic data based on the DATEX II traffic data model. Utilizing the modular implementation as described below, ASFINAG can also provide some of the data, first and foremost SRTI, additionally as a Data Source L2, thereby serving Data Aggregators with an infrastructure component in an aggregation to L2' Data. The setup of a system with registration and key-based data access did require a central data distribution server as a pre-requisite as well as the implementation of a registration portal and a data streaming frontend. The frontend is a two-tier system comprising of an xml-creator to translate database data into xml format and a REST-interface module to pack the xml data into the transmission packet for the subscriber interface.

The complete list of implemented items indicates a considerable overall effort:

- Pre-requisite: Central Data Distribution Server;
- Gateway to the Central Data Distribution Server;
- Connector Manager module to create DATEX II packets according to profiling;
- Frontend to handle subscriber polling and push transactions; and
- Web portal for registration and acquisition of Resource Keys for data access.

However, a central Data Distribution Server, which converts data from all the legacy interfaces in the field into a normalized database structure, would in many cases already exist independent of L3 services. Likewise, a web portal is usually already available, so the registration and provision of Resource Keys only have to be added on.

Implementation aspects

Modular approach

As a principle, monolithic components should be avoided. Providing an L3 data stream from various sources for various output formats in multiple versions is a rather complex endeavour, so it is advisable to stick to a highly modularized architecture. We did not build a single data transformer from database to interface, but instead ended up with a Serializer to transform data from the central database into a specific data model i.e. DATEX II & SENSORIS, or DENM Converter to convert the data into a specific format, i.e. XML, PROTOBUF, or ASN.1an Uploader, to transmit the data to the interface. This approach allows for the data to be additionally provided as L2 Data in SENSORIS format.

Asynchronous approach

In addition to providing the correct format to the interface, there is also the matter of data volume to be considered. Data passes through various gateways before arriving at the interface, which are all prone to data clogging at some point or other. Designing an asynchronous hand-over at these critical points – no "waiting" for anything at the receiving end – ensures that the clogging of one gateway does not lead to a domino effect which will eventually kill the system. Instead the fault can then be pin pointed by a monitoring system and quickly resolved.

Elementarization and versioning

As mentioned above, a key factor in being able to maintain the servicing of a number of subscribers with contrasting use cases, is to elementarize the data content, so that the subscriber picks needed elements and aggregates on his end. This also enables a high system availability, as the failure of one element or channel does not affect the others. The same goes for a strict versioning of the elements. There may be subscribers who need additional data fields in a new version. This has to be implemented while leaving the other versions untouched, as they may have had to pass a rigid test regime by other subscribers.

Tool Specification

All software was built in C# and Java environments.

The subscriber interface is realized as a REST-interface in HTTPS for polling of DATEX II, as well as PUSH variant for specific subscribers requiring this.

For authentication we use unique Resource Keys which are provided to customers via the official ASFINAG website. A resource key is unique for a resource and a customer. If another customer requests the same resource, a new Resource Key is generated.

The following is an example API call to request SRTI data:

```
https://content.asfinag.at/services/resource/<customer resource key>
```

6.5 Technical Support

Current members of the consortium should commit to providing advice and technical support to any new members joining the consortium. Should any new members require support or have any questions, they should contact the appropriate consortium member.

1

APPENDIX

Detailed Data Definitions

L2 Data

In the context of vehicle sensor data, various sensor signals can potentially be used to create one of the 8 categories of the SRTI. However, it must be accounted for the fact that the sensor signals in the vehicle can (and must be) aggregated and processed in the vehicle and/or in the OEM backend before being delivered to the outside world.

Example: A signal that is broadcasted once every 100ms on a vehicle bus might be aggregated to provide a mean value (or maximum value, or minimum value etc.) for a defined period of time before being sent by the vehicle. All data falling in that category are so-called "Level 1" data and are not further specified in the context of the EU Data Task Force.

The following shall list some examples of Level 1 data in the categories. Note, this data is not necessarily available within certain OEMs vehicles or might not be possible at all (especially in the case of object recognition capabilities based on visual sensors such as cameras, radars, LIDARs, etc) in the current state of the art:

The following data categories have been identified by the Delegated Regulation (EU) 886/2013 to be cases that are deemed safety related:

1. **Temporary slippery road:** Activation events of the electronic driving dynamic stabilization program of the vehicle ("lamp on"), absolute friction values as detected by the vehicle ("µ"), etc;
2. **Animal, people, obstacles, debris on the road:** object recognition from rich sensors for outside situations OR emergency call / breakdown call from vehicles;
3. **Unprotected accident area:** object recognition from rich sensors for outside situations OR emergency call / breakdown call from ego-vehicle;
4. **Short-term road works:** recognitions of road work signs;
5. **Reduced visibility:** activation events of the vehicle light (fog lights), rain sensor data, wiper activation, etc.;
6. **Wrong-way driver:** object recognition from rich sensors for outside situations or ego-vehicle detection by sign-recognition;
7. **Unmanaged blockage of road:** object recognition from rich sensors for outside situations; and
8. **Exceptional weather conditions:** activation events of the vehicle light (fog lights), rain sensor data, wiper activation, activation events of the electronic driving dynamic stabilization program of the vehicle ("lamp on"), absolute friction values as detected by the vehicle ("µ"), etc.

The main characteristics of L2 data are as follows:

- The data can originate from varying sources (rich sensors, classical sensors, driver behaviors, etc.);
- L2 data is pre-processed; and
- It can be discrete events or analogue values.

It is suggested, that each value two data object is categorized along the following categorization scheme, which should allow the data users to qualify the data concerning the confidence level that the data point should be treated with along the processing chain.

The following are examples of a datatype set regarding the L2 signal:

- In-Vehicle User Interface Element triggered by customer - Example: wiper, manual breakdown call);
- In-Vehicle User Interface Element triggered by vehicle regularly - Example: ABS Lamp, Stability Program Lamp);
- In-Vehicle User Interface Element triggered by vehicle rarely - Example: automatic e-call, automatic breakdown-call;
- Simple Sensor Reading, minimally processed - Example: temperature, friction value representing a known physical value;
- Locally simple combined sensor data - Example: sending ABS only if brake force <x;
- Locally complex fused sensor data - Example: rain density by locally fusing wiper frequency and rain sensor data with speed and windshield angle; and
- Complex object detection - Example: object detection by camera.

It is important to note that the provision of L2 data is the responsibility of the OEM.

L2' Data

Level 2' Data is an enriched version of Level 2 (L2) Data created by cross referencing the Data (L2) across multiple L2 data sources and/or through data harmonization and cleansing of the Data (L2), also referred to as "Level 2 Prime Data".

