

SWP 2.3 System Specifications System Overview WP 2 - System Definition Version: 03.60

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Overview of changes

No.	Version	Status	Date	Type of Change
1	01.00	Released	2014-11-20	First Release
2	02.00	Released	2015-03-12	Second Release
3	03.00	Released	2015-07-15	Third Release
4	03.10	Released	2015-10-28	Third Release – Update
5	03.50	Released	2016-04-29	Third Release – Second Update
6	03.60	Released	2016-07-29	Third Release – Third Update

Table 1: Document History

Reference to the status- and version administration:

Status:

In progress	the document is currently in editing mode
Released	the document has been checked and released by quality assurance, it can only be modified if the
	version number is updated.

Versions:

Takes place in two stages. Released documents receive the next higher integral version number.		
00.01, 00.02 etc.	Not released versions, with the status in progress	
01, 02, etc.	Released version with the status released	



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1 Document Information

1.1 Purpose of this Document

This document describes the ECo-AT system as it has been agreed by all ECo-AT partners at the time of writing.

- It creates a common understanding for all project partners in ECo-AT regarding the system architecture, specification of system components and its general requirements, description of interfaces, and message management.
- It serves as the basis for the development of the more detailed functional requirements in WP3.
- It is the basis for communication with the other Corridor partners in DE and NL in order to come to harmonised Corridor-wide specifications.

The document is not a finalized complete specification of the system, but it reflects the current status of the ECo-AT project. All not-yet-agreed specifications are described as such with an additional note.

Abbreviation / Term	Definition
ВТР	Basic Transport Protocol
BÜS	Betriebsüberwachungssystem (operations monitoring system)
САМ	Common Awareness Message
CDD	Common Data Dictionary
C-ITS	Cooperative ITS
C-ITS-S	Central ITS Station
DENM	Decentralized Environmental Notification Message
DSRC	Dedicated Short Range Communication
GBC	GeoBroadcast
GN	Geo Network
GNSS	Global Navigation Satellite System
GUI	Graphical User Interface
IF	Interface
ITS	Intelligent Transport System

1.2 Definitions, Terms and Abbreviations



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Abbreviation / Term	Definition
I2V	Infrastructure to vehicle
IVI	In-vehicle Information
LDoC	Last Date of Change
MIB	Management Information Base
NTP	Network Time Protocol
OID	Object Identifier
OSI	Open Systems Interconnection
PKI	Public Key Infrastructure
QoS	Quality of Service
REQ	Requirement
RHW	Road Hazard Warning
R-ITS-S	Roadside ITS Station
RWW	Roadworks Warning
SNMP	Simple Network Management Protocol
SOAP	Simple Object Access Protocol
SPAT	Signal Phase and Timing
SW	Software
SWP	Sub Work Package
TCC	Traffic Control Center
TLC	Traffic Light Controller
TWG	Topical Working Group
UC	Use Case
UML	Unified Modeling Language
UTC	Coordinated Universal Time
V2I	Vehicle-to-Infrastructure
V-ITS-S	Vehicle ITS Station



Abbreviation / Term	Definition
WSDL	Web Service Description Language

Table 2: Definitions, Terms and Abbreviations

1.3 References

All references in this document can be found in the master table of references available in the "Eco-

AT_SWP2.3_MasterTableOfReferences_v03.60.pdf" document.



2 Introduction

2.1 Structure of the Document

This document is structured as follows: Chapter 2.2 describes the organizational structure inside ECo-AT. Chapter 3 describes the procedure for the development of the system architecture and requirements. In Chapter 4 the high level system architecture of ECo-AT is described including the boundaries of the ECo-AT system. Chapter 5 gives an overview of the ECo-AT system components, the general requirements of the system components, and the current state of the interface specification. Chapter 6 summarizes the description of data element with references on the specific use case document for the data element tables. Furthermore, it gives an overview how operations monitoring shall be specified in ECo-AT. Chapter 7 describes the message management with focus on the interruption of links between system components. In Chapter 8 ANNEX the usage of the RWW DENM data elements in ECo-AT and possible open issues are summarized. Finally Chapter 9 ANNEX defines the GeoNetworking profiling for ECo-AT.

2.2 Structure of the ECo-AT Project

The internal structure of ECo-AT, in order to achieve the stated goals, is divided into 2 main work packages (WPs) for system specification: WP2 – system definition and WP3 – functional specification & development. And 1 main work package for test case specification and operation of the living lab: WP4 – Living Laboratory: compliance. In WP2 the general requirements for system components and interfaces are developed, including Use Case (UC) descriptions, high level system architecture, functionalities of system components, data elements, security architecture, and roles & responsibilities. The work is split up into sub-work packages:

- SPW2.1: Use cases
- SWP2.2: Roles & responsibilities, legal issues
- SWP2.3: System overview
- SWP2.4: Security architecture
- SWP2.5: Coexistence (ITS-G5 CEN-DSRC)
- SWP2.6: Convergence strategy (ITS-G5 cellular)
- SWP2.7: Upwards compatibility

The use cases and roles & responsibilities are specified in separated SWPs compared to the system overview, because they can be specified quite independently of the general architecture, whereas the use cases and especially their requirements act as input for the system architecture. The roles & responsibilities are defined after the system architecture is set up. The main SWP for general requirements specification is SWP2.3, where all results from SWP2.4 – SWP2.7 will be collected. SWP2.4 - SWP2.7 are divided into separate SWPs because they deal with quite large topics that should be addressed individually.



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WP3 specifies the functional requirements for all system components and interfaces and the profiling of data elements. Based on this specification a system implementation shall be possible. WP3 is structured more on a component level, because the functional requirements are defined for each component:

- SWP3.1: C-ITS-S
- SWP3.2: R-ITS-S
- SWP3.3: V-ITS-S
- SWP3.4: Security
- SWP3.5: Co-existence (ITS-G5 CEN-DSRC)
- SWP3.6: Convergence strategy (ITS-G5 cellular)
- SWP3.7: Test tools for living lab

In SWP3.7 test tools for living lab shall be developed in order to test the whole system architecture in a live test system, the living lab.

WP4 specifies the test cases for all requirements and includes the operation of the living lab. It has a similar structure as WP3, but with differences in the last three SWPs:

- SWP4.1: C-ITS-S
- SWP4.2: R-ITS-S
- SWP4.3: V-ITS-S
- SWP4.4: Security
- SWP4.5: Co-existence (ITS-G5 CEN-DSRC)
- SWP4.6: Use cases
- SWP4.7: System requirements verification
- SWP4.8: Operation living lab

During the project, topical working groups (TWGs) were / will be formed that are dealing with very specific questions and tasks in smaller expert groups. They are linking different SWPs of WP2, WP3, and WP4. The present topics of the TWGs are:

- TWG 1: Confirmation of release 1 UC (finalized, TWG closed)
- TWG 2: Roadside selection area related questions (finalized, TWG closed)
- TWG 3: Harmonization of C-ITS-S <-> R-ITS-S and TCC <-> C-ITS-S interfaces (TWG closed, open item assigned to SWP2.3 and SWP3.1)



- TWG 4: Interface between R-ITS-S and trailer (finalized, TWG closed)
- TWG 5: Specification of data elements at all interfaces (TWG closed, open items assigned to SWP2.1)
- TWG 6: Message management (TWG closed, open items assigned to SWP2.3 and WP3)
- TWG 7: C-ITS monitoring
- TWG 8: UC scenarios, REQ update
- TWG 9: open issues



3 Common System Engineering / Procedure

This chapter describes the common procedure how the ECo-AT system architecture is developed.

The general question "What is C-ITS architecture?" can be summarized as:

- Description and representation of the structure and the components of a system
- Sub-architectures with different points of view
 - o Organizational
 - o Functional
 - o Technical
 - o ...
- System architecture
 - \circ = sum of all points of view
 - \circ = framework of the whole system and all system components

Furthermore, the general parts of an architecture are:

- Different points of view / sub-architectures
 - o Description of the organizational structures, roles & responsibilities
 - Functional description processes and sequences (use cases)
 - o Description of the exchanged information (content and format)
 - o Description of the interfaces
 - o Description of the technical implementation

The following sections describe the step-wise procedure taken in ECo-AT, in order to generate the above mentioned descriptions. The whole procedure is not as strictly sequential as it may sound. On the contrary many steps are running in parallel or even iterative.

