

# NordicWay Service Definitions Messages

NordicWay 2

Deliverable D22:2 (Part 2)

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## Document Information

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## 1 Introduction

### 1.1 This report

The NordicWay2 Grant Agreement includes a set of tasks related to Activity 2 Technical Coordination. Relating to system design the most important tasks are:

- Improvement of the core architecture designed under the Action NordicWay 2014-EU-TA-0060-S by bringing in the additional services being piloted under Activities 5, 8 and 9. This work will include the development of detailed definitions of each chosen service, including the definition of data value chains, definition of service levels and quality requirements and the definition and agreement on partnership models within NordicWay2 for future full scale implementation.
- Expansion of the security functionality of the Interchange Network defined under the Action NordicWay 2014-EU-TA-0060-S by including confidential channels and improving the granularity of the geo-lookup functions to accommodate use also for applications with high requirements on geographical precision (e.g. intersection level). The security framework will fit with appropriate parts of the security framework developed by the C-ITS Platform working group and will contribute to the security development within C-Roads.

This work is to be reported in deliverables which after adoption by the Project Management Board also constitute formal milestones of NordicWay2. This document is part of the deliverable on Service Definitions (D22:2) describing messaging.

### 1.2 Relation to C-Roads

The results reported from NordicWay2 concerning Service Definition and Architecture (including this deliverable) are also provided as input to C-Roads. As the documents have been developed following not exactly the same time schedule as C-Roads, eventual differences between the NordicWay and the C-Roads documents shall be understood as an effect of this rather than being intentional. The work objective is to have fully synchronized results from the projects.

The NordicWay approach differs from the approach of the C-Roads specifications in two ways, the use of DATEX II for provision of C-ITS services and the role of service providers in message generation.

- In NordicWay2, DATEX II (in addition to ETSI standard messages) is used for transmission of C-ITS/ITS related information. The DATEX II messages are communicated between service operators as payloads of AMQP messages following the C-Roads defined BI interface [TF4-BI].
- In the C-Roads ecosystem perspective, the focus has been on communication involving Road Operators and Vehicles equipped with certified OBUs (On-Board Units). The NordicWay2 perspective allows other service providers to provide C-ITS related information based on information collected from different sources.

### 1.3 Purpose of document

The purpose of this document is to provide specifications for harmonized representation of C-ITS/ITS messages being communicated and exchanged during C-ITS service provision in the NordicWay2 Pilots. The specifications include:

- Rules for encoding C-ITS/ITS messages in terms of DATEX II and ETSI standards;
- Rules for mapping between DATEX II and ETSI standard representations of C-ITS/ITS messages.

The specifications are developed with the aim of being compatible with the specifications which are developed in C-Roads. With this in view, message profiles are defined following the same structure and format which are used in the C-Roads specifications, and by reusing profiles from these specifications.

In addition, the document provides an overview of the considerations and solutions with respect to mappings between DATEX II and ETSI standard on one hand the message standards used for communication via cellular links in the NordicWay2 Pilots on the other.

The document is the second part of the deliverable (D22:2) of the Task: NordicWay Service Definition, of the NordicWay2 project. The first part describes the C-ITS services and use cases being deployed in the NordicWay2 Pilots and the communication environment in which these services and use cases are deployed. The two documents provide the final specifications for Service Definitions based on revisions and updates following Pilot experiences.

## 1.4 Scope

### 1.4.1 NordicWay2 Pilots

The NordicWay2 project includes 3 Pilots which implement C-ITS services. These Pilots are managed and operated by the Norwegian, Finnish and Swedish partner, respectively. Pilot execution is from June 2019 to May 2020.

Table 1 provides an overview of the Pilots.

Pilot	Description	Responsible Partner
Norwegian Pilot 1: C-ITS Services	The Pilot builds on the C-ITS Platform – with a focus on the rural road network. The benefits of C-ITS services and use cases to road users, freight transport operators and/or road authorities will be explored. Also, the feasibility of services under the prevailing conditions in the subarctic areas will be explored [NO-PILOT].	Norway
Finnish Pilot 2: C-ITS Services	In the Finnish Pilot 3 consortia deliver Day 1 C-ITS services over cellular networks. Focus in the Finnish Pilot is the collection of data from users and vehicles and the exchange of messages to all actors in the Finish ecosystem.	Finland
Swedish Pilot: C-ITS Services	The Swedish Pilot is based around four service clusters (Emergency vehicles warning, Traffic signals, Access control and Road Work Warnings). For each of these clusters one or several services will be developed, implemented, piloted and evaluated. The Pilots will take place in real traffic in the cities of Stockholm, Uppsala and Gothenburg. Vehicles for the Pilots are provided by industry partners, and there are also app-based services being implemented [SW-PILOT].	Sweden

**Table 1 NordicWay2 Pilots implementing C-ITS Services**

### 1.4.2 Types of Services

The NordicWay2 Pilots target deployment of the Day-1 and Day-1.5 C-ITS services plus some additional C-ITS and CAD-related services [NW2-WP]. For description of these services, refer [SD-SP].

### 1.4.3 The NordicWay Interoperability Stack

The concept of the interoperability stack serves to separate the different interoperability issues into different layers and to define facilities accordingly such that each layer is defined without regard to the internal implementation and technology. Taken together the layers support building and deploying harmonized and interoperable services in a modular and flexible way.

The basic layers of the NordicWay interoperability stack are as follows:

- The protocol interoperability layer facilitates end-to-end communication and delivery of messages and data between entities in a C-ITS environment. The core asset of this layer is AMQP-based communication via the interchange system. The layer builds upon the physical layer of communication network technologies (long-range, short-range) used to connect entities.
- The information and data interoperability layer facilitate sharing of information and data between entities in a C-ITS environment. The core asset of this layer is standard message representation using DATEX II and ETSI data standards. The layer builds upon the protocol interoperability layer using the services provided by this layer.
- The service interoperability layer facilitates harmonized activities, operations and strategies in a C-ITS environment. The basic asset of this layer is harmonized and standardized service and use case specifications. The layer builds upon the other two layers using the services provided by these layers.