With the characteristics of L2 data outlined in the preceding section, the Level 2' data is characterized by processing L2 data from various sources to make the further processing more efficient.

Tasks performed in providing Level 2' data from Level 2 data can be a one or more of the following:

- Creating L2 data from various sources accessible in a consistent manner;
- Harmonizing L2 data (e.g. normalizing sensor readings from absolute values in percentage values); and
- Cleansing of L2 data for obvious errors (e.g. invalid values or locations).

The source of the original L2 data shall remain referenceable across the L2 to L2' processing to allow for the accountability of source specific characteristics. For the sake of clarity: all L2 data is by definition anonymous but may still be located by OEM. The mentioned reference ability shall only provide for the handling of source specific characteristics in the processing chain towards L2' and L3 (see below) and does not necessarily provide an OEM identification.

L3 Data Provider

How data is made available

ASFINAG provides a data interface for the streaming of all of its traffic data based on the DATEX II traffic data model. The data is secured by means of Resource Keys, which hold subscriber id, data stream and version thereof in an encrypted alphanumeric string, and which have to be included in every data poll request to the interface. In case the data is pushed to the subscriber, data is secured by means of certificates.

The Austrian National Access Point directs potential subscribers to the ASFINAG website. After registering and being cleared by ASFINAG staff, access is granted, and the subscriber can acquire Resource Keys for the desired DATEX II services.

Organization of the data

Data is organized into elementary parts in order to make it possible to service a multitude of subscribers from a variety of engineering interests. It is the data recipient who aggregates the required end product from these elements. DATEX II's profiling feature made this possible, where parts of the overall structure can be isolated. The data repository is advertised Here, complete with all necessary documentation.

European harmonization

European initiatives are gradually standardizing the elementary parts of DATEX II. The DFRS has standardized the SRTI profile, which holds all unplanned, safety relevant events. This will be followed by the Traffic Regulations profile which will hold all road regulatory.

L2 Data Field Classification

L2 Data consists of multiple attributes that are categorised as the following:

- Mandatory attributes for all messages (M) – Fields that are required for the proper function of the use case temporal and geo localization, message identification, … (e.g. longitude, latitude and timestamp);
- Message Triggered content (T); and
- Event type optional information (O) - Actual sensor readings that alone cannot derive SRTI content but may be used to identify false positives or negatives of an information (e.g. outside air temperature, actual acceleration.

Table 4 below describes L2 data and how it can be used to create L3 events.

Possible relevance to SRTI Data Types: (M – Mandatory, T – Triggered, O – Optional)

Content	Sorting ID	L2 Signals	Example of a DataType set regarding the L2 Signal	Use Case A:Temporary slippery road	Use Case B: Animal/people/ on the road	Use Case C Unprotected accident area	Use Case D: short term roadworks	Use Case E: Reduced visibility	Use Case F: Wrong way driver	Use Case G: Unmanaged blockage of a road	Use Case H: Exceptional weather conditions
Mandatory	1	Unique Identifier		M	M	M	M	M	M	M	M
Mandatory	2	Position WGS84	long, lat in WGS84coordinate system	M	M	M	M	M	M	M	M
Mandatory	3	Timestamp	time of event observation	M	M	M	M	M	M	M	M
Mandatory	4	Heading or Trace	0..360 - or list of positions	M	M	M	M	M	M	M	M
Mandatory	5	Confidence Level	A-G as per Glossary	M	M	M	M	M	M	M	M
Trigger	10	Event: Slippery Road	Boolean, Subcategory, Source Classification	T							
Trigger	10	Event: Obstacle	Boolean, Subcategory, Source Classification		T						
Trigger	10	Event: Accident	Boolean, Subcategory, Source Classification			T					
Trigger	10	Event: Road Work	Boolean, Subcategory, Source Classification				T				
Trigger	10	Event: Reduced Visibility	Boolean, Subcategory, Source Classification					T			
Trigger	10	Event: Wrong Way Driver	Boolean, Subcategory, Source Classification						T		
Trigger	10	Event: Road Block	Boolean, Subcategory, Source Classification							T	
Trigger	10	Event: "Exceptional Weather Condition"	Boolean, Subcategory, Source Classification								T
Trigger	20	System ESP	Boolean, Source Classification	T							
Trigger	20	System Traction Control	Boolean, Source Classification	T							
Trigger	20	Sensor meta: Visibility Distance	Value, Accuracy, Source Classification					T			
Trigger	20	Road Surface: Friction Value	Value, Accuracy, Source Classification	T							
Trigger	20	Traffic Sign: Road Work Signs	Compex Type, Source Classification				T				
Trigger	20	Crash	Boolean, Source Classification			T					
Trigger	20	Crash: battery cut-off	Boolean, Source Classification			T					
Trigger	20	Crash: airbag deployment	Boolean, Source Classification			T					
Trigger	20	System Automated Braking	Boolean, Source Classification		T	T					
Trigger	20	Detected Object Data	Complex Type, Source Classification		T				T		
Trigger	20	Connectivity: Ecall	Boolean, Source Classification		T	T					
Trigger Optional	30	System ABS	Boolean, Source Classification	T						O	
Trigger Optional	30	Windshield wiper	Value, Source Classification	O				O			T
Trigger Optional	30	Detected Lane Geometry	Complex Type, Source Classification		O		T				
Trigger Optional	30	Light Status: Rear Fog Light	Boolean, Source Classification					T			O
Trigger Optional	30	Traffic Sign: Road Block Signs	Compex Type, Source Classification				T			O	
Trigger Optional	30	ego-broken down vehicle	Boolean, SourceClassification			O				T	
Optional	40	Speed	Value, Accuracy, SourceClassification	O			O	O	O	O	O
Optional	40	System Emergency Braking	Boolean, SourceClassification		O	O			O	O	
Optional	40	Environment: Outside Air Temp	Value, Accuracy, Source Classification	O				O			O
Optional	40	Sensor: Brake Pedal Pressure	Value, Accuracy, Source Classification	O							
Optional	40	Dynamics: G-Forces	Value, Accuracy, Source Classification	O							
Optional	40	Chassis: Suspension	Value, Accuracy, Source Classification	O	O						
Optional	40	Environment: Humidity	Value, Accuracy, Source Classification	O				O			O
Optional	40	Environment: Luminocity	Value, Accuracy, Type, Source Classification					O			
Optional	40	Air Quality Information	Value, Accuracy, Source Classification					O			O
Optional	40	Cross Wind Detection	Value, Accuracy, Source Classification								O
Optional	40	Light status: Front Fog	Boolean, Source Classification					O			O
Optional	40	Dynamics: Dangerours slow down	Boolean, Source Classification		O	O				O	

Table 4: DFRS SRTI L3-L2 Mapping

Examples of the implementation of this interface will be showcased in a technical implementation guideline (Addendum to this document).