3.1 Procedure

- Specification of each UC
- Specification of high level system architecture
 - o Specification of which system components are part of the system
 - o Specification of which interfaces are part of the system
- Specification of main functionalities of the system components



- Specification of required data elements a so called bottom up method is used, where the bottom in this case is the fixed data format at the ITS-G5 interface, the steps are described with the following sub-bullet items
 - o Data elements are specified separately for each UC
 - Furthermore data elements are specified separately for potentially different scenarios in each UC (e.g. RWW triggered by TCC, RWW triggered by standalone trailer)
 - Starting point are the required data elements necessary for the chosen Day 1 C-ITS messages (the ECo-AT formats have to comply with the standards for C-ITS messages)
 - Specification of the source of data elements in the system (which system component generates the information for the specific data elements)
 - Specification of additional, supporting data elements which are required on top of the chosen Day 1 C-ITS message data elements (at TCC, C-ITS-S, or R-ITS-S)
- Specification of interfaces
 - Based on the specification of system component source of each data element all the required data elements for the interfaces can be defined (WP2)
 - Specification of the OSI layers (WP3)
 - Physical & network layer
 - Security layer
 - Protocol layer
 - Data layer
- Security
- Specification of roles and responsibilities
- Specification of functionalities of system components
 - Based on the steps before (e.g. specification of system components, source of data elements) the detailed functionalities for each system component are specified
 - Specification of general system requirements on system component level (WP2)
 - Specification of functional requirements for system components (WP3)
- Profiling of data elements for each UC



3.2 Releases during the Project

The system architecture specification documents in ECo-AT will be developed in 4 releases containing following content:

- Release 1 (November 2014)
 - Explanatory Release Note
 - Use case specifications
 - Overview on use cases
 - Road works warning
 - CAM aggregation (draft)
 - In-vehicle information (draft)
 - Intersection Safety (draft)
 - Other DENM application (hazard location warning/event) (draft)
 - o System overview
- Release 2 (March 2015)
 - Explanatory Note Release 2
 - Use case specifications
 - Overview on Use Cases
 - Road Works Warning
 - CAM Aggregation
 - In-Vehicle Information
 - Intersection Safety
 - Other DENM applications (hazard location warnings/events)
 - $\circ\,$ System overview
 - Security Concept
 - o Convergence of ITS-G5 with cellular communication systems
 - o Concept for Upwards Compatibility
 - Living Lab Concept
 - o C-ITS System Monitoring



- Release 3 (July 2015)
- Release 3.1 (October 2015)
- Release 3.5 (April 2016)
- Release 3.6 (July 2016)
- Release 4 (planned for October 2016)
 - $\circ\,$ Final version

Figure 1 summarizes the development procedure of the ECo-AT system architecture as it is descripted in Chap. 3.1.



Figure 1: ECo-AT system architecture development procedure



4 High Level System Architecture

The ECo-AT system architecture specifies the following major ITS components

- the **C-ITS-S** (central ITS station, the instance of an ITS Station that is in a "central" location such as a Traffic Control Center (TCC) or Service Provider Centre),
- the R-ITS-S (roadside ITS station, the instance of an ITS Station that is located at the roadside) and
- the V-ITS-S (vehicle ITS station, the instance of an ITS Station that is located in the vehicle), as shown in Figure 2.

Combined together, these components form the complete ECo-AT ITS end-to-end solution. Irrespective of the ETSI architecture, Ref. [ETSI 302 665], the C-ITS-S are not obliged to have a full ETSI ITS stack implementation (ITS access technology layer, ITS network & transport layer, ITS facility layer, ITS application layer) in ECo-AT. The ETSI ITS communication protocol stack obviously has to be implemented in the R-ITS-S to enable communication with the V-ITS-S via ITS-G5, whereas the required higher layer services can be part of either the R-ITS-S or the C-ITS-S, depending on what seems best suited for the respective application.

For a full usage of cooperative ITS (C-ITS) systems in an infrastructure to vehicle (I2V) scenario, already existing traffic management components need to be integrated with new C-ITS components. In most cases these systems include a TCC which runs the local or national traffic management. The C-ITS-S exchanges cooperative data continuously with these centers in real-time. In order to enable security within a C-ITS system an interface to a certification authority has to be included. In the ECo-AT system architecture there is only one direct connection to the certification authority, via the C-ITS-S. This interface handles all necessary security tasks to / from the security authority for all ECo-AT system components (C-ITS-S, R-ITS-S).

Further components in the ECo-AT system are traffic light controllers (TLC) and road works safety trailers (with or without pre-warners). These field components are locally connected to the R-ITS-S. In an urban environment, a TLC provides the required traffic light signal information to the R-ITS-S for further processing and final transmission of respective ITS-G5 messages (SPaT/MAP). R-ITS-Ss directly connected to safety trailers are capable of providing mobile road works warning messages autonomously.

Common interfaces and functional requirements shared amongst all components and stakeholders of C-ITS is the most crucial / critical criterion for success. The V2V interfaces and functions mostly exist, defined and standardized by ETSI, ISO and IEEE with strong contribution from the C2C-CC, whereas the infrastructure interfaces yet have to be specified, enhanced or otherwise resolved:

- Interface C-ITS-S to R-ITS-S (physical and logical)
- Interface C-ITS-S to TCC (integration into existing TCC's)
- Definition of communication protocol
- Definition of required content for each use case
- Definition of data format



All interfaces shown in Figure 2 – except for IF4 - address exactly these questions.

Additionally, a common set of functional features have to be guaranteed in the main ITS components (C-ITS-S and R-ITS-S modules) to enable seamless services across national borders to the vehicles. Functional requirements include amongst others:

- Processing of C-ITS data for Day 1 UCs
- Forwarding of processed data to TCC systems
- Aggregation of C-ITS data for Day 1 UCs
- Connection and monitoring methods between central and roadside infrastructure
- Location referencing / map matching
- Transmit, receive and store of data
- Security Management (PKI)
- etc.

ECo-AT does not address the specification of all possible interfaces and functionalities within a C-ITS system. Figure 2 highlights which components and interfaces will be defined within the project.



Figure 2: High level system architecture



5 Description of System Components and Interfaces

ECo-AT defined several topics (UCs and others) and one or more scenarios for each topic:

• UC CAM aggregation

o 5 scenarios, see Ref. [ECo-AT SWP2.1 UC CAM aggr]

- UC RWW
 - o 3 scenarios, see Ref. [ECo-AT SWP2.1 UC RWW]
- UC IVI
 - o 1 scenario, see Ref. [ECo-AT SWP2.1 UC IVI]
- UC Other DENM

o 2 scenarios, see Ref. [ECo-AT SWP2.1 UC other DENM]

UC ISS

o 3 scenarios, see Ref. [ECo-AT SWP2.1 UC ISS]

- Coexistence
 - o 4 scenarios, see Ref. [ECo-AT SWP3.5 coexistence]
- Management
 - o 3 scenarios, see Chapt. 7.1

In the following description (Chapt. 5.1 and Chapt. 5.2) the general system requirements and general component requirements (TCC, C-ITS-S, R-ITS-S, and V-ITS-S) are mapped to these topics/scenarios.

Each requirement has a specific status that means:

- Agreed: common agreement of the requirement in ECo-AT
- In progress: requirement is currently in progress and will be defined finally in a later release
- New: this requirement is new compared to the previous release (Release 3.5)
- Updated: this requirement is updated compared to the previous release (Release 3.5)



5.1 Overall system

5.1.1 General system requirements

The general approach is to assign the requirements to the specific system components. This chapter describes general requirements that cannot be assigned to specific system components.

The wording "DENM data", "DENM information", "IVI data", "IVI information", "CAM data", "CAM information", "SPAT/MAP data", and "SPAT/MAP information" does not describe the encoded message, but describes the required content for these messages (e.g., "The TCC shall send DENM information to the C-ITS-S" means that the required data elements from the TCC, in order to generate an ITS-G5 conform message in the C-ITS system shall be sent).

Table 3 gives an overview about the general system requirements and their mapping to ECo-AT topics/scenarios.



Table 3: General system requirements and mapping to ECo-AT topics/scenarios

R. ID	Requirement Title	Version	Criticality	Status	LDoC				
R_G_002	Unique messages	0.2 shall updated 27.7.201							
	Description: Messages in the C-ITS system shall be unique and traceable to the source.								
	Guidance: The message traceability is defined in Ref. [ECo-AT SWP3.1 IF1 data] Chapt. 4.2.4.								
	Qualification: Testing								

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_G_008	Log entries timestamp	0.1	shall	agreed	24.3.2016		



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<i>Description:</i> All log entries produced on the C-ITS-S and R-ITS-S shall have a UTC based time stamp.
Guidance:
Qualification: testing

R. ID	Requirement Title	Version	Criticality	Status	LDoC				
R_G_009	Logging format	0.1	shall	agreed	24.3.2016				
	Description: All log entries shall be available in a human readable format (except binary message information possibly contained) and in a way no vendor specific tooling is needed for reading.								
	Guidance:								
	Qualification: testing								

5.2 System Components

5.2.1 Traffic Control Center (TCC)

5.2.1.1 Overview

The TCC is responsible for traffic management. It provides traffic information and traffic events that are source for the C-ITS services / use cases disseminated via the C-ITS system. Furthermore it is the recipient of traffic data collected from the vehicles and potentially of operational data from road works trailers via the C-ITS system that can be used for processing of the enhancement of traffic management. The TCC has one interface to the C-ITS-S (IF1).





Figure 3: Integration of the TCC into the ECo-AT system

5.2.1.2 General TCC requirements

The wording "DENM data", "DENM information", "IVI data", "IVI information", "CAM data", "CAM information", "SPAT/MAP data", and "SPAT/MAP information" does not describe the encoded message, but describes the required content for these messages (e.g., "The TCC shall send DENM information to the C-ITS-S" means that the required data elements from the TCC, in order to generate an ITS-G5 conform message in the C-ITS system shall be sent).

Table 4 gives an overview about the general TCC requirements and their mapping to ECo-AT topics/scenarios.