This document (the second part of the deliverable on service definitions) covers the issues of information and data interoperability while the document on services and use cases (the first part of the deliverable) covers the issues of service interoperability.

Protocol interoperability issues are covered by the deliverables on architecture and interchange node development.

## 1.5 Document Overview

The document is structured as follows:

- Chapter 1 (Introduction) defines the purpose of the document and outlines the scope of the work.
- Chapter 2 (Abbreviations and Definitions) lists abbreviations and definitions which apply to the document.
- Chapter 3 (References) lists the references which apply to the document.
- Chapter 4 (Standard Message Representation) describes the standard message representations used in the service and use case deployments of the NordicWay2 Pilots. These messages include ETSI and DATEX II messages. The chapter also defines rules and constraints on how to use these standards to support information and data interoperability.
- Chapter 5 (Mappings between Standard Message Representations) summarizes proposals for mapping between ETSI and DATEX II standard message representations.
- Chapter 6 (Information and Data Interoperability in NordicWay) provides a summary assessment of the level of information and data interoperability in the NordicWay service and use case deployments.
- Chapter 7 (Appendices) includes appendices of the document.

A separate document on the Finnish DATEX II profile [FI-DATEXII] shall be considered as annexed to the document.



## 2 Abbreviations and Definitions

### 2.1 Abbreviations

For the purpose of this document, the following abbreviations apply.

Term	Definition
AFV	Alternative Fuel Vehicle
AMQP	Advanced Message Queuing Protocol
API	Application Programming Interface
BI	Basic Interface
CAD	Connected and Automated Driving
CAM	Cooperative Awareness Message
C-ITS	Cooperative Intelligent Transport Systems
CZ	Control Zone
DENM	Decentralized Environmental Notification Message
DSRC	Dedicated Short Range Communication
EBL	Emergency Brake Lights
Eco-AT	European Corridor – Austrian Testbed for Cooperative Systems
ETSI	European Telecommunications Standards Institute
EVA	Emergency Vehicle Approaching
GLOSA	Green Light Optimal Speed Advisory
HLN	Hazardous Location Notifications
I2V	Infrastructure-To-Vehicle
IVS	In Vehicle Signage
JSON	JavaScript Object Notation
MAPEM	MAP (topology) Extended Message
MCS	Motorway Control Systems
N/A	Not applicable
NAP	National Access Point
OBU	On-Board Unit
OEM	Original Equipment Manufacturer
PDA	Personal Digital Assistant
PVD	Probe Vehicle Data
RTA	Road Traffic Authority
RWW	Road Works Warning
SI	Signalized Intersections
SPATEM	Signal Phase And Timing Extended Message
SRTI	Safety Related Traffic Information
SWD	Shockwave Damping

Term	Definition
TBD	To be defined
TSP	Traffic Signal Priority request by designated vehicles
TTG	Time To Green
TTR	Time To Red
UML	Unified Modeling Language
V2I	Vehicle-To-Infrastructure
V2V	Vehicle-To-Vehicle
VMS	Variable Message Sign
XML	Extensible Markup Language

## 2.2 Definitions

For the purpose of this document, the following terms and definitions apply.

Term	Definition
Actor	An entity (human, system) which is involved in the provision of an ITS or C-ITS service.
C-ITS Actor	Actor involved in the provision of a C-ITS service.
C-ITS Message	ITS message being distributed and exchanged between actors during provision of a C-ITS service. In the C-Roads platform C-ITS messages are ETSI and ISO standard messages.
C-ITS Service	An ITS service provided to ITS users by distributing and exchanging secured and trusted ITS messages. In the C-Roads platform security is implemented using the EU C-ITS Security Credential Management System.
ITS Message	Message being distributed and exchanged between actors during provision of an ITS Service.
ITS Service	Service provided to an ITS User.
Service Profile	A set of functional specifications for the provision of an ITS or C-ITS service.
Message Profile	A set of functional and technical specifications for messages which represent the information being exchanged during the provision of an ITS or C-ITS service.
Scenario	A sequence of messages, events and actions in the interaction between actors in a use case for provision of an ITS or C-ITS service.

### 3 References

AMQP	ISO/IEC 19464:2014 Information technology Advanced Message Queuing Protocol (AMQP) v1.0 specification
CEN-CZ	CEN/TS 17380:2019 Intelligent transport systems Urban-ITS 'Controlled Zone' management for UVARs using C-ITS
DATEXII-ED	DATEX II Implementations – Extensions Directory <a href="https://datex2.eu/implementations/extension_directory">https://datex2.eu/implementations/extension_directory</a>
DATEXII-EG	DATEX II Content Model - Extension guide <a href="https://docs.datex2.eu/extensions/extensionguide_include.html">https://docs.datex2.eu/extensions/extensionguide_include.html</a>
DATEXII-PD	DATEX II Implementations – Profile Directory <a href="https://datex2.eu/implementations/profile_directory">https://datex2.eu/implementations/profile_directory</a>
DATEXII-PG	DATEX II Content Model - Profiling guide <a href="https://docs.datex2.eu/profiling/profilingguide_include.html">https://docs.datex2.eu/profiling/profilingguide_include.html</a>
DG-886/2013	Commission Delegated Regulation (EU) No 886/2013 Official Journal of the European Union 18.9.2013
DRIVE	DRIVE Sweden Innovation Cloud interpretation of utilization of the SAEJ2735 ISO 19091 (v0.7) 2019-08-27
ETSI-BS1	Intelligent Transport Systems (ITS) Vehicular Communications Basic Set of Applications Part 3: Specifications of Decentralized Environmental Notification Basic Service ETSI EN 302 637-3 V1.2.2 (2014-11)
ETSI-BS2	Intelligent Transport Systems (ITS) Vehicular Communications Basic Set of Applications Part 3: Specifications of Decentralized Environmental Notification Basic Service ETSI EN 302 637-3 v1.3.1 (2019-04)
ETSI-BS3	Intelligent Transport Systems (ITS) Vehicular Communications Basic Set of Applications Part 2: Specification of Cooperative Awareness Basic Service ETSI EN 302 637-2 V1.3.2 (2014-11)
ETSI-BS4	Intelligent Transport Systems (ITS) Vehicular Communications Basic Set of Applications Part 2: Specification of Cooperative Awareness Basic Service ETSI EN 302 637-2 V1.4.1 (2019-04)
ETSI-TS	Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services ETSI TS 103 301 V1.2.1 (2018-08)
FI-DATEXII	NordicWay Finnish DATEX II 3.0 profile Version 1.0 Date: 3 April 2019