Stages for Data Flow

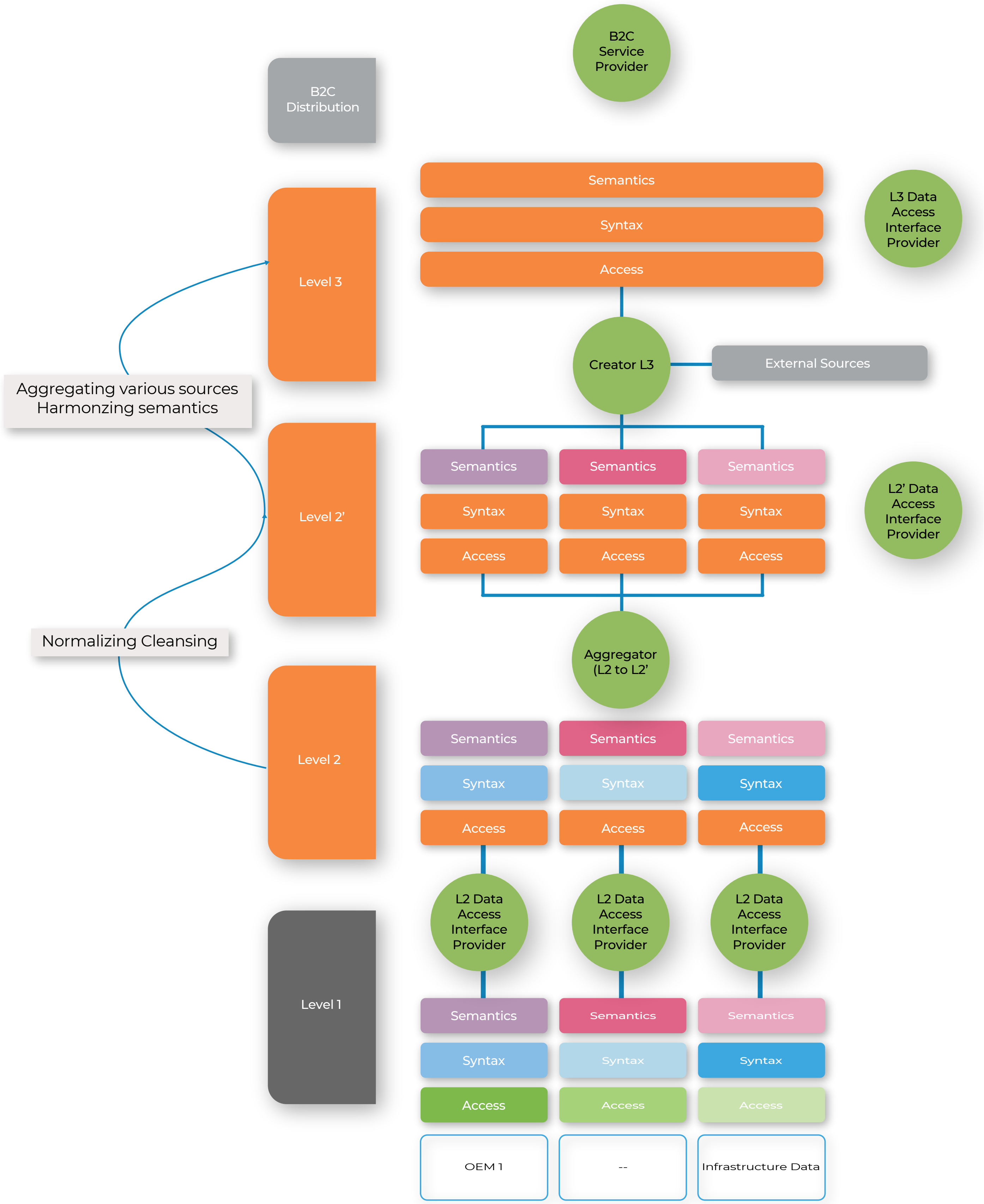

Figure 3: Stages for Data Flow

Example 1: Unprotected Accident Area

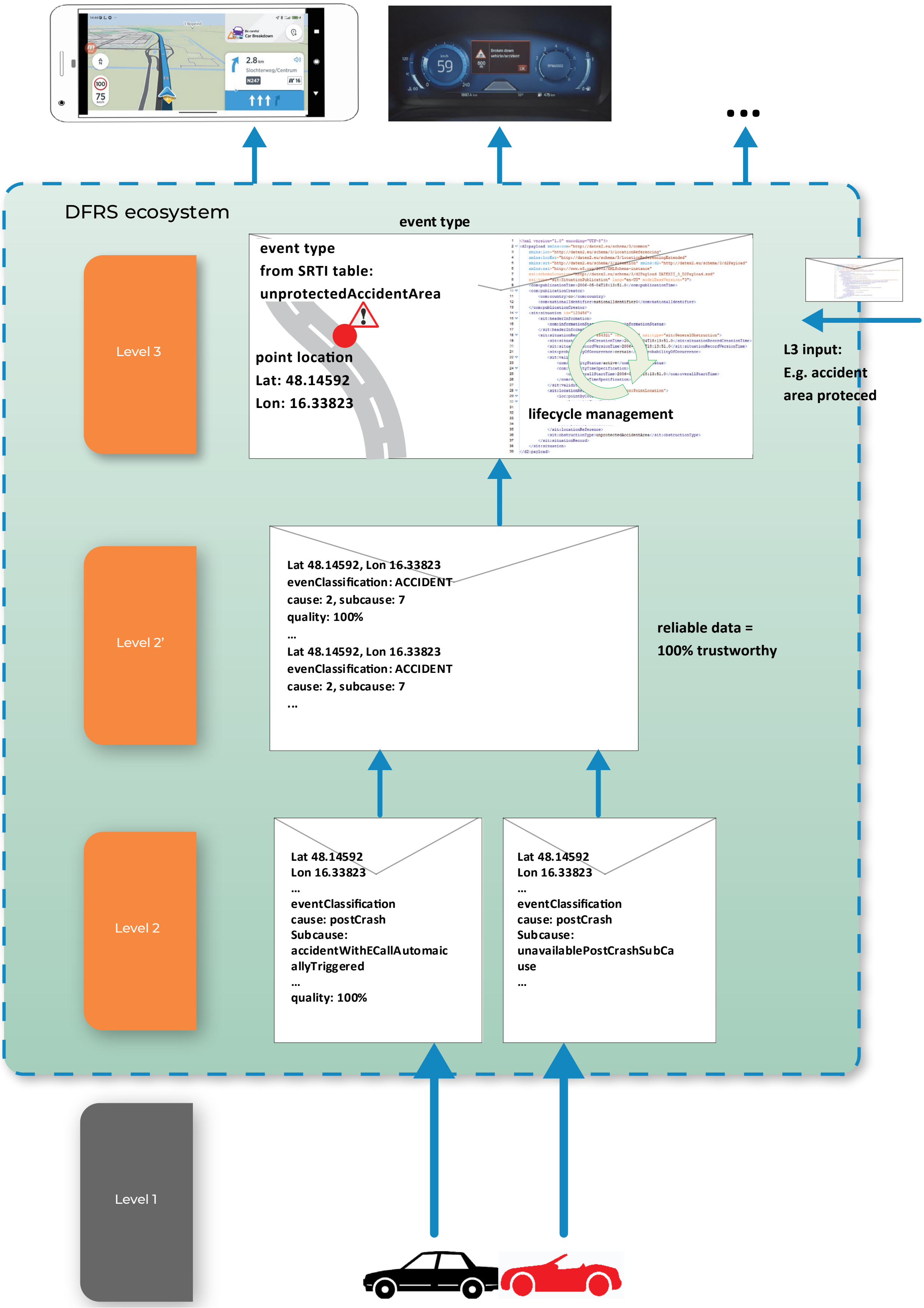

Figure 4: Unprotected Accident Area

Overall Description

A vehicle creates a trigger information about a safety related event with 100% certainty. Obvious examples are ego vehicle events with clear triggering conditions like airbag activation. Such an L2 information is forwarded immediately and unprocessed on L2'. The L3 service creator processes the information immediately into an L3 SRTI situation object.

The L3 location is processed from the L2 input. Hence, if the L2 information contains only a point location, the L3 situation also has that point location. The type of the L3 information is determined based on the SRTI table that matches cause/subcause codes to DATEX II situation record types.

Additional L3 input can be merged in, if it can be matched to the situation triggered by the vehicle data. Concrete impact of additional L3 input depends on the details of this data. It could potentially be used to validate the point location. The most important input from a merged-in L3 feed would be information management, in particular to end the situation when the situation on the road is cleared, for example because the accident area is protected.

Tasks per role

L2

- Provide an event information with sufficient minimum information to create an L3 information (position coordinates and bearing; cause and subcause code; 100% reliability indicator).

L2'

- Pass information onward immediately; don't add latency or change content.

L3

- Create an L3 situation; check/update, whether such a situation already exists (□ unlikely);
- Merge with existing information (e.g. via L3 input feeds);
- Use location from L2 input and match L2 cause / subcause code to L3 object type (select class and type specialisation value via the SRTI matching table); and
- Perform information management via L3 input (e.g. situation cleared, accident protected, etc.) – fallback is default timing.

Challenges

If we assume that the 100% trust indicator can be agreed on in a liable way, the main challenges in this scenario may be the location generation and the information management.

L3 service provider will most likely forward the vehicle position as coordinates and bearing but would also want to match the location to the road network. This is a potential source of error. L2 information from other vehicles, if any, can help. L3 input – if available – could also be used to verify the location created. Note that we use the term "L3 input" to comprise all input already on an L3 information layer, which includes e.g., operator observations via cameras or on-site reports.

The most important use of L3 input is to perform information management, since vehicle data ingested in the ecosystem will most likely trigger L3 situation creation or update, but not ending situations.