					UC CAM aggregation scenarios	UC RWW scenarios	UC RWW scenarios	UC RWW scenarios	UC IVI scenarios	UC Other DENM scenarios	UC Other DENM scenarios	UC ISS scenarios	UC ISS scenarios	UC ISS scenarios	Coexistence scenarios	Coexistence scenarios	Coexistence scenarios	Coexistence scenarios	Management scenarios	Management scenarios	Management scenarios				
R. ID	Requirement Title	Version	Status	LDoC	1	2	3	4	5	1	2	3	1	1	2	1	2	3	1	2	3	4	1	2	3
тсс																									
R_T_001	DENM Data Provision to C-ITS-S	1.2	agreed	21.03.2016							Х	Х		Х											
R_T_014	DENM Data Reception from C-ITS-S	0.3	agreed	16.02.2016											Х										
R_T_016	Aggregated CAM Data Reception from C-ITS-S	0.2	agreed	10.02.2015	Х																				
R_T_023	Single vehicle data reception from C-ITS-S	0.1	agreed	11.02.2016		Х	Х																		
R_T_024	Travel time estimation	0.1	agreed	11.02.2016			Х																		
R_T_003	IVI Data Provision to C-ITS-S	0.3	agreed	10.02.2015									Х												
R_T_021	TCC Overall security	0.1	agreed	02.03.2015																					
R_T_025	Provision of CEN-DSRC protected zone data for download	0.1	agreed	22.12.2015															Х						
R T 026	Provision of CEN DSRC protected zone data to C-ITS-S	0.1	agreed	22.12.2015					1		1								х	X	х	Х		Т	T

Table 4: General TCC requirements and mapping to ECo-AT topics/scenarios

R. ID	Requirement Title	Version	Criticality	Status	LDoC					
R_T_001	DENM Data Provision to C-ITS- S	vision to C-ITS-1.2Shallagreed21.3.2016								
	Description: The TCC shall send DENM information to the C-ITS-S coded as DATEX II publications, as described in Ref. [ECo-AT SWP2.1 UC RWW] and Ref. [ECo-AT SWP2.1 UC other DENM] (UC RWW and UC other DENM applications). The information is sent to the C-ITS-S for a new DENM and for an update to an existing DENM.									
	Guidance:									



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Qualification: Testing

R. ID	Requirement Title	Version	Criticality	Status	LDoC				
R_T_014	DENM Data Reception from C- ITS-S	- 0.3 Shall agreed 16.2.2016							
	Description: The TCC shall receive DENM information (UC other DENM applications) from the C-ITS-S.								
	<i>Guidance:</i> The UC scenario "sending event information from vehicles to the TCC" is described in the Ref. [ECo-AT SWP2.1 UC other DENM].								
	Qualification: Testing								

R. ID	Requirement Title	Version	Criticality	Status	LDoC				
R_T_016	Aggregated CAM Data Reception from C-ITS-S	0.2	Shall	agreed	10.2.2015				
	Description: The TCC shall receive aggregated CAM data (aggregated by the R-ITS-S) from the C-ITS-S.								
	<i>Guidance:</i> V-ITS-S originated CAMs are aggregated by the R-ITS-S and forwarded to the C-ITS-S to be forwarded to the TCC.								
	Qualification: Testing								

R. ID	Requirement Title	Version	Criticality	Status	LDoC				
R_T_023	Single vehicle data reception from C-ITS-S	0.1 Sł		agreed	11.2.2016				
	Description: The TCC shall receive single vehicle data from the C-ITS-S via IF1.								
	Guidance: Details can be found in Ref. [ECo-AT SWP2.1 UC CAM aggr].								
	Qualification: Testing								

R. ID	Requirement Title	Version	Criticality	Status	LDoC						
R_T_024	Travel time estimation	0.1	Shall	agreed	11.2.2016						
	Description: For travel time estimation the TCC shall take single vehicle data (received from the C-ITS-S) from different R-ITS-S where the vehicleID is the same.										



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Guidance: Details can be found in Ref. [ECo-AT SWP2.1 UC CAM aggr].
Qualification: Testing

R. ID	Requirement Title	Version	Criticality	Status	LDoC				
R_T_003	IVI Data Provision to C-ITS-S	0.3	Shall	agreed	10.2.2015				
	<i>Description:</i> The TCC shall send IVI information to the C-ITS-S, as described in Ref. [ECo-AT SWP2.1 UC IVI]. The information is sent to the C-ITS-S for a new IVI and for an update to an existing IVI.								
	Guidance:								
	Qualification: Testing								

R. ID	Requirement Title	Version	Criticality	Status	LDoC					
R_T_021	TCC Overall system security 0.1 shall agreed 2.3.2015									
	Description: TCC shall fulfill the overall system security.									
	Guidance:									
	Qualification:									

R. ID	Requirement Title	Version	Criticality	Status	LDoC					
R_T_025	Provision of CEN-DSRC protected zone data for download	0.1	Shall	agreed	22.12.2015					
	Description: The road operator shall provide a publicly available list of CEN-DSRC protected zones for the tolling stations on the operator's road network for download. This list is continually updated when new tolling stations / protected zones become available.									
	<i>Guidance:</i> This list can be used by the OEMs for implementation into the V-ITS-S. For more information see Ref. [ECo-AT SWP3.5 coexistence].									
	Qualification: testing									



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R. ID	Requirement Title	Version	Criticality	Status	LDoC					
R_T_026	Provision of CEN DSRC protected zone data to C-ITS-S	0.1	Shall	agreed	22.12.2015					
	<i>Description:</i> The TCC shall send CEN-DSRC protected zone data for the tolling stations on the operator's road network to the C-ITS-S. This list is continually updated when new tolling stations / protected zones become available.									
	<i>Guidance:</i> These protected zone data will be broadcasted by selected R-ITS-Ss via CAM to the vehicles. For more information see Ref. [ECo-AT SWP3.5 coexistence].									
	Qualification: testing									

5.2.2 Central ITS Station (C-ITS-S)

5.2.2.1 Overview

The C-ITS-S is the central component in the C-ITS system. Its main tasks are the downlink to the R-ITS-S and the vehicles (V-ITS-S) to disseminate the C-ITS services / use cases of ECo-AT and the uplink to the TCC to deliver data collected from vehicles and safety trailers. For the downlink / service dissemination, it receives traffic information and traffic events from the TCC, preprocesses the data, generates a service framework, and disseminates it to the relevant R-ITS-Ss. In the case of uplink / data collection from vehicles / trailers, the C-ITS-S receives information from the R-ITS-Ss, further processes and aggregates the data whenever necessary and forwards the information to the TCC. This means that the main message management has to be handled by the C-ITS-S in conjunction with the R-ITS-S – the exact distribution between these two components still has to be defined. Furthermore, the C-ITS-S is responsible for maintenance and monitoring of the R-ITS-S. The C-ITS-S has one interface to the TCC (IF1) and an interface to the R-ITS-S in the system (IF3). There is an additional interface for a cellular connection to vehicles (IF5) that will however not be specified within ECo-AT. This interface is currently under discussion.







Figure 4: Integration of the C-ITS-S into the ECo-AT system

5.2.2.2 General C-ITS-S requirements

The wording "DENM data", "DENM information", "IVI data", "IVI information", "CAM data", "CAM information", "SPAT/MAP data", and "SPAT/MAP information" does not describe the encoded message, but describes the required content for these messages (e.g., "The TCC shall send DENM information to the C-ITS-S" means that the required data elements from the TCC, in order to generate an ITS-G5 conform message in the C-ITS system shall be sent).

Table 5 gives an overview about the general C-ITS-S requirements and their mapping to ECo-AT topics/scenarios.