ISO	Intelligent transport systems — Cooperative ITS — Using V2I and I2V communications for applications related to signalized intersections ISO/TS 19091:2017
NO-PILOT	Pilot Plan for the Norwegian Pilot 1: Use cases of Day and Day 1.5 C-ITS services Version 1.0 29. October 2018
NW-ARC	NordicWay Architecture, Services and Interoperability Issue 1.0 25 October 2016
NW2-WP	NordicWay2 Work Plan Version 0.95 15. May 2018
SAE	Dedicated Short Range Communications (DSRC) Message Set Dictionary J2735_201603
SCOOP-MES	Specification of DATEX II v2.3 messages in conjunction with CAMs and DENMs in SCOOP Deliverable 2.4.1.4 Activity 2: Studies Version 2.00
SD-SP	NordicWay Service Definitions: Services and Use cases NordicWay2 Deliverable D22:2 (First Part)
SRTI	Safety related message sets – Selection of DATEX II, Codes, DENM Event Types, TPEG2-TEC Causes and TMC Events for EC high level Categories ITSTF17001 v1.0 2017-02-14
SW-PILOT	M35 Pilot Plan NordicWay2 16 November 2018
SW-RWW	D9.9.4 Data exchange interface specifications for RWW NordicWay2 – Swedish Pilot Version 1.0
TF2-SD	Common C-ITS Service and Use Case Definitions Version 1.7 C-Roads Platform Working Group 2 Technical Aspects Taskforce 2 Service Harmonisation
TF3-IFS	C-ITS Message Profiles and Parameters Version 1.7 C-Roads Platform Working Group 2 Technical Aspects Taskforce 3 Infrastructure Communication 10/07/2020
TF4-BI	C-ITS IP Based Interface Profile Version 1.7 C-Roads Platform Working Group 2 Technical Aspects Taskforce 4 Hybrid Communication

## 4 Standard Message Representation

### 4.1 Introduction

The purpose of this chapter is two-fold.

- It identifies the standard representations of C-ITS/ITS messages (message profiles) used in service provision in the NordicWay2 Pilots. This includes DATEX II and ETSI standard messages. These message representations are primarily used in backend communication of service provision via the interchange system.
- It identifies requirements and constraints on how the standard messages should be encoded and used to support information and data interoperability.

Communication between backend systems on one hand and road-side systems and road user systems on the other is primarily done via providers' application backend systems using the protocols and messages of these systems. These messages are not covered here.

The implementation model for backend communication is AMQP (Advanced Messaging Queuing Protocol) [AMQP]. With this model C-ITS/ITS messages are communicated between publishing and subscribing systems as payloads of AMQP messages. AMQP communication is payload-agnostic in the sense that data of any type and format (standard and non-standard) can be transferred as payloads. Payload handling is the responsibility of the communicating actors.

### 4.2 Standard Messages in NordicWay

#### 4.2.1 ETSI Standards in NordicWay

The following table gives an overview of the ETSI message types which are used in service and use case deployments in the NordicWay2 Pilots.

Pilots	Message Type	Standard	Version (of Standard)
Finland	N/A	N/A	N/A
Norway	DENM	ETSI EN 302 637-3 [ETSI-BS2]	v1.3.1 (2019-04) (Protocol-version 1)
	CAM	ETSI EN 302 637-2 [ETSI-BS3]	v1.3.1 (2018-08) (Protocol-version 0)
Sweden	SPATEM/MAPEM	SAE J2735 [SAE]	J2735_201603
		ISO/TS 19091 [ISO]	ISO/TS 19091:2017
	DENM	ETSI EN 302 637-3 [ETSI-BS1]	v1.2.2 (2014-11)
		ETSI EN 302 637-3 [ETSI-BS2]	v1.3.1 (2019-04)
	CAM	ETSI EN 302 637-2 [ETSI-BS3]	v1.3.1 (2018-08)
ETSI EN 302 637-2 [ETSI-BS4]		v1.4.1 (2019-04)	
Denmark	N/A	N/A	N/A

**Table 2 ETSI Standards in the NordicWay2 Pilots**

The Danish and Finish partners do not support ETSI message representation for C-ITS/ITS messages.

The SPATEM/MAPEM message representation used in the Swedish deployment is based on SAE J2735 [SAE] which is referenced in ISO TS 19091 [ISO]. This standard is again referenced in ETSI TS 103 301 [ETSI-TS] which is used in the C-Roads specification.

Appendix 7.2 provides a summary of the ETSI standard message representation used for the C-ITS/ITS messages in service and use case deployments in the NordicWay2 Pilots.

#### 4.2.2 DATEX II in NordicWay

DATEX II message representation is defined in terms of data models which include the predefined DATEX II Level A data model plus possible extensions and profiles.

Extensions serve to enlarge DATEX II data models by incorporating new (application-specific) data elements which are not in the general Level A model. Extensions may be of type B (preserving

interoperability with the Level A model) and type C (no interoperability with the Level A model). The two types of extensions are developed following the Level B and Level C extension rules of the Standard.

Profiling provides for tailoring DATEX II message representation to specific purposes by using subsets (profiles) of DATEX II data models for message representation. This involves deselecting and restricting data elements of the selected DATEX II model such that the profile only contains the elements needed for the specific type of message representation. Profiling applies to Level A models and to Level A models with Level B extensions.