Example 2: Hazardous Driving Conditions

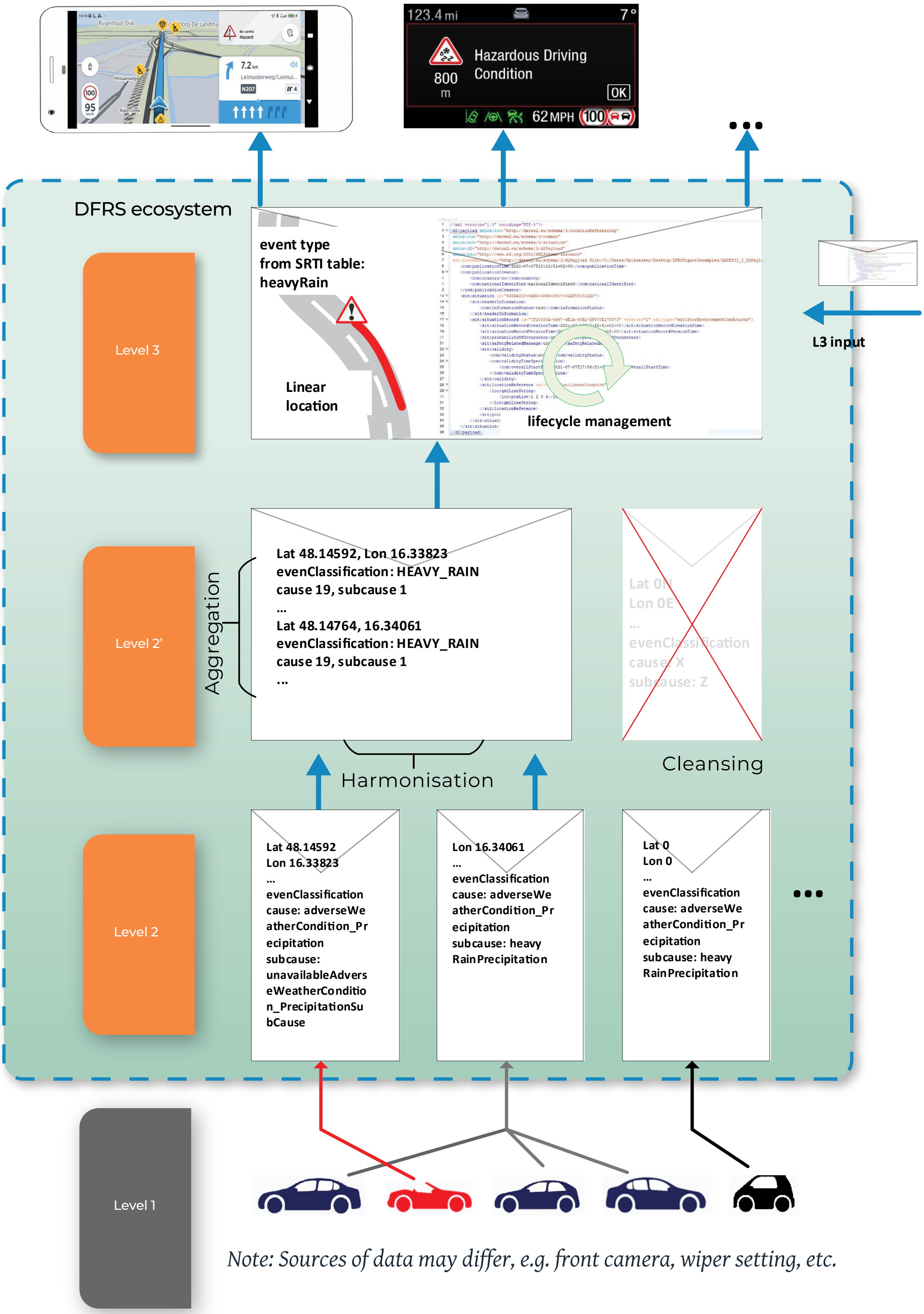

Figure 5: Hazardous Driving Conditions

Overall Description

Several vehicles in a area affected by heavy rain detect the hazardous situation. These are different vehicles from one fleet as well was vehicles from different fleets. Their L2 data structures are different, both between different vehicles/vehicle generations inside one fleet as well as between vehicles from different fleets.

L2’ creators process the incoming stream of L2 data. They perform data integrity checks e.g., to remove data sets with incorrect position coordinates (→ cleansing). They also harmonise the data set syntax e.g., in case different code sets are used (→ harmonisation) and aggregate individual L2 data sets into one aggregated l2’ data set (→ aggregation).

The L3 service creator has to process multiple of those L2’ data sets into L3 situation records, where L2’ data sets reporting a single situation type in spatial proximity are integrated into one situation record with a linear or an area location being processed from the L2’ data set position input.

Additional L3 input can be merged in, if it can be matched to the situation triggered by the vehicle data. Concrete impact of additional L3 input depends on the details of this data. It could potentially be used to validate the location. The merged-in L3 feed could also be used for information management, in particular to end the situation when the situation on the road seems to have ended.

Tasks per role

L2

- Provide an information with a safety related observation of the vehicle environment.

L2’

- Collect and aggregate incoming L2 data, potentially from multiple feeds;
- Check incoming L2 data and remove data sets with obviously invalid content ;