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C-ITS-S		renarem	oluluo		. ·	-	Ū	<u> </u>	Ű	<u> </u>	- 1	•	·	· .	- 1	· .	-	<u> </u>	·	- 1	•	÷	÷	-	-
R_C_003	DENM Data Reception from TCC	1.2	agreed	21.03.2016							Х	Х		Х									Т		
R_C_083	DEMN Data Provision to TCC	0.1	agreed	10.02.2015											Х										
R_C_001	IVI Data Reception from TCC	0.3	agreed	10.02.2015									Х												
R_C_004	Aggregated CAM Data Provision to TCC	0.4	agreed	11.02.2016	Х	×																	_		
R_C_094	Forward single vehicle data	0.1	agreed	11.02.2016		х	Х												v	v	v	V	\rightarrow		_
R_C_095	CEN-DSRC protected zones reception from TCC	0.1	agreed	22.12.2015							_	_	_	_		_			^	^	^	^	\rightarrow		_
R_C_080	DENM Data Provision to R-ITS-S	0.1	agreed	10.02.2015							x	x		x	_						-		-	-	
R_C_013	DENM Data Reception from R-ITS-S	0.3	agreed	10.02.2015							~	~		~	х							_	-		
R_C_012	RWW Data Reception from R-ITS-S	0.4	agreed	10.02.2015								Х													
R_C_011	Aggregated CAM Data Reception from R-ITS-Ss	0.2	agreed	10.02.2015	Х																			-	
R_C_090	Single vehicle data reception from R-ITS-S	0.1	agreed	11.02.2016		Х	Х																		
R_C_085	IVI Data Provision to R-ITS-S	0.1	agreed	10.02.2015									Х												
R_C_017	R-ITS-S selection for message distribution	0.3	agreed	10.02.2015							Х	Х	Х	Х									\rightarrow		Х
R_C_097	CEN-DSRC protected zones distribution	0.1	agreed	22.12.2015															X	X	X	X	_		X
R_C_098	CITS S overall overage acquirity	0.1	agreed	22.12.2015															~	~	^	~			~
R_C_007	Event Manning from DATEX II to DENM (IE3)	0.1	agreed	16.02.2015							¥	×		Y								_	\rightarrow		
R C 108	Event Mapping from DATEX II to DENM (IF5)	0.1	agreed	21.03.2016							~	~		x								_	-		
R C 100	C-ITS-S Message Management for DENM (IF3)	0.1	agreed	16.02.2016							х	х		X									-		Х
R_C_109	C-ITS-S Message Management for DENM (IF5)	0.1	agreed	21.03.2016										х											Х
R_C_101	DENM message generation for IF3	0.1	agreed	16.02.2016							Х	Х		Х											
R_C_112	DENM message generation for IF5	0.1	agreed	24.03.2016										Х											
R_C_102	Event Mapping from DENM to DATEX II	0.1	agreed	16.02.2016											Х								\rightarrow		
R_C_106	RWW data augmentation	0.1	agreed	21.03.2016								Х													
R_C_110	C-ITS-S "augmented RWW" DENM transmission: IF3 connect	0.1	agreed	24.03.2016								X									_	_	\rightarrow		X
R_C_111 R_C_076	C-IIS-S augmented RVVV DENV transmission: updated RV	0.1	agreed	24.03.2016				×				X									_	_	\rightarrow	Y	_
R_C_089	Manning of CAM aggregation data	0.2	agreed	11 02 2016	x			~				-	_	-		_			_		-		\rightarrow	~	
R C 091	Mapping of single vehicle data	0.1	agreed	11.02.2016	~	х	х																-		
R_C_092	Mapping stationID to vehicleID for single vehicle data	0.1	agreed	11.02.2016		Х	Х																	-	
R_C_093	Storage duration: mapping stationID to vehicleID	0.1	agreed	11.02.2016		Х	Х																	-	
R_C_103	Event Mapping from DATEX II to IVI	0.1	agreed	16.02.2016									Х												
R_C_104	C-ITS-S Message Management for IVI (IF3)	0.1	agreed	16.02.2016									Х										\rightarrow		Х
R_C_105	IVI message generation for IF3	0.1	agreed	16.02.2016									Х										\rightarrow		
R_C_113	IVI info mapping from DATEX II to IVI (IF5)	0.1	agreed	24.03.2016									X												V
R_C_114	C-ITS-S Message Management for IVI (IF5)	0.1	agreed	24.03.2016									X												
R_C_030	Configuration of R-ITS-S	0.1	agreed	02 03 2015								-	^	-		_			_		-		\rightarrow	x	
R C 069	C-ITS-S Time Synchronization	0.2	agreed	10.02.2015								-	_	-	-	_							\rightarrow	~	
R_C_120	R-ITS-S basic initialization	0.1	in progress	24.03.2016																			-	х	
R_C_121	R-ITS-S device management	0.1	agreed	24.03.2016																				Х	
R_C_073	Log Availability	0.3	agreed	24.03.2016																			Х		
R_C_116	IF1 and IF3 logging in C-ITS-S	0.1	agreed	24.03.2016																		[Х		
R_C_117	Message dissemination logging	0.1	agreed	24.03.2016																		$ \rightarrow$	X		
R_C_118	R-IIS-S reboot logging	0.1	agreed	24.03.2016									_			_						\dashv	X	\rightarrow	
R_C_119	IF1 and IF3 content logging in C-ITS-S Visualization of P-ITS-S	0.1	agreed	24.03.2016	-							_		_							_		×	-+	_
R C 050	Visualization of RW trailer	0.2	agreed	10.02.2015	-							_		_	_			-			_	-	$\frac{1}{x}$	-	
R C 088	Presentation of status of deployed messages	0.2	agreed	24.03.2016	-							_		-	_			-				-	x	-	
R_C_096	Grouping of CEN-DSRC protected zones	0.1	agreed	22.12.2015								-							х	х	х	х	+	\neg	х
R_C_107	C-ITS-S convergence functionality	0.1	agreed	21.03.2016									Х	х										_	

Table 5: General C-ITS-S requirements and mapping to ECo-AT topics/scenarios



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R. ID	Requirement Title	Version	Criticality	Status	LDoC					
R_C_003	DENM Data Reception from TCC	1.2	Shall	agreed	21.3.2016					
	Description: The C-ITS-S shall receive DENM information from the TCC coded as DATEX II publication, as described in Ref. [ECo-AT SWP2.1 UC RWW] and Ref. [ECo-AT SWP2.1 UC other DENM] (UC RWW and UC other DENM applications).The information is received from the TCC for a new DENM and for an update to an existing DENM.									
	Guidance:									
	Qualification: Testing									

R. ID	Requirement Title	Version	Criticality	Status	LDoC						
R_C_083	DENM Data Provision to TCC	0.1	shall	agreed	10.02.2015						
	<i>Description</i> : The C-ITS-S shall forward DENM information (DENM data / UC other DENM applications) to the TCC.										
	Guidance: The over the air (ITS-G5) DENMs from the V-ITS-Ss are received by the R-ITS-S and the DENM data is forwarded via the C-ITS-S to the TCC.										
	Qualification: Testing										

R. ID	Requirement Title	Version	Criticality	Status	LDoC						
R_C_001	IVI Data Reception from TCC	0.3	Shall	agreed	10.2.2015						
	Description: The C-ITS-S shall receive IVI data from the TCC, as described in Ref. [ECo-AT SWP2.1 UC IVI].										
	Guidance:										
	Qualification: Testing										

R. ID	Requirement Title	Version	Criticality	Status	LDoC					
R_C_004	Aggregated CAM Data Provision to TCC	0.4	Shall	agreed	11.2.2016					
	Description: The C-ITS-S shall forward aggregated CAM data received from the R-ITS-S to the									



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TCC considering requirements R_C_011, R_C_089.
Guidance: Details can be found in Ref. [ECo-AT SWP2.1 UC CAM aggr].
Qualification: Testing

R. ID	Requirement Title	Version	Criticality	Status	LDoC					
R_C_094	Forward single vehicle data	0.1	Shall	agreed	11.2.2016					
	<i>Description:</i> The C-ITS-S shall forward single vehicle data received from the R-ITS-S to the TCC considering requirements R_C_090, R_C_091, R_C_092, R_C_093.									
	Guidance: Details can be found in Ref. [ECo-AT SWP2.1 UC CAM aggr].									
	Qualification: Testing									

R. ID	Requirement Title	Version	Criticality	Status	LDoC					
R_C_095	CEN-DSRC protected zones reception from TCC	0.1	Shall	agreed	22.12.2015					
	Description: The C-ITS-S shall be able to receive CEN-DSRC protected zone data from the TCC.									
	Guidance:									
	Qualification: testing									

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_C_086	C-ITS-S interface to PKI server	0.1	shall	agreed	2.3.2015		
	Description: There shall be an interface from the C-ITS-S to the PKI server.						
	Guidance: PKI server definition is still pending.						
	Qualification:						

R. ID	Requirement Title	Version	Criticality	Status	LDoC
	DENM Data Provision to R-ITS-				
R_C_084	S	0.1	Shall	agreed	10.2.2015



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<i>Description:</i> The C-ITS-S shall send DENM data to the R-ITS-S, as described in Ref. [ECo-AT SWP2.1 UC RWW] and Ref. [ECo-AT SWP2.1 UC other DENM] (UC RWW and UC other DENM applications). The information is sent to the R-ITS-S for a new DENM and for an update to an existing DENM.
Guidance:
Qualification: Testing

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
	DENM Data Reception from R-						
R_C_013	ITS-S	0.3	shall	agreed	10.2.2015		
	<i>Description:</i> The C-ITS-S shall be able to receive DENM information (based on DENM from the vehicle / UC other DENM applications) from R-ITS-S.						
	<i>Guidance:</i> Incident information will be used to extend the information basis of the TCC, on the one hand as additional information for the operator on the other hand as information to be distributed via V2I communication to the vehicles.						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_C_012	RWW Data Reception from R- ITS-S	0.4	shall	agreed	21.3.2016		
	Description: The C-ITS-S shall be able to receive "basic RWW from R-ITS-S" DENM as well as operational data from the RW trailer via IF3.						
	<i>Guidance:</i> Details can be found in Ref. [ECo-AT SWP3.1 C-ITS-S], Ref. [ECo-AT SWP2.1 UC RWW], and Ref. [ECo-AT SWP3.1 IF3 comm].						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_C_011	Aggregated CAM Data Reception from R-ITS-Ss	0.2	Shall	agreed	10.2.2015		
	Description: The C-ITS-S shall receive aggregated CAM data from the R-ITS-Ss.						
	<i>Guidance:</i> V-ITS-S originated CAMs are aggregated by the R-ITS-S and forwarded to the C-ITS-S to be forwarded to the TCC.						