The following table gives an overview of the DATEX II versions, extensions and profiles which are used in service and use case deployments in the NordicWay2 Pilots.

Pilots	Versions	Profiles and Extensions	Comments
Finland	v3.0	Finnish profile without extensions [FI-DATEXII]	OpenLR is used for location referencing. No schema defined for profile.
Norway	v2.3	Level B Friction extension	
Sweden	v2.3	Level C Extension to Exchange part of DATEX II Message	Schema available for extension.
	v3.0	SituationPublication profile without extensions.	OpenLR is used for location referencing.
		Level B Emergency Vehicle Assignment information extension [DATEXII-ED]	Schema available for extension.
Denmark	v2.3	Level B extensions for SRTI (Safety Related Traffic Information) and OpenLR	Schema available for extensions.

**Table 3 DATEX II Versions, Extensions and Profiles in the NordicWay2 Pilots**

The Danish partner has no separate NordicWay2 Pilots but uses DATEX II Version 2.3 for communication with other NordicWay2 Pilots.

Appendix 7.1 provides a detailed summary of the DATEX II standard message representation used for the C-ITS/ITS messages in service and use case deployments in the NordicWay2 Pilots.

### 4.3 Requirements and Constraints to Standard Message Representation

#### 4.3.1 General Requirements and Constraints

The following general requirements apply to any standard representation of C-ITS/ITS messages.

- Messages should be represented following accepted and commonly used standard data models for C-ITS/ITS messages. These standards include DATEX II, and ETSI standard data models.
- Data models should be machine-readable.
- It should be possible to automatically validate message representations against data models.

Message profiles should be described at a logical level independent of platforms and technologies (communication protocols, serialization formats, etc.) and deployment models.

#### 4.3.2 ETSI Standard Message Representation

ETSI and ISO standards should be used following the C-Roads specifications. This means that C-ITS messages should be represented in accordance with the C-Roads specifications for C-ITS message representation for C-ITS services [TF3-IFS] using the standards and versions prescribed in these specifications.

#### 4.3.3 DATEX II Message Representation

##### 4.3.3.1 General Requirements and Constraints

The general requirements to DATEX II representation of C-ITS/ITS messages are as follows.

- Message representations shall be defined in terms of data models consisting of the predefined DATEX II Level A standard data model with possible Level B extensions. Extensions may include

existing extensions or extensions developed specifically for NordicWay. Level C extensions should be avoided.

- Extensions should be defined following the extension guidelines of the DATEX II Standard [DATEXII-EG].
- Data models may be profiled for the specific purpose of NordicWay. The profiles may include existing profiles as well as profiles defined specifically for NordicWay.
- Profiles should be defined following the profiling guidelines of the DATEX II Standard [DATEXII-PG].

In addition, DATEX II message representation is subject to the following constraints:

- The versions of the DATEX II Standard which are allowed for message representation in NordicWay are version 2.3 and version 3.0. Other versions of the DATEX II Standard are not allowed.
- It should be possible to automatically check that message representations are compliant with the selected data model by validating the representations against standard XML schemas of that model.
- Possible Level B extensions and profiles defined in NordicWay should be published in the DATEX II Extension Directory [DATEXII-ED] and the DATEX II Profile Directory [DATEXII-PD], respectively.

#### 4.3.3.2 Profiles and Extensions

The following requirements and constraints apply to the definition and use of profiles and extensions to DATEX II message representation.

- The use of profiles should be kept at a minimum.
- Reuse of existing profiles is preferred over developing and using new profiles.
- The use of extensions should be kept at a minimum.
- Extensions shall be used only if the required representation cannot be mapped to data elements of the DATEX II Level A model.
- Reuse of existing and approved extensions is preferred over developing and using new extensions.

Introducing extensions means that communicating actors will have to implement these extensions if they need to communicate and process the extended data. The above requirements and constraints serve to minimize effort and costs required by actors to implement and use extensions.

#### 4.3.4 DATEX II in Other C-ITS projects

The following table summarizes the DATEX II versions, Level B extensions and profiles used in the SCOOP and Eco-AT projects. The table does not include all extensions and profiles used by the projects - only those developed within the projects.

Project	Version	Extension (Level B)	Profile
SCOOP	DATEXII v2.3	SosActivationPublication ([SCOOP-MES], chapter 6.3.1)	
		RoadTypeScoopExtension ([SCOOP-MES], chapter 7.5.4.2)	
Eco-AT	DATEXII v2.3	MeasurementSiteRecordExtension	ECo-AT - DATEX II profile for CAM aggregation [DATEXII-PD]
		PointCoordinatesExtension	
		PointExtension	
		TrafficSpeedExtension	
		VehicleCharacteristicsExtension	ECo-AT - DATEX II profile for DSRC protected zones [DATEXII-PD]
		ProtectedZoneExtensions	ECo-AT - DATEX II profile for IVI [DATEXII-PD]
		VmsLocationExtension	ECo-AT - DATEX II profile for RWW [DATEXII-PD]
		VmsPictogramDispalyAreaExtension	
	ECo-AT - DATEX II profile for OtherDENM [DATEXII-PD]		
	ECo-AT - DATEX II profile for RWW [DATEXII-PD]		

**Table 4 DATEX II versions, extensions and profiles in other C-ITS projects**

## 5 Mappings between Standard Messages

### 5.1 Data Mapping and Data Mapping Rules

Data mapping is the process of mapping between data elements of different data models. This process is governed by rules defining how to map between data elements of different models. Note that the mapping rules should be defined on the data model level, and that they are independent of the rules which is applied for encoding C-ITS/ITS messages in terms of data models.

In NordicWay, the need for data mapping is twofold.