- Harmonise data set syntax; and
- Forward the aggregated l2’ data set to L2 service creators.

L3

- Create L3 situations based on the L2’ data by aggregating data sets of semantically matching type and spatial proximity into single L2 situation records (potentially with linear location);
- Merge with existing information (e.g. via L3 input feeds);
- Match L2 cause / subcause codes to L3 object type (select class and type specialisation value via the SRTI matching table); and
- Perform information management via analysing the continuation of L2 input against timing requirements; if possible, support the information management by observations fed in as L3 input.

Challenges

The creation and the lifecycle management of L3 situation records from a swarm of L2’ observations with different locations is a difficult task. Situation records have to be created with aggregated locations. They may have to be amended constantly, e.g. with their location extending. It may also be needed to split such objects into two, e.g. in case of fog banks separating. Finally, it has to be decided when the objects lifecycle has come to an end (e.g. via timers or – better – via L3 input). It is also not always clear, whether and how different L2’ types should be combined into one L3 object type, or whether different L3 objects should be created.

Example 3: Merging vehicle and non-vehicle data

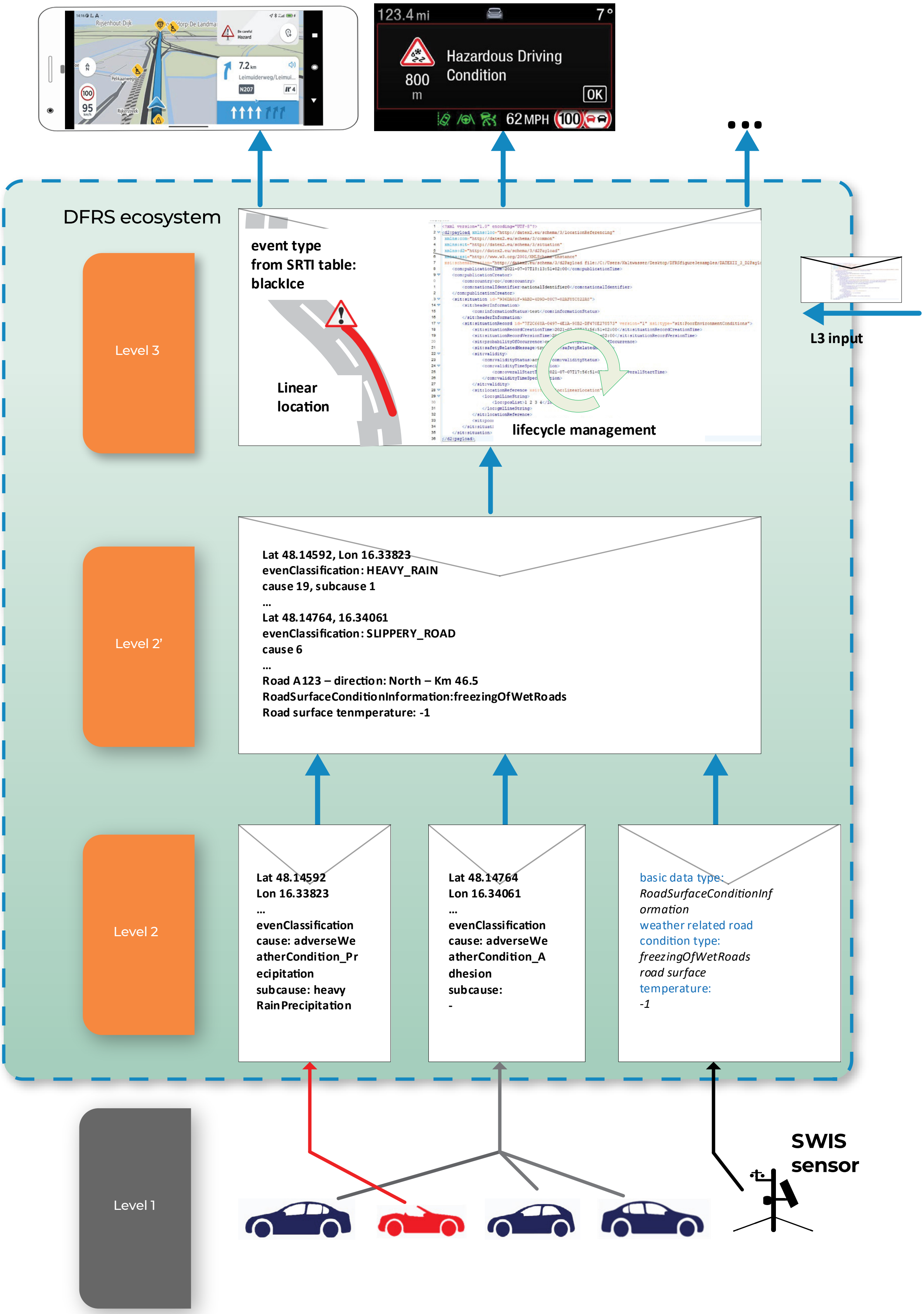

Figure 6: Merging vehicle and non-vehicle data

Overall description

L2 data may not come only from vehicles. Other, non-vehicle sources are possible e.g., like infrastructure sensors. This data maybe available only in specific areas, and it may have an entirely different data structure and syntax.