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Version: 03.60 | 2016-07-29 | Status: Released

Qualification: Testing

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_C_090	Single vehicle data reception from R-ITS-S	0.1	Shall	agreed	11.2.2016		
	Description: The C-ITS-S shall receive single vehicle data from the R-ITS-S.						
	<i>Guidance:</i> The data model of the single vehicle data on IF3 is described in Ref. [ECo-AT UC SWP2.1 CAM aggr] and in Ref. [ECo-AT SWP3.1 IF3 comm].						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_C_085	IVI Data Provision to R-ITS-S	0.1	Shall	agreed	10.2.2015		
	<i>Description:</i> The C-ITS-S shall send IVI data to the R-ITS-S, as described in Ref. [ECo-AT SWP2.1 UC IVI]. The information is sent to the R-ITS-S for a new IVI and for an update to an existing IVI.						
	Guidance:						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_C_017	R-ITS-S selection for message distribution	0.3	shall	agreed	10.2.2015		
	Description: The C-ITS-S shall be able to send DENM data and IVI data to a subset of R-ITS-Ss. This subset shall be chosen, based on the R-ITS-S dissemination selection method, as described in Ref. [ECo-AT SWP3.1 C-ITS-S].						
	Guidance: This requirement is necessary, a) in order to limit the data traffic from the C-ITS-S to the R-ITS-S b) in order to limit the data traffic from the R-ITS-S to the V-ITS-S.						
	Qualification: Testing						

R. ID Re	equirement Title	Version	Criticality	Status	LDoC
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R_C_097	CEN-DSRC protected zones distribution	0.1	Shall	agreed	22.12.2015		
	Description: The C-ITS-S shall ensure that each CEN-DSRC protected zone is at least transmitted to one R- ITS-S per stream direction.						
	Guidance:						
	Qualification: testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_C_098	Provision of CEN-DSRC protected zone data to R-ITS-S	0.1	Shall	agreed	22.12.2015		
	Description: The C-ITS-S shall provide CEN-DSRC protected zone data individually (max. 16) to R-ITS-Ss.						
	Guidance:						
	Qualification: testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC
R_C_087	C-ITS-S Overall system security	0.1	shall	agreed	2.3.2015
	Description: C-ITS-S shall fulfill the overall system security.				
	Guidance:				
	Qualification:				

R. ID	Requirement Title	Version	Criticality	Status	LDoC
R_C_099	Event Mapping from DATEX II to DENM (IF3)	0.1	Shall	agreed	16.2.2016
	<i>Description:</i> The C-ITS-S shall map the DATEX II event data received from the TCC via IF1 to appropriate DENM events sent on interface IF3.				



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Version: 03.60 2016-07-29	Status: Released
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<i>Guidance:</i> The mapping is described in the Ref. [ECo-AT SWP2.1 UC other DENM], Ref. [ECo-AT SWP2.1 UC RWW], and Ref. [ECo-AT SWP3.1 DATEX II mapping] DATEXII_Translation_OtherDENM_V03.60.xlsx.
Qualification: Testing

R. ID	Requirement Title	Version	Criticality	Status	LDoC
R_C_108	Event Mapping from DATEX II to DENM (IF5)	0.1	Shall	agreed	21.3.2016
	<i>Description:</i> The C-ITS-S shall map the DATEX II event data received from the TCC via IF1 to appropriate DENM events sent on interface IF5 (convergence).				
	<i>Guidance:</i> The mapping is described in the Ref. [ECo-AT SWP2.1 UC other DENM], Ref. [ECo-AT SWP2.1 UC RWW], Ref. [ECo-AT SWP3.1 DATEX II mapping] DATEXII_Translation_OtherDENM_V03.60.xlsx, and Ref. [ECo-AT SWP3.6 convergence].				
	Qualification: Testing				

R. ID	Requirement Title	Version	Criticality	Status	LDoC
R_C_100	C-ITS-S Message Management for DENM (IF3)	0.1	Shall	agreed	16.2.2016
	<i>Description:</i> The C-ITS-S shall perform message management of DENM content based on the DATEX II data on IF1 before sending it on IF3.				
	Guidance: The C-ITS-S has to check the validity of (DENM UC based) DATEX II data records				
	on IF1 and initiate or cancel the provision of DENMs on IF3 based on that validity.				dity.
	Further a regular update of the DENM (regarding the validity) shall be sent to the R-ITS-S as				
	specified in Ref. [ECo-AT SWP3.1 C-ITS-S].				
	Qualification: Testing				

R. ID	Requirement Title	Version	Criticality	Status	LDoC
R_C_109	C-ITS-S Message Management for DENM (IF5)	0.1	Shall	agreed	21.3.2016
	Description: The C-ITS-S shall perform message management of DENM content based on the DATEX II data on IF1 before sending it on IF5 (web server for convergence).				
	<i>Guidance:</i> The C-ITS-S has to check the validity of (DENM UC based) DATEX II data records on IF1 and initiate or cancel the provision of DENMs on IF5 based on that validity.				



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Further a regular update of the DENM (regarding the validity) shall be sent to the web server as it will be specified in a later release in Ref. [ECo-AT SWP3.6 convergence].
Qualification: Testing

R. ID	Requirement Title	Version	Criticality	Status	LDoC
R_C_101	DENM message generation for IF3	0.1	Shall	agreed	16.2.2016
	Description: The C-ITS-S shall be able to generate DENM messages for transmission to the R-ITS-S. The C-ITS-S shall support encoding of DENM: UPER, XER, and XERC				
	<i>Guidance:</i> The encoding and the data model on IF3 is described in Ref. [ECo-AT SWP3.1 IF3 comm].				
	Qualification: Testing				

R. ID	Requirement Title	Version	Criticality	Status	LDoC
R_C_112	DENM message generation for IF5	0.1	Shall	agreed	24.3.2016
	<i>Description:</i> The C-ITS-S shall be able to generate DENM messages for transmission to the web server via IF5. The C-ITS-S shall support encoding of DENM: UPER, XER, and XERC				
	<i>Guidance:</i> Detailed information can be found in Ref. [ECo-AT SWP3.6 convergence].				
	Qualification: Testing				

R. ID	Requirement Title	Version	Criticality	Status	LDoC
R_C_102	Event Mapping from DENM to DATEX II	0.1	Shall	agreed	16.2.2016
	<i>Description:</i> The C-ITS-S shall map the event data received from the R-ITS-S via IF3 to appropriate DATEX II events sent on interface IF1.				



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Guidance: The mapping is described in the Ref. [ECo-AT SWP2.1 UC other DENM] and Ref.
[ECo-AT SWP3.1 DATEX II mapping] DATEXII_Translation_OtherDENM_V03.60.xlsx.
Qualification: Testing

R. ID	Requirement Title	Version	Criticality	Status	LDoC			
R_C_106	RWW data augmentation	0.1	Shall	agreed	21.3.2016			
	<i>Description:</i> The C-ITS-S shall augment the "basic RWW from R-ITS-S" DENM(s) received from R-ITS-S(s) mounted on RW trailers with "augmentation RWW from TCC". The resulting "augmented RWW" DENM(s) shall be sent to relevant R-ITS-Ss. The C-ITS-S shall set the "augmentation FLAG" for the DENMs send to involved R-ITS-S(s) (R-ITS-S(s) that sent an "basic RWW from R-ITS-S" to the C-ITS-S which information is included in the "augmented RWW" DENM). For all other R-ITS-Ss the "augmentation FLAG" shall not be set.							
	<i>Guidance:</i> Details about the augmentation can be found in Ref. [ECo-AT SWP2.1 UC RWW] and Ref. [ECo-AT SWP3.1 C-ITS-S].							
	Qualification: Testing							

R. ID	Requirement Title	Version	Criticality	Status	LDoC	
R_C_110	C-ITS-S "augmented RWW" DENM transmission: IF3 connection lost/resumed	0.1	shall	agreed	24.3.2016	
	<i>Description:</i> The C-ITS-S is responsible for message management (e.g. cancel DENM, run out DENM, store DENM info) when it is transmitting an "augmented RWW" DENM to the R-ITS-S and loses or resumes the IF3 connection.					
	Guidance: Details about this behavior are described in Ref. [ECo-AT SWP3.1 C-ITS-S].					
	Qualification: Testing					

R. ID	Requirement Title	Version	Criticality	Status	LDoC	
R_C_111	C-ITS-S "augmented RWW" DENM transmission: updated RWW information	0.1	shall	agreed	24.3.2016	
	<i>Description:</i> The C-ITS-S is responsible for updating the "augmented RWW" DENM sent to the R-ITS-S in case an update of "augmentation RWW from TCC" is received via IF1 or an update of "basic RWW from R-ITS-S" is received on IF3.					


Guidance: Details about this behavior are described in Ref. [ECo-AT SWP3.1 C-ITS-S].
Qualification: Testing

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_C_076	Configuration of CAM Aggregation Parameters	0.2	shall	agreed	10.2.2015		
	<i>Description:</i> The parameters that control the aggregation of CAM data in all R-ITS-Ss shall be adjustable at the C-ITS-S.						
	<i>Guidance:</i> CAM aggregation and the parameters are described in Ref. [ECo-AT SWP2.1 UC CAM aggr].						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_C_089	Mapping of CAM aggregation data	0.1	Shall	agreed	11.2.2016		
	Description: The C-ITS-S shall map the CAM aggregated data received from the R-ITS-S in IF3 format to DATEX II format for interface IF1.						
	<i>Guidance:</i> The mapping is described in Ref. [ECo-AT SWP3.1 DATEX II mapping] DATEXII_Translation_CAMAggregation_V03.60.xlsx.						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_C_091	Mapping of single vehicle data	0.1	Shall	agreed	11.2.2016		
	Description: The C-ITS-S shall map the single vehicle data received from the R-ITS-S in IF3 format to DATEX II format for interface IF1.						
	Guidance: The mapping is described in Ref. [ECo-AT SWP3.1 DATEX II mapping] DATEXII_Translation_CAMAggregation_V03.60.xlsx.						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC
R_C_092	Mapping stationID to vehicleID	0.1	Shall	agreed	11.2.2016