- The first aspect is the need for mapping between the standard data models (DATEX II and ETSI data models) used in backend communication. DATEX II is widely used for road and traffic data exchange for the purpose of traffic management and information across Europe. Many traffic operators use DATEX II based services and facilities. Standard data mapping rules is a means for integrating these applications and C-ITS applications by enabling translation of messages across representations in a uniform way.
- The second aspect is the need for mapping between DATEX II and ETSI models on one hand and the message types used in non-backend communication via cellular and other communication links. These mappings are required in NordicWay due to the use of cellular technology for communication with non-backend entities (vehicles, roadside units, personal devices).

In NordicWay2, the focus has been on the first type of mapping.

### 5.2 General Requirements and Constraints

The following identifies the general requirements to rules for mapping between DATEX II and ETSI standard message representations.

- Mapping rules should be accepted and commonly used standard rules, if available. This should enable mapping of messages across representations in a consistent way and such that information content is preserved.
- Mapping rules should be compliant to the mapping rules defined for DATEX II and DENM representations of Safety Related Traffic Information messages [SRTI]. Section 7.3.1 provides a summary of these mapping rules. Note that these mapping rules apply to SRTI messages only and does not cover other types of C-ITS/ITS messages.
- Reuse of existing mapping rules is preferred over developing and using new mapping rules.



The SCOOP and Eco-AT projects have provided proposals for mapping rules in addition to the mapping rules defined in [SRTI]. For a summary of these proposals and rules, see section 4.3.4.

## 5.3 Data Mappings in NordicWay

### 5.3.1 Mappings between ETSI and DATEX II Messages

Mappings between ETSI and DATEX II standard messages are used to a limited extent in backend communication in the NordicWay2 Pilots. Mappings have been implemented separately by the individual projects, where required. These mappings are based on the proposals for standard mapping rules (e.g. [SRTI]), where applicable.

No further development of standard rules and services for this type of mappings have been done in NordicWay2.

### 5.3.2 Mappings to and from Other Message Standards

Mappings between DATEX II and ETSI standard messages on one hand and the messages used for communication via cellular links on the other are provided as part of API's of the backend system facilities used for cellular communication. The mappings are developed by the providers of these backend facilities on a case-by-case basis.

## 6 Information and Data Interoperability in NordicWay

The NordicWay approach is to support information and data interoperability between cloud-based services and entities by using standard message representation for C-ITS/ITS messages being shared and exchanged between the services and entities. The standards used are the DATEX II and ETSI data standards.

The standard messages are distributed between communicating entities as payloads of AMQP (Advanced Messaging Queuing Protocol) messages using the AMQP standard protocol v1.0. Entities connect to an AMQP-based network via an API (Application Programming Interface) which is developed to be compliant with the C-Roads BI (Basic Interface) [TF4-BI].

An additional API has been developed supporting message exchange and sharing across multiple networks. This API provides the basis for the C-Roads II (Improved Interface) specification which is under development [TF4-BI].

In certain cases, C-ITS/ITS messages are not represented in terms of standard messages. For example, the use case for Dynamic Access Control of Designated Infrastructure is deployed with the request/response type of messages in a custom-defined JSON format where messages are not defined in terms of a standard data model like DATEX II.

### 6.1 DATEX II

The NordicWay2 deployments differ from C-Roads specifications by using DATEX II representation for C-ITS/ITS messages. This type of message representation has not been accepted as a standard for C-ITS messages in the C-Roads Platform, and the NordicWay2 deployments are therefore - with a few exceptions - not compliant with the C-Roads specifications.

Information and data interoperability with DATEX II are supported by the requirement that data should be defined using the same version of the DATEX II Level A model with possible profiles and Level B extensions. This ensures that services and entities are interoperable as regards Level A data definitions irrespective of any Level B extensions they support, and that they are interoperable at Level B as regards common Level B extensions.

The use of DATEX II supports information and data interoperability with DATEX II based ITS services and entities - including the NAP-based services (where DATEX II is the mandated data model for road and traffic data).

Information and data interoperability in NordicWay are limited in the following respects.

- The use of different incompatible versions of DATEX II. (v2.3 and v3.0). This means that communicating services and entities using different versions cannot be guaranteed to be interoperable at

Levels A and B (unless they support both versions). Migration from DATEX II v2.3 to DATEX II v3.0 is ongoing.

- The use of Level C extensions. Services and entities are only interoperable if they support the Level C data definitions. They need not be interoperable at Level A and B. Level C extensions have not been used in the NordicWay2 deployments with one exception (where the extension has later been replaced by Level A and B data definitions).
- The use of Level B extensions. Introducing extensions means that services and entities will have to support these extensions if they need to communicate and process extended data. To reduce extension dependencies between services and entities and to minimize the effort and costs required by actors to implement and use extensions it is recommended to keep the use of extensions at a minimum and to reuse existing and approved extensions where possible.

## 6.2 ETSI and C-Roads

The NordicWay2 Pilots include deployments of ETSI standards in selected pilots. These deployments are based on ETSI standards prescribed by C-Roads specifications. Compliance with the C-Roads profiling of these standards has not been tested.

## 6.3 ETSI – DATEX II Mapping

With the use of both DATEX II and ETSI standards for standard message representation, information and data interoperability across multiple message representations becomes an issue. This aspect of interoperability is also relevant when DATEX II based ITS services end entities – like NAP services and entities – are included in backend communication.

This aspect of interoperability may be supported by using standard mapping rules/services for translating between DATEX II and ETSI standard messages. No common mapping support has been developed and used in the NordicWay2 Pilots. Mappings have been implemented separately by the individual pilots, where required.

## 7 Appendices

### 7.1 DATEX II Message Representation in NordicWay

#### 7.1.1 DATEX II Payload Publication Representation

The following tables show the DATEX II payload publications which are used for message representation in backend communication of service and use case deployments in the NordicWay2 Pilots.