The advantage of merging vehicle and non-vehicle data lies in the fact that the different aspects of the non-vehicle L2 data may allow better L3 object creation, e.g. knowledge of surface temperature from roads sensors combined with vehicles reporting precipitation can be combined into a danger of black ice warning.

Tasks per role

L2

- Vehicle L2 as in Scenario 2; and
- Other L2 sources provide information with safety related observations together with timestamp and location.

L2'

- For vehicle L2 feeds as in Scenario 2; and
- Non-vehicle L2 may also be integrated into the aggregation task.

L3

- As in Scenario 2, with specific processing for non-vehicle L2 data and matching this with the vehicle L2' generated information. Note that the L3 service creator has to be able to process the non-vehicle L2 input data syntactically and semantically, which may differ significantly from the processing of vehicle generated L2' input.

Challenges

Different types of non-vehicle L2 may have very diverging formats, semantics and processing requirements. Matching these with streams of vehicle generated L2' data adds another layer of complexity. The trade-off for this complexity is the potentially substantial increase in L3 data quality that is possible, where non-vehicle L2 input is available for merging.

2

APPENDIX

SENSORIS Data Format

As stated in the specification documentation on the website ,

"The Sensor Interface Specification (SENSORIS) defines an interface for requesting and sending vehicle sensor data from vehicles to clouds and across clouds. The specification and its standardization focus on the content and encoding of the interface."

It is therefore well suited as protocol for delivering L2 data into the SRTI ecosystem.

Encoding is done using the protobuf standard, as of 2021 in the version 3, see https://developers.google.com/protocol-buffers/.

The data model of SENSOR-IS is well documented (see e.g. V 1.2.2 as of 09/2021, https://sensoris.org/wp-content/uploads/sites/21/2021/09/sensoris-specification-v1.2.2-public-1.zip

sensoris/protobuf/messages/data.proto

sensoris.protobuf.messages.data

DataMessage

Data message.

Field	Type	Description
envelope	DataMessage.Envelope	Envelope.
event_group	repeated EventGroup	Event group.
event_relation	repeated DataMessage.EventRelation	Event relation.
event_source	repeated DataMessage.EventSource	Event source.

As an example, a json representation (for better readability) of a L2 message (Example: BMW fog message) is given below.

Reading the example, one can follow along the structure of the DataMessage and the EventGroup:

Group of events with same origin.

Field	Type	Description
envelope	EventGroup.Envelope	Envelope.
localization_category	sensoris.protobuf.categories.localization.LocalizationCategory	Localization category.
object_detection_category	sensoris.protobuf.categories.objectdetection.ObjectDetectionCategory	Object detection category.
weather_category	sensoris.protobuf.categories.weather.WeatherCategory	Weather category.
driving_behavior_category	sensoris.protobuf.categories.drivingbehavior.DrivingBehaviorCategory	Driving behavior category.
intersection_attribution_category	sensoris.protobuf.categories.intersectionattribution.IntersectionAttributionCategory	Intersection attribution category.
road_attribution_category	sensoris.protobuf.categories.roadattribution.RoadAttributionCategory	Road attribution category.
traffic_regulation_category	sensoris.protobuf.categories.trafficregulation.TrafficRegulationCategory	Traffic regulation category.
traffic_events_category	sensoris.protobuf.categories.trafficevents.TrafficEventsCategory	Traffic events category.
traffic_maneuver_category	sensoris.protobuf.categories.trafficmaneuver.TrafficManeuverCategory	Traffic maneuver category.
brake_category	sensoris.protobuf.categories.brake.BrakeCategory	Brake category.
powertrain_category	sensoris.protobuf.categories.powertrain.PowertrainCategory	Powertrain category.
map_category	sensoris.protobuf.categories.map.MapCategory	Map category.

First, the localization category gives the position of the event

Then the actual message "weather category" is given.

Weather category.

Field	Type	Description
envelope	sensoris.protobuf.types.base.CategoryEnvelope	Envelope.
precipitation	repeated Precipitation	Precipitation.
atmosphere_condition	repeated AtmosphereCondition	Atmosphere condition.
wind_condition	repeated WindCondition	Wind condition.
visibility_condition	repeated VisibilityCondition	Visibility condition.

Since "Fog" is considered to be a visibility condition, this type is used:

VisibilityCondition

Visibility condition.

Field	Type	Description
envelope	sensoris.protobuf.types.base.EventEnvelope	Event envelope.
type_and_confidence	VisibilityCondition.TypeAndConfidence	Type and confidence of type. If type is NONE, then distances shall not be set.
visible_distance_and_accuracy	sensoris.protobuf.types.base.Int64ValueAndAccuracy Unit Meter Resolution 1 Range [0,)	Visible light distance and accuracy.
sensor_detection_distance_and_accuracy	sensoris.protobuf.types.base.Int64ValueAndAccuracy Unit Meter Resolution 1 Range [0,)	Non visible light (sensor) distance and accuracy.

Supported event relations
1 sensoris.protobuf.categories.weather.VisibilityCondition IMPACT 1 sensoris.protobuf.categories.trafficevents.Hazard

VisibilityCondition.TypeAndConfidence.Type

Type.

Name	#	Description
UNKNOWN_TYPE	0	Unknown.
CLEAR	1	No impact on visibility.
MIST	2	Mist with no impact on visibility.
LOW_HEAVY_RAIN	3	Heavy rain with impact on visibility.
LOW_HEAVY_SNOW	4	Heavy snow with impact on visibility.
LOW_SMOKE	5	Smoke with impact on visibility.
LOW_FOG	6	Fog with impact on visibility.
LOW_SUN_GLARE	7	Sun glare with impact on visibility.

It is important to understand, that a single vehicle observation needs to be categorised concerning its "quality" – Sensoris starting with Version 1.2 accommodates this issue with the field "detection type" in the event envelope:

Event envelope is the mandatory first field of each event.