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for single vehicle data						
Description: The C-ITS-S shall map the stationID received in the single vehicle data from the R-ITS-S to a vehicleID for transmission to the TCC.						
Guidance: Details can be found in Ref. [ECo-AT SWP2.1 UC CAM aggr].						
Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_C_093	Storage duration: mapping stationID to vehicleID	0.1	Shall	agreed	11.2.2016		
	<i>Description:</i> Each mapping of stationID to vehicleID in the mapping table (stationID/vehicleID) in the C-ITS-S for single vehicle data shall be kept 120min after receiving the specific stationID. After 120min counted from the first single vehicle data with this stationID, the stationID vs. vehicleID shall be deleted.						
	<i>Guidance:</i> Details can be found in Ref. [ECo-AT SWP2.1 UC CAM aggr]. This storage duration value will be verified in the Living Lab and possibly updated afterwards.						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_C_103	Event Mapping from DATEX II to IVI	0.1	Shall	agreed	16.2.2016		
	Description: The C-ITS-S shall map the DATEX II IVI data received from the TCC via IF1 to appropriate IVI sent on interface IF3.						
	<i>Guidance:</i> The mapping is described in the Ref. [ECo-AT SWP2.1 UC IVI] and Ref. [ECo-AT SWP3.1 DATEX II mapping] DATEXII_Translation_IVI_V03.60.xlsx.						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_C_104	C-ITS-S Message Management for IVI (IF3)	0.1	Shall	agreed	16.2.2016		
	Description: The C-ITS-S shall perform message management of IVI content based on the DATEX II data on IF1 before sending it on IF3.						
	Guidance: The C-ITS-S has to check the validity of (IVI UC based) DATEX II data records on						



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IF1 and initiate or cancel the provision of IVIs on IF3 based on that validity.
Further a regular update of the IVI (regarding the validity) shall be sent to the R-ITS-S as
specified in Ref. [ECo-AT SWP3.1 C-ITS-S] (will be available in a later release).
Qualification: Testing

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_C_105	IVI message generation for IF3	0.1	Shall	agreed	16.2.2016		
	<i>Description:</i> The C-ITS-S shall be able to generate IVI messages for transmission to the R-ITS-S. The C-ITS-S shall support encoding of IVI: UPER, XER, and XERC						
	<i>Guidance:</i> The encoding and the data model on IF3 is described in Ref. [ECo-AT SWP3.1 IF3 comm].						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_C_113	IVI info mapping from DATEX II to IVI (IF5)	0.1	Shall	agreed	24.3.2016		
	<i>Description:</i> The C-ITS-S shall map the DATEX II IVI information received from the TCC via IF1 to appropriate IVI messages sent on interface IF5 (convergence).						
	<i>Guidance:</i> The mapping is described in the Ref. [ECo-AT SWP2.1 UC IVI], Ref. [ECo-AT SWP3.1 DATEX II mapping] DATEXII_Translation_IVI_V03.60.xlsx, and Ref. [ECo-AT SWP3.6 convergence].						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC	
R_C_114	C-ITS-S Message Management for IVI (IF5)	0.1	Shall	agreed	24.3.2016	
	Description: The C-ITS-S shall perform message management of IVI content based on the DATEX II data on IF1 before sending it on IF5 (web server for convergence).					
	<i>Guidance:</i> The C-ITS-S has to check the validity of DATEX II IVI data records on IF1 and initiate or cancel the provision of IVIs on IF5 based on that validity.					



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Version: 03.60 2016-07-29	Status: Released
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Further a regular update of the IVI (regarding the validity) shall be sent to the web server as it will
be specified in a later release in Ref. [ECo-AT SWP3.6 convergence].
Qualification: Testing

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_C_115	IVI message generation for IF5	0.1	Shall	agreed	24.3.2016		
	Description: The C-ITS-S shall be able to generate IVI messages for transmission to the web server via IF5. The C-ITS-S shall support encoding of IVI: UPER, XER, and XERC						
	<i>Guidance:</i> Detailed information can be found in Ref. [ECo-AT SWP3.6 convergence].						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC	
R_C_030	Configuration of R-ITS-S	0.2	shall	agreed	2.3.2015	
	<i>Description:</i> The C-ITS-S shall provide the necessary functionality (windows, parameter sets) for the configuration of the R-ITS-S (system parameter sets, firmware update).					
	<i>Guidance:</i> The C-ITS-S serves as the operator station for the management of the roadside stations (R-ITS-S).					
	Qualification: Testing					

R. ID	Requirement Title	Version	Criticality	Status	LDoC	
R_C_069	C-ITS-S Time Synchronization	0.2	shall	agreed	10.2.2015	
	<i>Description:</i> C-ITS-S time shall be synchronized to a common time reference which originates from the TCC.					
	<i>Guidance:</i> All components of the ECo-AT system shall use the same time base. This can be a common NTP server or a GNSS source.					
	Qualification: Testing					

R. ID	Requirement Title	Version	Criticality	Status	LDoC
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R_C_120	R-ITS-S basic initialization	0.1	shall	in progress	24.3.2016		
	Description: The basic initialization of an R-ITS-S (deployment of a new R-ITS-S) shall be supported by the C-ITS-S with following tasks						
	Guidance: The REQ has to be defined in detail in the next release.						
	Qualification: testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_C_121	R-ITS-S device management	0.1	shall	agreed	24.3.2016		
	Description: The C-ITS-S is responsible for the device management of the R-ITS-Ss.						
	<i>Guidance:</i> Detailed information about the device management of the R-ITS-Ss is described in Ref. [ECo-AT SWP3.1 IF3 management].						
	Qualification: testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_C_073	Log Availability	0.3	shall	agreed	24.3.2016		
	<i>Description:</i> All logs created by and stored within the C-ITS-S shall be available to a C-ITS-S operator for a minimum period of time of 6 months.						
	<i>Guidance:</i> Logging data should be accessible on demand by authorized users within the project, without manual interaction by vendor / operator / maintainer.						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_C_116	IF1 and IF3 logging in C-ITS-S	0.1	shall	agreed	24.3.2016		
	Description: C-ITS-S shall be able to log type and time of received and sent messages over IF1 and IF3.						
	Guidance:						
	Qualification: testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC
R_C_117	Message dissemination logging	0.1	shall	agreed	24.3.2016



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<i>Description:</i> The C-ITS-S shall be able to log the list of all R-ITS-Ss, which were selected for message dissemination. Further the C-ITS-S shall be able to log the list of R-ITS-Ss, which successfully received the messages generated by the C-ITS-S.
Guidance:
Qualification: Testing

R. ID	Requirement Title	Version	Criticality	Status	LDoC							
R_C_118	R-ITS-S reboot logging	0.1	shall agreed 24.3.2016									
	Description: The C-ITS-S shall be able to log all occurrences of R-ITS-S reboots.											
	Guidance: The operator needs to know the status of all connected devices.											
	Qualification: Testing											

R. ID	Requirement Title	Version	Criticality	Status	LDoC						
R_C_119	IF1 and IF3 content logging in C-ITS-S	0.1 should agreed 24.3.									
	Description: The C-ITS-S should be able to log full message content for messages received and sent on IF1 and IF3.										
	Guidance:										
	Qualification: testing										

R. ID	Requirement Title	Version	Criticality	Status	LDoC						
R_C_049	Visualization of R-ITS-S	0.2	shall	agreed 10.2.201							
	<i>Description:</i> The visualization of the R-ITS-S shall be via an icon of the R-ITS-Ss on the C-ITS-S GUI. The rough position and the name shall be indicated on the display. An operator shall be able to call for additional, detailed status information.										
	Guidance: The operator needs to know the status of all connected devices.										
	Qualification: Testing										

R. ID	Requirement Title	Version	Criticality	Status	LDoC
R_C_050	Visualization of RW trailer	0.2	shall	agreed	10.2.2015



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<i>Description:</i> Position of road works trailer. A road works trailer connected to the C-ITS-S shall be indicated by an icon on the C-ITS-S GUI.
<i>Guidance:</i> The term RW trailer refers to a safety or pre-warning trailer that is equipped with a portable R-ITS-S.
Qualification:

R. ID	Requirement Title	Version	Criticality	Status	LDoC						
	Presentation of status of										
R_C_088	deployed messages	0.2	shall	agreed 24.3.2016							
	Description: The C-ITS-S shall present status of currently deployed messages.										
	Guidance: The operator shall be informed about the situations currently active.										
	Qualification: Testing										

R. ID	Requirement Title	Version	Criticality	Status	LDoC						
R_C_096	Grouping of CEN-DSRC protected zones	0.1	Shall	agreed	22.12.2015						
	Description: The C-ITS-S shall group CEN-DSRC protected zones, received by the TCC, for each relevant R-ITS-S (max. 16).										
	<i>Guidance:</i> The max. number of protected zones in one CAM is 16.										
	Qualification: testing										

R. ID	Requirement Title	Version	Criticality	Status	LDoC							
R_C_107	C-ITS-S convergence functionality	0.1	shall	shall agreed 21.3.201								
	Description: The C-ITS system shall provide convergence functionality (possibility of C-ITS messages distribution via another communication technology beside ITS-G5), as described in Ref. [ECo-AT SWP3.6 convergence]. The C-ITS-S shall provide IVI and DENM downstream information via IF5 to a webserver.											
	Guidance:											



Qualification: Testing

5.2.3 Roadside ITS Station (R-ITS-S)

5.2.3.1 Overview

The R-ITS-S is a C-ITS system component located along the road. It is physically either fixed or temporarily setup or moving – e.g. at a road works safety trailer. It communicates to vehicles passing by. The R-ITS-S shall have the possibility to de- and encode C-ITS messages sent / to be sent over the ITS-G5 link. Towards the C-ITS-S it acts as information pre- or post-processor. It combines frequently received, redundant roadside data into higher level information before transmitting it to the C-ITS-S. Towards the V-ITS-S it shall be able to compose / decompose / transcode traffic information and service data provided by center side (via TCC and C-ITS-S) into a C-ITS message structure for sending via ITS-G5 and vice versa. The C-ITS message encoding includes final message creation and signature.