##### 7.1.1.1 In Vehicle Signage (IVS)

Deployment	Message	DATEX II Payload	Version and Level	Profiles and Extensions
Denmark	Status and settings of VMS units	VmsPublication	v2.3 (Level B)	None
	VMS unit characteristics	VmsTablePublication		
Finland	VMS message	SituationPublication	v3.0 (Level A)	Finnish profile
Norway	VMS message	SituationPublication	v2.3 (Level B)	None

**Table 5 In Vehicle Speed Limits**

##### 7.1.1.2 Hazardous Locations Notification (HLN)

Deployment	Message	DATEX II Payload	Version and Level	Profiles and Extensions
Denmark	Weather and road condition	SituationPublication	v2.3 (Level B)	Level B extensions for SRTI (Safety Related Traffic Information) and OpenLR.
Finland	Weather and road condition	SituationPublication	v3.0 (Level A)	Finnish profile
Norway	Weather and road condition	SituationPublication	v2.3 (Level A)	None

**Table 6 Weather and Road Conditions**

Deployment	Message	DATEX II Payload	Version and Level	Profiles and Extensions
Denmark	Slow and stationary vehicles	SituationPublication	v2.3 (Level B)	Level B extensions for SRTI (Safety Related Traffic Information) and OpenLR.
Finland	Slow and stationary vehicles	SituationPublication	v3.0 (Level A)	Finish profile
Norway	Slow and stationary vehicles	SituationPublication	v2.3 (Level A)	None

**Table 7 Slow and Stationary Vehicles**

Deployment	Message	DATEX II Payload	Version and Level	Profiles and Extensions
Denmark	Emergency vehicle approaching	SituationPublication	v2.3 (Level B)	Level B extensions for SRTI (Safety Related Traffic Information) and OpenLR.
Finland	Emergency vehicle approaching	SituationPublication	v3.0 (Level A)	Finish profile
Sweden	Emergency vehicle approaching	SituationPublication	v3.0 (Level B)	Level B Emergency Vehicle Assignment information extension [DATEXII-ED]

**Table 8 Emergency Vehicle Approaching**

Deployment	Message	DATEX II Payload	Version and Level	Profiles and Extensions
Denmark	Traffic ahead	SituationPublication	v2.3 (Level B)	Level B extensions for SRTI (Safety Related Traffic Information) and OpenLR.
Finland	Traffic ahead	SituationPublication	v3.0 (Level A)	Finnish profile
Norway	Traffic ahead	SituationPublication	v2.3 (Level A)	None

**Table 9 Traffic Ahead Warning**

Deployment	Message	DATEX II Payload	Version and Level	Profiles and Extensions
Denmark	Emergency brake warning	SituationPublication	v2.3 (Level B)	Level B extensions for SRTI (Safety Related Traffic Information) and OpenLR.
Finland	Emergency brake warning	SituationPublication	v3.0 (Level A)	Finnish profile
Norway	Emergency brake warning	SituationPublication	v2.3 (Level A)	None

**Table 10 Emergency Brake Lights**

Deployment	Message	DATEX II Payload	Version and Level	Profiles and Extensions
Denmark	Animal or person on the road	SituationPublication	v2.3 (Level B)	Level B extensions for SRTI (Safety Related Traffic Information) and OpenLR.
Finland	Animal or person on the road	SituationPublication	v3.0 (Level A)	Finnish profile

**Table 11 Animal or person on the road**

Deployment	Message	DATEX II Payload	Version and Level	Profiles and Extensions
Denmark	Obstacle on the road	SituationPublication	v2.3 (Level B)	Level B extensions for SRTI (Safety Related Traffic Information) and OpenLR.
Finland	Obstacle on the road	SituationPublication	v3.0 (Level A)	Finnish profile

**Table 12 Obstacle on the road**

Deployment	Message	DATEX II Payload	Version and Level	Profiles and Extensions
Denmark	Zone description	SituationPublication	v2.3 (Level B)	Level B extensions for SRTI (Safety Related Traffic Information) and OpenLR.
Finland	Zone description	SituationPublication	v3.0 (Level A)	Finish profile

**Table 13 Accident Zone Description**

Deployment	Message	DATEX II Payload	Version and Level	Profiles and Extensions
Norway	VehicleObstruction	SituationPublication	v2.3 (Level A)	None

**Table 14 Cooperative Collision Warning/ Alert Wrong Way Driving**

7.1.1.3 Road Works Warning (RWW)

Deployment	Message	DATEX II Payload	Version and Level	Profiles and Extensions
Denmark	Road and lane closure	SituationPublication	v2.3 (Level B)	Level B extensions for SRTI (Safety Related Traffic Information) and OpenLR.
Finland	Road and lane closure	SituationPublication	v3.0 (Level A)	Finnish profile
Norway	Road and lane closure	SituationPublication	v2.3 (Level A)	None
Sweden	Road and lane closure	SituationPublication	v3.0	SituationPublication profile with OpenLR.

**Table 15 Road and Lane Closure**

Deployment	Message	DATEX II Payload	Version and Level	Profiles and Extensions
Denmark	Mobile road works	SituationPublication	v2.3 (Level B)	Level B extensions for SRTI (Safety Related Traffic Information) and OpenLR.
Finland	Mobile road works	SituationPublication	v3.0 (Level A)	Finnish profile
Sweden	Mobile road works	SituationPublication	v3.0	SituationPublication profile with OpenLR.

**Table 16 Mobile Road Works**

#### 7.1.1.4 Probe Vehicle Data (PVD)

Deployment	Message	DATEX II Payload	Version and Level	Profiles and Extensions
Norway	Road Surface Condition Measurement	MeasuredDataPublication	v2.3 (Level B)	Friction Extension

**Table 17 Single Vehicle Data**

DATEX II Measured and Elaborated Data Publications target representation of direct measurement data from equipment or outstations, e.g. traffic and weather measurements, and data derived and computed from measurement data, respectively. The measurements sites may be static, but can be mobile, e.g. vehicles. DATEX II does not constrain Publications to representation of data from static measurements sites only.

The possible problems of using these Publications for probe vehicle data are primarily related to the problems inherent in using XML which is the standard serialization format for DATEX II. These problems include size of payloads and complexity of parsing.