Field	Type	Description
id	google.protobuf.Int64Value Unit 1 Resolution 1 Range [1,)	Identifier, shall be unique for all events in a data message.
timestamp	Timestamp	Timestamp. This is the timestamp of when the event has been detected. In case of a longer identification cycle, the actual timestamp of detection needs to be back-calculated. Example: At time t = 10, a traffic sign is observed with the camera sensor. At time t = 15, the processing unit calculates the existence and position of the traffic sign, then the traffic sign event with t = 10 is to be created, so that the relative position fits to the localization of the vehicle at t = 10 in the sensoris.protobuf.categories.localization.VehiclePositionAndOrientation event.
detection_type	EventEnvelope.DetectionType	Detection type. Basic description of the processing of the source to determine the additional complexity of the source reading.
extension	repeated google.protobuf.Any	Proprietary extension. An event proprietary extension provides additional information for the specific event, e.g. provides metadata for the set event fields or adds additional information that is not part of the SENSORIS specification.

EventEnvelope.DetectionType

Detection type.

Field	Type	Description
type	EventEnvelope.DetectionType.Type	Type.

EventEnvelope.DetectionType.Type

Type.

Name	#	Description
UNKNOWN_TYPE	0	Unknown.
TRIGGERED_MANUALLY	1	Manually triggered message (e.g. if hazard warning lights is triggered).
TRIGGERED_AUTOMATED_REGULAR	2	Automatically triggered message (e.g. if ABS event is activated).
TRIGGERED_AUTOMATED_RARE	3	Automatically triggered message (e.g. if airbag is deployed).
READING_SINGLE	4	A value based from a single continuous sensor reading with minimal processing (e.g. outside air temperature).
READING_SIMPLE	5	Locally simple fused value from continuous sensor reading with some minimal processing (e.g. vehicle speed as the average speed of the four values of the wheels).
READING_FUSION	6	Locally complex fused sensor data (e.g. rain density by locally fusing wiper frequency and rain sensor data with speed and windshield angle).
COMPLEX	7	A value derived from complex calculation. This could also be calculations that come from a black box device (e.g. object detection result by camera).

This mechanism shall convey the "trustworthiness" of the single message in the processing chain further upwards towards L3. A "Triggered Automated Rare" example would be e.g. an automated e-call, which is considered to be so rare, that nobody will ever misuse that. This would indicate towards the post processing, that this event can be treated with "higher" trustworthiness.

Please also note, that the actual values given in the fields can be interpreted differently across various data sources (e.g. OEMs). It could be a task of an L2' aggregator role in the ecosystem to normalize these possible different usages across various L2 sources.

```
{
  "envelope": {
    "version": {
      "major": "1"
    },
    "submitter": [{
      "primaryId": "BMW AG"
    }]
  },
  "dataMessage": [{
    "eventGroup": [{
      "localizationCategory": {
        "vehiclePositionAndOrientation": [{
          "positionAndAccuracy": {
            "geographicWgs84": {
              "longitude": {
                "value": "-404497000"
              },
              "latitude": {
                "value": "5577387200"
              }
            }
          },
          "orientationAndAccuracy": {
            "eulerVehicle": {
              "yaw": {
                "value": "21515"
              }
            }
          }
        }, {
          "envelope": {
            "timestamp": {
              "posixTime": "1617092099517"
            }
          },
          "positionAndAccuracy": {
            "geographicWgs84": {
              "longitude": {
                "value": "-404504300"
              },
              "latitude": {
                "value": "5577381900"
              }
            }
          },
          "orientationAndAccuracy": {
            "eulerVehicle": {
              "yaw": {
                "value": "21515"
              }
            }
          }
        }, {
          "positionAndAccuracy": {
            "geographicWgs84": {
              "longitude": {
                "value": "-404511300"
              },
              "latitude": {
```

```
                "value": "5577376500"
              }
            }
          },
          "orientationAndAccuracy": {
            "eulerVehicle": {
              "yaw": {
                "value": "21515"
              }
            }
          }
        }]
      },
      "weatherCategory": {
        "visibilityCondition": [{
          "envelope": {
            "timestamp": {
              "posixTime": "1617092100000"
            },
            "detectionType": {
              "type": "READING_FUSION"
            }
          },
          "typeAndConfidence": {
            "type": "LOW_FOG"
          }
        }]
      }
    }]
  }]
}
```


The above code is presented for information and can be accessed for use through the DFRS GitHub found HERE.

3

APPENDIX

DATEX II Data Format

Rationale

The signatories of the Multi-Party Agreement have agreed to use DATEX II to encode SRTI Level 3 data. They further agreed to use a common DATEX II profile, based on the SRTI *Recommended Reference Profile* which ensures compliance with the Commission Delegated Regulation (EU) 886/2013. This RRP is based on the common mapping table from DR886 to ITS standards, jointly developed by the DATEX II Program Support Action, TISA and the Amsterdam Group.

DATEX II model used

The profile is based on the DATEX II Situation package, which was downloaded from the website as a DATEX II pre-assembled package[1], containing the packages Common, LocationReferencing and Situation. The package contains also an empty Extension package, which has been filled by two DATEX II Level B extensions to extend the classes Linear and Point. The extensions provide one attribute respectively that takes up the corresponding location references – i.e. either a point or a linear – in OpenLR binary format. This format was preferred to the structured OpenLR encoding capabilities that exist in the LocationReferencing package.

Selection agreements

Based on this model, a selection was performed to define the common L3 profile. The selection was based on the SRTI RRP and no RRP-governed elements were de-selected.

The profile was created on the following principles, which had been agreed amongst the signatories:

1. ***Additional values that allow adding further detailed information to the classes used in the SRTI mapping table:*** It was agreed to keep these out of the DFRS profile initially, unless we get concrete requirements for certain attributes to be included from DFRS partners that want to provide the respective information details;
2. ***Data elements to specify time validity aspects beyond overalStartTime and overallEndTime:*** It was agreed that no further timing details are required/available for SRTI information;
3. ***Optional classes to further detail the SiutationRecord base class of all SRTI events:*** It was agreed that these classes are not suitable/relevant for SRTI information, if the L3 information is created out of L2 vehicle data. In case that partners fuse non-vehicle L2 or L3 data feeds into the L3 generation process, they should state concrete requirements if they need any of these data elements;
4. ***Location referencing:*** The following agreements were made to tailor the location referencing options in the profile:
   - Only point and linear locations are used (i.e. no area locations);
   - Options based on EN ISO 19148 and TPEG location referencing are not selected;
   - ALERT-C location referencing is supported as an option for points and linears – in both cases only ALERT-C Method 4 (including offset distance from pre-defined location points) is used for SRTI; ALERT-C linears by AlertCLinearByCode is not selected;
   - OpenLR location referencing is supported as an option for points and linears, but not the structured model available in DATEX II, but the binary encoding provided by OpenLR – this encoding is introduced as a string via a Level B extension; and
   - Co-ordinate based location references for points and linears (PointByCoordinates, GmlLineString) are used and made mandatory, to achieve interoperability with all clients. Note that the GmlLinearRing specialisation for GmlLineString is excluded, since it is used for area locations.