The R-ITS-S has one interface (IF3) to the C-ITS-S that is specified in ECo-AT. The interface to the V-ITS-S (IF4) is based on the C-ITS specifications, e.g. Ref. [ETSI 302 637-3], Ref. [ETSI 302 637-2]. Furthermore there are proprietary interfaces to the TLCs (IF6) and to road works safety trailers (IF7), based on their respective specifications. The necessary security tasks to / from the security authority are handled via the C-ITS-S and IF2.



Figure 5: Integration of the R-ITS-S into the ECo-AT system



5.2.3.2 General R-ITS-S requirements

The wording "DENM data", "DENM information", "IVI data", "IVI information", "CAM data", "CAM information", "SPAT/MAP data", and "SPAT/MAP information" does not describe the encoded message, but describes the required content for these messages (e.g., "The TCC shall send DENM information to the C-ITS-S" means that the required data elements from the TCC, in order to generate an ITS-G5 conform message in the C-ITS system shall be sent).

Table 6 gives an overview about the general C-ITS-S requirements and their mapping to ECo-AT topics/scenarios.



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					CAM aggregation scenarios	RWW scenarios	RWW scenarios	RWW scenarios	IVI scenarios	Other DENM scenarios	Other DENM scenarios	ISS scenarios	ISS scenarios	ISS scenarios	existence scenarios	existence scenarios	existence scenarios	existence scenarios	nagement scenarios	nagement scenarios	nagement scenarios				
					9	S	9	3	9	S	3	3	3	3	3	3	3	9	ð	ð	ð	ð	<u>s</u>	Ma	Ma
R. ID	Requirement Title	Version	Status	LDoC	1	2	3	4	5	1	2	3	1	1	2	1	2	3	1	2	3	4	1	2	3
R-115-5	ITS-G5 communication	0.1	agreed	12 02 2014	-		-		-	v	v	×	×	v		Y	Y	Y	Y	Y	Y	Y	_		
R R 002	ITS-G5 GN protocol	0.1	agreed	27 03 2014	x	x	x			X	×	×	×	×	x	X	X	X	X	X	X	X	-	-	
R R 003	ITS-G5 BTP	0.1	agreed	12.02.2014	X	X	X			X	X	X	X	X	X	X	X	X	Х	Х	X	X		-	
R R 092	ITS-G5 BTP ports	0.2	updated	27.07.2016	Х	Х	X			X	X	X	X	X	X	Х	Х	X	Х	X	X	X		_	
R_R_004	ITS-G5 DENM	0.2	agreed	27.03.2014						Х	Х	Х		Х	Х										
R_R_005	ITS-G5 CAM	0.2	agreed	27.03.2014	Х	Х	Х												Х	Х	Х	Х			
R_R_009	IVI Data Provision to V-ITS-S	0.2	agreed	10.02.2015									Х												
R_R_072	SPAT/MAP Data Provision to V-ITS-S	0.1	agreed	04.03.2015												Х	Х	Х							
R_R_093	R-ITS-S Message Management for SPAT/MAP	0.1	agreed	24.03.2016												Х	Х	Х							Х
R_R_079	R-ITS-S identification of CEN-DSRC protected zone	0.1	agreed	22.12.2015																Х	Х	Х			
R_R_081	R-ITS-S message encoding exception	0.1	agreed	16.02.2016							Х	Х	Х	Х											
R_R_101	ITS-G5 CAM transmission	0.1	new	27.07.2016															Х	Х	Х	Х			
R_R_042	Performance on ITS-G5	0.2	agreed	11.02.2016	Х	Х	Х			Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х			
R_R_017	DENM Data Provision to C-ITS-S	0.3	agreed	16.02.2016											Х										<u> </u>
R_R_018	DENM Data Reception from C-ITS-S	0.2	agreed	27.03.2014							Х	X		Х											
R_R_069	basic RVVV from R-ITS-S DENIX provision to C-ITS-S	0.2	agreed	21.03.2016	v							X												_	
R_R_020	Aggregated CAM Data Provision to C-115-5	0.3	agreed	11.02.2010	^	Y	v																	_	
R R 019	IVI Data Recention from C-ITS-S	0.1	agreed	27 03 2014		^	^						Y										_	_	
R R 077	CEN-DSRC protected zones reception from C-ITS-S	0.2	agreed	22 12 2015									~						х	x	х	x	_	_	
R R 073	SPAT Data reception from TLC	0.3	updated	27.07.2016												х	х	х	~	~	~	~		-	
R_R_071	R-ITS-S Overall system security	0.1	agreed	02.03.2015																					
R_R_028	CAM Data processing	0.2	agreed	10.02.2015	Х																				
R_R_076	Self-configuration of detection zones	0.1	agreed	11.02.2016					Х																
R_R_062	CAM aggregation parameters	0.3	agreed	15.02.2016				Х																Х	
R_R_075	Single vehicle data CAM filter	0.1	agreed	11.02.2016		Х	Х																		
R_R_080	R-ITS-S Message Management for DENM	0.1	agreed	16.02.2016							Х	Х		Х											Х
R_R_082	V-ITS-S DENM filtering	0.1	agreed	16.02.2016											Х										Х
R_R_083	V-ITS-S DENM storage duration	0.1	agreed	16.02.2016											Х										Х
R_R_087	R-ITS-S DENM broadcast: IF3 connection lost/resumed	0.1	agreed	24.03.2016							Х			Х											Х
R_R_070	Generate "stand-alone RWW at R-ITS-S" DENM	0.2	agreed	24.02.2016						X															
R_R_086	Iriggering conditions for transmission of "stand-alone RWW a	0.1	agreed	21.03.2016						х		V									_		_		v
R_R_000	R-ITS-S augmented RWW DENW broadcast. IFS connection	0.1	agreed	24.03.2016						v		X													^
R R 090	R-ITS-S in "augmented mode"	0.1	agreed	24.03 2016						^		×			-				_					-	
R R 085	Access to RW trailer data	0.1	agreed	24.02.2016	-			-		х		X										_		\neg	
R R 084	R-ITS-S Message Management for IVI	0.1	agreed	16.02.2016						Ê		~	х											\neg	х
R_R_091	R-ITS-S IVI broadcast: IF3 connection lost/resumed	0.1	agreed	24.03.2016									X					_			-	_		\neg	Х
R_R_050	Clock Synchronization	0.2	agreed	10.02.2015												Х	Х	Х							
R_R_058	R-ITS-S position	0.2	agreed	10.02.2015						Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х	Х			
R_R_068	Remote configuration of R-ITS-S	0.1	agreed	10.02.2015																				Х	
R_R_100	R-ITS-S basic initialization	0.1	in progress	24.03.2016																				Х	
R_R_094	IF3 logging in R-ITS-S	0.1	agreed	24.03.2016																			х		
R_R_095	Logging type and time availability on IF3	0.1	agreed	24.03.2016					L														Х		
R_R_096	IF4 logging in R-ITS-S	0.1	agreed	24.03.2016				-															X		
K_K_097	Logging availability for IF4	0.1	agreed	24.03.2016								-											×		
R_R_098	IFS content logging in K-115-5	0.1	agreed	24.03.2016				-															×		
R_R_099	DSPC Coexistence	0.1	agreed	24.03.2016				\vdash				-			-					Y	y	Y	^	$ \rightarrow$	-
R R 078	CEN-DSRC protected zone data in CAM	0.3	agreed	22 12 2015				-			\vdash	-							x	X	x	X		\neg	
R R 102	RWW transmission indication	0.1	new	27.07 2016	-				-	x	x	-							~	~	~	~	-	\neg	
R R 043	Outdoor usage	0.2	in progress	05.03.2014	-				-	Ê	Ĥ	-			-						-	-		\neg	
R_R_044	Temperature range	0.1	agreed	11.02.2014														_				_		\neg	
R_R_046	Market certifications	0.1	in progress	11.02.2014																					
R_R_047	Mounting	0.1	agreed	11.02.2014															-				-		

Table 6: General R-ITS-S requirements and mapping to ECo-AT topics/scenarios



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R. ID	Requirement Title	Version	Criticality	Status	LDoC							
R_R_001	ITS-G5 communication	0.1	shall	agreed	12.02.2014							
	Description: The R-ITS-S shall communicate to the V-ITS-S using ITS-G5 communication as defined by Ref. [ETSI 302 663].											
	Guidance: The ITS G5 communication is used for data transmission between vehicles (V-ITS-S) and the roadside stations (R-ITS-S) in Europe. The ITS-G5 communication may be tested using an air protocol analyzer.											
	Qualification: Testing											

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_002	ITS-G5 GN protocol	0.2	shall	agreed	27.03.2014		
	Description:						
	The R-ITS-S shall be able to encode/decode ITS-G5 messages using the Geo Network (GN) protocol as defined by Ref. [ETSI 302 636-4-1].						
	Guidance: The Geo-Network protocol is the mandatory network protocol used within ITS-G5 communication						
	between vehicles and road side equipment in Europe. The ITS-G5 communication may be tested						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_003	ITS-G5 BTP	0.1	shall	agreed	12.02.2014		
	Description: The R-ITS-S shall be able to encode/decode ITS-G5 messages using the Basic Transport Protocol (BTP) as defined by Ref. [ETSI 302 636-5-1].						
	<i>Guidance:</i> The basic transport protocol is a mandatory protocol part used within ITS-G5 communication between vehicles and road side equipment in Europe. The ITS-G5 communication may be tested using an air protocol analyzer.						