7.1.1.5 Traffic Management (TM)

Deployment	Message	DATEX II Payload	Version and Level	Profiles and Extensions
Norway	Road and lane closure	SituationPublication	v2.3	None

**Table 18 Traffic Information and Smart Routing**

7.1.1.6 Information on Parking Facilities

Deployment	Message	DATEX II Payload	Version and Level	Profiles and Extensions
Denmark	Characteristics of parking facilities	GenericPayload-Publication	v2.3 (Level B)	Level B extension for ParkingTablePublication
	Status of parking facilities	GenericPayload-Publication	v2.3 (Level B)	Level B extension for ParkingStatusPublication
Norway	Status and settings of VMS units	VMS Publication	v2.3 (Level A)	None

**Table 19 On street parking information and management**

7.1.1.7 Dynamically Controlled Zones

Deployment	Message	DATEX II Payload	Version and Level	Profiles and Extensions
Sweden	Dynamic Environmental Zone	predefinedControlledZoneContainer	v2.3 (Level C)	Level C Extension to Exchange part of DATEX II Message. Based on CEN/TS 17380:2019 ASN.1 [CEN-CZ]

**Table 20 Dynamic Environmental Zone**

7.1.2 DATEX II Situation Publication Representation

The following table shows how messages are represented in terms of SituationRecord types of DATEX II SituationPublications in service and use case deployments of the NordicWay2 Pilots. The column on Record Types provides examples of encodings used; it is not intended to provide a complete specification of how this SituationRecord attribute should be encoded.

7.1.2.1 In Vehicle Signage (IVS)

Deployment	Use Case	DATEX II SituationRecord	Record Types
Finland	In Vehicle Speed Limits	SpeedManagement	observeSpeedLimit

**Table 21 SituationRecord types for In Vehicle Signage**

7.1.2.2 Hazardous Locations Notification (HLN)

Use Case	Deployment	DATEX II SituationRecord	Record Types		
Accident Zone Description	Denmark	Accident			
		SpeedManagement			
		RoadOrCarriagewayOrLaneManagement			
		AbnormalTraffic			
		ReroutingManagement			
Weather and Road Conditions	Denmark	PoorEnvironmentConditions			
		NonWeatherRelatedRoadConditions			
		WeatherRelatedRoadConditions			
Weather and Road Conditions	Finland	PoorEnvironmentConditions	badWeather, visibilityReduced		
		NonWeatherRelatedRoadConditions	slipperyRoad		
		WeatherRelatedRoadConditions			
Weather and Road Conditions	Norway	PoorEnvironmentConditions			
		Slow and Stationary Vehicle	Denmark	VehicleObstruction	
		Slow and Stationary Vehicle		SpeedManagement	
Slow and Stationary Vehicle	Finland	VehicleObstruction		slowVehicle	
Traffic Ahead Warning	Denmark	AbnormalTraffic			
		AbnormalTraffic	stationaryTraffic		
Emergency Brake Lights	Norway	VehicleObstruction			
Emergency Vehicle Approaching	Finland	VehicleObstruction	emergencyVehicle		
	Sweden	Vehicle Obstruction with EmergencyVehicleObstructionExtension	highSpeedEmergencyVehicle		
Animal or person on the road	Denmark	AnimalPresenceObstruction			
		GeneralObstruction			
		Finland	AnimalPresenceObstruction		
Obstacle on the road	Denmark	EnvironmentalObstruction			
		GeneralObstruction			
		Finland	Accident		
		EnvironmentalObstruction			
Cooperative Collision Warning/ Alert Wrong Way Driving	Norway	GeneralObstruction	objectOnTheRoad		
		VehicleObstruction	vehicleOnWrongCarriageway		

**Table 22 SituationRecord types for Hazardous Locations Notification (HLN)**

7.1.2.3 Road Works warning (RWW)



Use Case	Deployment	DATEX II SituationRecord	Record Types
Road or Lane Closure	Denmark	MaintenanceWorks	
		SpeedManagement	
		RoadOrCarriagewayOrLaneManagement	
		AbnormalTraffic	
	Finland	MaintenanceWorks	roadworks
	Sweden	MaintenanceWorks	roadworks
Mobile Road Works	Sweden	MaintenanceWorks	roadworks

**Table 23 SituationRecord types for Road Works Warning (RWW)**

## 7.2 ETSI Standard Message Representation in NordicWay

The following tables shows the ETSI standard messages which are used in service and use case deployments in the NordicWay2 Pilots.

### 7.2.1 Road Works Warning (RWW)

Use Cases	Deployment	ETSI EN 302 637-3 [ETSI-BS2]	
		Cause Code	Sub Cause Code
Road or Lane Closure	Sweden	3 (Roadworks)	0 (unavailable)
			1 (majorRoadworks)
			4 (shortTermStationaryRoadworks)
Mobile Road Works	Sweden	3 (Roadworks)	3 (slowMovingRoadMaintenance)
Other RWW Use Cases	Sweden	3 (Roadworks)	2 (roadMarkingWorks)
			5 (streetCleaning)
			6 (winterService)
		94 (Stationary vehicles)	

**Table 24 DENM Messages for Road Works Warning (RWW)**

### 7.2.2 In Vehicle Signage (IVS)

Use Case	Deployment	Message Type	Standard
In Vehicle Speed Limits	Norway	DENM	ETSI EN 302 637-3 [ETSI-BS2]
		CAM	ETSI EN 302 637-2 [ETSI-BS3]
	Sweden	SPATEM/MAPEM	ETSI TS 103 301 [ETSI-TS]