1 https://docs.datex2.eu/

Application

The profile is provided in a package with the following documents:

- SRTI L3 Profile Briefing Note 00-04-00.pdf: an entry point documentation into the package;
- DATEX II PIM v3.1 with OpenLR binary 00-01-00.eap: the DATEX II pre-packaged Situation UML model including the OpenLR binary extensions;
- DATEX II PIM v3.1 with OpenLR binary 00-01-00.xml: the XMI export from the UML model above needed for the profile generation;
- L3Profile 00-04-00.sel: the selection file that represents the data profile in the schema generation process (note that the version number may increase if additional requirements are added to the profile selection); and
- ITSTF20001 - SafetyRelatedMessageSets 1.2.xlsx: the DR886 mapping table which is the basis for the current RRP as well as this profile.

A folder named DATEXII_v3.1_L3_Profile with the following content:

DATEXII_3_Common.xsd
DATEXII_3_D2Payload.xsd
DATEXII_3_Extension.xsd
DATEXII_3_LocationReferencing.xsd
DATEXII_3_Situation.xsd
-- all these are the schema files created for the different namespaces by the DATEX II schema generation tool[2] based on the profile data above
instance1 00-01-00.xml
-- an example file with a valid message instance for testing purposes

The following options of using the package are possible:

Implementation of the whole profile

If you want to implement the profile "as-is", you simply use the provided XML schemas (*.xsd files in the subfolder) for creating the serialisation functions of your interface, e.g. for data binding.

Creating a sub-schema

If your system does not handle all the data elements in this profile, you can create a tailored sub-schema for your system. This will reduce the implementation costs for clients that only want to connect to your data feed. Note that the DATEX II methodology and toolkit ensure that all valid SRTI instances against such a sub-schema are by definition also valid against the full profile schema, i.e. this step does not create interoperability problems.

In order to create a sub-schema, follow the following steps:

1. Put the package in a folder on your hard disk;
2. Open the DATEX II schema creation wizard at https://webtool.datex2.eu/wizard;
3. In Step 1 – Source: Go to the "Your own model" tab; then click on the Browse... button and select your XMI file ("DATEX II PIM v3.1 with OpenLR binary 00-01-00.xml") from your local folder; click on "Next";
4. In Step 2 – Selection file: Go to the "Your own selection" tab; then click on the Browse... button and select your .sel file ("L3Profile 00-04-00.sel") from your local folder; click on "Next" ;
5. In Step 3 – RRP Selection: Select the "C: SRTI: Delegated Regulation (EU) 886/2013" option;

2 https://webtool.datex2.eu/wizard

6. In Step 4 – Profile Location: simply click on “Next” (the profile options are already chosen in the selection file loaded in Step 3);
7. In Step 5 – Selection: Now go through the selection tree and de-select the elements that your system does not support; Note that the tool will warn you if you de-select elements governed by the DR, but that is OK if your system doesn’t hold the content; Do not change the multiplicity of pointByCoordinates and gmlLineString, since we have agreed to make these mandatory IMPORTANT: do not add elements, a sub-schema can only remove (optional) elements in order to stay interoperable;
8. In Step 6 – Options: select the “Save selection to file selection.sel” to make sure you have your modified selection available for future iterations; use this file in Step 2 instead of the selection file provided initially with the package; and
9. In Step 7 – Finish: save the ZIP with the schema files you have created and the corresponding selection file (see Step 6) on your hard disk and proceed with them towards interface implementation as described in the previous section.

Extending the schema, extending the model

If the model or the selection in the schema are not sufficient for your data feed, do not extend the model/ selection yourself. Contact the Tech Group to discuss modifications, which would then be made available for all users of the package.

4

APPENDIX

SRTI Ecosystem – Entrant Information and Self-Declaration Form

New entrants need to hand in a document containing information related to their (planned) role in the SRTI Ecosystem and available (or planned) data access interfaces. The SRTI ecosystem works best if the following technical requirements are met:

1. The data and the data access interface are thoroughly documented;
2. The data access interface uses open standards exclusively; and
3. Metadata for the data access point is made available in the SRTI ecosystem's metadata repository (**see chapter 5.3**).

The following information needs to be provided by all new entrants:

- Organizational profile; and
- Declaration of what technical role(s) the applicant wishes to fulfill in the SRTI ecosystem together with a short description of planned activities in this context.

Some metadata of provided data or data access interfaces.

The MPA mandates the use of a form to provide information and a self-declaration regarding the new entrants' role(s). The next two pages are a template to be used for this.

SRTI Ecosystem - Entrant information and self-declaration form
Form Version 05.10.2020

Organisational Profile

Party (organisation name)	
Authorised signatory representing the Partner	
Contact person (project management, General Assembly representative)	
Contact person (technical working group representative)	
Motivation	
Declaration of what technical role(s) the entrant wishes to fulfil	☐ Data Source of ☐ L2 vehicle-generated data ☐ L2 non-vehicle data ☐ L3 data - vehicle-based ☐ L3 data - non-vehicle-based ☐ L2 Data Access Interface Provider * ☐ Aggregator (L2 to L2') ☐ L2' Data Access Interface Provider * ☐ Creator (L3) ☐ L3 Data Access Interface Provider * ☐ Service Provider ☐ National Access Point ** Note: A 'Data Access Interface Provider' is no Party to the Multi-Party Agreement and thus has no voting rights in the General Assembly.*
Data interest	
Timeline	

Data Provided

Name of dataset	
Description of dataset	
Who collected or created the data?	☐ Our organization ☐ Another organization:
Who is managing the data access interface for the data?	☐ Our organization ☐ Another organization:
Data Level	
Description of measures taken to ensure that the data provided is not person identifiable	
Start date of publication	
Area covered by publication	
Transportation mode(s)	
Data format - Encoding	
Data format - Syntax	
Data format - Data Model	
Data format description	
Access interface	
API documentation	
Additional information	

(add additional tables if more than one dataset / data access interface is provided)

If interested in applying to join the SRTI ecosystem, please extract the last 2 pages of the document for submission or use the separately provided entrants word document.

WSP has been acting as Tech Group Chair and coordinator for DFRS on behalf of National Highways at the time of authoring this publication, as such WSP has contributed to the development of this report as well as the provision of the report template.