**Table 25 Messages for In Vehicle Signage Use Cases (IVS)**

### 7.2.3 Hazardous Location Notifications (HLN)

Use Case	Deployment	Message Type	Standard
Slow and Stationary Vehicle	Norway	DENM	ETSI EN 302 637-3 [ETSI-BS2]
		CAM	ETSI EN 302 637-2 [ETSI-BS3]
Emergency Vehicle Approaching	Sweden	DENM	ETSI EN 302 637-3 [ETSI-BS2]
		CAM	ETSI EN 302 637-2 [ETSI-BS3]
Emergency Brake Lights	Norway	DENM	ETSI EN 302 637-3 [ETSI-BS2]
		CAM	ETSI EN 302 637-2 [ETSI-BS3]
Cooperative Collision Warning/Alert Wrong Way Driving	Norway	DENM	ETSI EN 302 637-3 [ETSI-BS2]
		CAM	ETSI EN 302 637-2 [ETSI-BS3]

**Table 26 Messages for Hazardous Location Notification Use Cases (HLN)**

#### 7.2.4 Signalized Intersections (SI)

Use Case	Deployment	Message Type	Standard
Time To Green and Time To Red	Sweden	SPATEM/MAPEM	SAE J2735 ISO/TS 19091 [DRIVE]
GLOSA (Green Light Optimal Speed Advisory)	Sweden	SPATEM/MAPEM	SAE J2735 ISO/TS 19091 [DRIVE]
Traffic Signal Priority Request	Sweden	SPATEM/MAPEM	SAE J2735 ISO/TS 19091 [DRIVE]

**Table 27 Messages for Signalized Intersection Use Cases**

SPATEM/MAPEM messages are not used in the Norwegian deployments of Signalized Intersection Use Cases. These deployments address scenarios where vehicles receive speed advice when approaching bottlenecks (tunnels, narrow bridges) so that they avoid meeting oncoming vehicles. The speed advice is provided by the Speed Advice Engine (SAE) which maintains an overview of vehicles in the "tactile area". SAE operates via an App, which reports the vehicle's position and speed regularly via GPS information. Based on this information, SAE tries to predict which cars may end up in bottleneck meeting situations, and then provides speed advice to one of the vehicles to prevent this.

#### 7.2.5 Other Services and Use Cases

Use Case	Deployment	Message Type	Standard
Dynamic Environmental Zone	Sweden	SPATEM/MAPEM	SAE J2735 ISO/TS 19091 [DRIVE]

**Table 28 Messages for Dynamic Environmental Zone Use Case**

### 7.3 DATEX II and ETSI Standard Message Mappings

#### 7.3.1 Mapping Rules for SRTI Messages

The following table summarizes the proposal for standard mappings between DATEX II Situation Publications (DATEX II version 2.3) and DENM standard representations for SRTI messages of [SRTI].

DATEX II SituationPublication	DENM		
Type of SituationRecord	Cause Code	Sub Cause Code	Description
MaintenanceWorks (RoadMarkingWork)	3	2(0)	road marking work
MaintenanceWorks (maintenanceWork)	3	4(0)	short-term stationary roadworks
With Impact:trafficConstrictionType (roadblocked)	N/A	N/A	N/A
VehicleObstruction (vehicleOnWrongCarriageway)	14	0	wrong way driving
VehicleObstruction (slowMovingMaintenance-Vehicle)	3	3(0)	slow moving road maintenance
VehicleObstruction (brokenDownVehicle)	94	2	vehicle breakdown
GeneralObstruction (UnprotectedAccidentArea)	2	7	unsecured accident
GeneralObstruction (objectOnTheRoad)	10	0	hazardous location -obstacle on the road
GeneralObstruction (shedLoad)	10	1	shed load
GeneralObstruction (obstructionOnTheRoad)	10	4	large objects
EnvironmentalObstruction (avalanches, landslips)			
GeneralObstruction (peopleOnTheRoadway)	12	0	human presence on the road
GeneralObstruction (childrenOnRoadway)	12	1	children on roadway
GeneralObstruction (cyclistsOnRoadway)	12	2	cyclists on roadway
GeneralObstruction (rescueAndRecoveryWork)	15	0	rescue and recovery work in progress
EnvironmentalObstruction (rockfalls)	9	1	rockfalls
EnvironmentalObstruction (fallenTrees)	10	5	fallen trees
AnimalsPresenceObstruction (animalsOn-TheRoad)	11	0	hazardous location -animal on the road
AnimalsPresenceObstruction (herdOfAnimalsOn-TheRoad)	11	2	herd of animals
AnimalsPresenceObstruction (largeAnimalsOn-TheRoad)	11	4	large animals
PoorEnvironmentConditions (stormForceWinds, strongWinds, crossWinds)	17	1	strong winds
PoorEnvironmentConditions (visibilityReduced)	18	0	adverse weather condition - visibility
PoorEnvironmentConditions (denseFog, patchyFog)	18	1	visibility reduced due to fog
PoorEnvironmentConditions (smokeHazard)	18	2	visibility reduced due to smoke
PoorEnvironmentConditions (heavySnowfall)	18	3	visibility reduced due to heavy snowfall
PoorEnvironmentConditions (lowSunGlare)	18	6	visibility reduced due to low sun glare
PoorEnvironmentConditions (heavyRain)	19	1	heavy rain
PoorEnvironmentConditions (heavySnowfall)	19	2	heavy snowfall
DisturbanceActivity (attackOnVehicle)	20	3	stone throwing persons
WeatherRelatedRoadCondition (surfaceWater, slipperyRoad)	6	0	adverse weather condition -adhesion
WeatherRelatedRoadCondition (ice, icyPatches)	6	5	ice on road
WeatherRelatedRoadCondition (blackice)	6	6	black ice on road
WeatherRelatedRoadCondition (snowDrifts)	9	5	snowdrifts

DATEX II SituationPublication	DENM		
Type of SituationRecord	Cause Code	Sub Cause Code	Description
NonWeatherRelatedRoadCondition (petrolOnRoad)	6	2	fuel on road
NonWeatherRelatedRoadCondition (mudOnRoad)	6	3	mud on road
NonWeatherRelatedRoadCondition (oilOnRoad)	6	7	oil on road
NonWeatherRelatedRoadCondition (looseChippings)	6	8	loose chippings

**Table 29 Mapping between DATEX II SituationPublication and DENM message representation**