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Qualification: Testing

R. ID	Requirement Title	Version	Criticality	Status	LDoC			
R_R_092	ITS-G5 BTP ports	0.2	Shall	updated	27.7.2016			
	<i>Description:</i> The BTP port numbers shall be used as specified in Ref. [ETSI 302 636-5-1] (CAM, DENM, SPAT, MAP) and in guidance below (IVI).							
	<i>Guidance:</i> CAM (2001), DE all messages using BTP-B.	ENM (200	02), MAP (2003), SPAT	(2004), IVI (2006)			
	Qualification: testing							

R. ID	Requirement Title	Version	Criticality	Status	LDoC			
R_R_004	ITS-G5 DENM	0.2	shall	agreed	27.03.2014			
	Description:							
	The R-ITS-S shall be able to encode/decode and transmit/receive DENM packets using the Geo Broadcast Mode to/from the V-ITS-S, as defined by Ref. [ETSI 302 637-3].							
	<i>Guidance:</i> The transmission of unexpected events shall be transmitted within a special geographical area. The geo broadcast mode of communication enables the definition of an area where to distribute the message. The event based DENM protocol (e.g. hazardous information, etc.) are transmitted by the V-ITS-S are received and decoded by the R-ITS-S. The ITS-G5 communication may be tested using an air protocol analyzer.							
	Qualification: Testing							

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_005	ITS-G5 CAM	0.2	shall	agreed	27.03.2014		
	Description:						
	The R-ITS-S shall be able to encode/decode and transmit/receive CAM packets using the Single-Hop-Broadcast (SHB) mode to/from the V-ITS-S, as defined by Ref. [ETSI 302 637-2].						
	Guidance:						
	The "common awareness messages" (CAM) by the R-ITS-S (e.g. tolling zone position information) are transmitted using the "single hop Broadcast mode" - SHB.						



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The CAM protocol (e.g. vehicles position information, speed, heading, etc.) transmitted by the V-ITS-S consequently (approximately every 100 milliseconds by each vehicle) are received and decoded by the R-ITS-S. The ITS-G5 communication may be tested using an air protocol analyzer.
Qualification: Testing

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_009	IVI Data Provision to V-ITS-S	0.2	shall	agreed	10.2.2015		
	Description: The R-ITS-S shall be able to encode and transmit IVI (In Vehicle Information) as defined in Ref. [ECo-AT SWP2.1 UC IVI].						
	<i>Guidance</i> : The "in vehicle information" IVI is used for broadcasting to the vehicle detailed traffic information (e.g. all traffic signs and road restriction). The ITS-G5 communication may be tested using an air protocol analyzer.						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC	
	SPAT/MAP Data Provision to V-					
R_R_072	ITS-S	0.1	shall	agreed	4.3.2015	
	Description:					
	The R-ITS-S shall be able to encode and transmit SPAT/MAP as defined in Ref. [ECo-AT SWP2.1 UC ISS] to the V-ITS-S.					
	Guidance:					
	The ITS-G5 communication may be tested using an air protocol analyzer.					
	Qualification: Testing					

R. ID	Requirement Title	Version	Criticality	Status	LDoC	
R_R_093	R-ITS-S Message Management for SPAT/MAP	0.1	Shall	agreed	24.3.2016	
	<i>Description:</i> The R-ITS-S shall periodically send out ITS-G5 SPAT/MAP on IF4 based on a predefined time scheme.					



Guidance: The time scheme (duration, interval) still has to be defined and specified in an ECo-
AT document.
Qualification: Testing

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_079	R-ITS-S identification of CEN- DSRC protected zone	0.1	Shall	agreed	22.12.2015		
	Description: R-ITS-S shall be able to identify if within a CEN-DSRC protected zone as described in Ref. [ECo-AT SWP3.5 coexistence]. If none of the possibilities is implemented the special coexistence mode shall be used always.						
	<i>Guidance:</i> Following possibilities ident implemented database, received	ifying C by CAM, d	EN-DSRC p etector, info fro	protected zones om C-ITS-S (see R_	are available: R_077)		
	Qualification:						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_081	R-ITS-S message encoding exception	0.1	Shall	agreed	16.2.2016		
	<i>Description:</i> If R-ITS-S does not support message encoding task (GN, BTP, UPER) might be shifted to C-ITS-S for R_R_002, R_R_003, R_R_004, R_R_005, R_R_009, R_R_072, and R_R_018. See Ref. [ECo-AT SWP3.1 IF3 comm] for communication mode negotiation.						
	Guidance:						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_101	ITS-G5 CAM transmission	0.1	shall	new	27.07.2016		
	Description:						
	The R-ITS-S shall only broadcast CAMs, if there is protected zone information for distribution available at the R-ITS-S. In normal mode the R-ITS-S shall not transmit CAMs.						



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Guidance: -
Qualification: Testing

R. ID	Requirement Title	Version	Criticality	Status	LDoC			
R_R_042	Performance on ITS-G5	0.2	shall	agreed	11.02.2016			
	Description: The R-ITS-S shall have system resources for operating with the following minimum performance: - Transmit of minimum 10 signed ITS-G5 message per second - Processing of min. 220 received messages within a second (min. 200 CAM and 20 DENM) - Validation of received certificates for new ITS-Stations (min. 30 per second)							
	<i>Guidance:</i> For achieving an interoperable system a R-ITS-S shall operate with a minimum performance.							
	<i>Qualification</i> : The test will be executed within th	ne manufac	turer test labs.					

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
	DENM Data Provision to C-ITS-						
R_R_017	S	0.3	shall	agreed	16.02.2016		
	Description: The R-ITS-S shall forward traffic event information based on DENM to the C-ITS-S.						
	Guidance:						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
	DENM Data Reception from C-						
R_R_018	ITS-S	0.2	shall	agreed	27.03.2014		
	Description:						
	The R-ITS-S shall be able to receive traffic event information from the C-ITS-S and encode it into DENM messages for transmission over ITS-G5.						
	<i>Guidance</i> : The C-ITS-S sends traffic information to the R-ITS-S and encodes it into the DENM protocol for transmission over the air (ITS-G5).						



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Qualification: Testing

R. ID	Requirement Title	Version	Criticality	Status	LDoC			
	"basic RWW from R-ITS-S"							
R_R_069	DENM provision to C-ITS-S	0.2	shall	agreed	21.03.2016			
	Description:							
	The R-ITS-S shall forward the "basic RWW from R-ITS-S" DENM data to the C-ITS-S.							
	Guidance:							
	The "basic RWW from R-ITS-S" in	nformation	from the trailer	r will be used to exte	end the information			
	basis of the C-ITS-S, on the one I	hand as ad	ditional inform	ation for the operato	or on the other			
	hand as information to be distribu	ted via ITS	-G5 communic	cation to the vehicles	s. Details can be			
	found in Ref. [ECo-AT SWP2.1 UC RWW], Ref. [ECo-AT SWP3.1 C-ITS-S], and Ref. [ECo-AT							
	SWP3.1 IF3 comm].							
	Qualification: Testing							

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
	Aggregated CAM Data Provision						
R_R_020	to C-ITS-S	0.3	shall	agreed	15.02.2016		
	Description:						
	The R-ITS-S shall transmit traffic information (aggregated CAM data) to the C-ITS-S.						
	Guidance:						
	See Ref. [ECo-AT SWP2.1 UC CAM aggr].						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_074	Forward single vehicle data	0.1	Shall	agreed	11.2.2016		
	<i>Description:</i> The R-ITS-S shall forward single vehicle data from the first received CAM from a vehicle to the C-ITS-S.						
	<i>Guidance:</i> Details and which content is included in the single vehicle data is described in Ref.[ECo-AT SWP2.1 UC CAM aggr].						
	Qualification: Testing						



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R. ID	Requirement Title	Version	Criticality	Status	LDoC		
	IVI Data Reception from C-ITS-						
R_R_019	S	0.2	shall	agreed	27.03.2014		
	Description:						
	The R-ITS-S shall be able to receive IVI content from the C-ITS-S.						
	Guidance:						
	The C-ITS composes IVI content messages and sends the message to the R-ITS-S.						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_077	CEN-DSRC protected zones reception from C-ITS-S	0.1	Shall	agreed	22.12.2015		
	Description: The R-ITS-S shall be able to receive CEN-DSRC protected zone data from the C-ITS-S.						
	Guidance:						
	Qualification: testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_073	SPAT Data Reception from TLC	0.3	shall	updated	27.07.2016		
	Description:						
	The R-ITS-S shall be able to receive SPAT content from the TLC.						
	Guidance: Details can be found in Ref. [ECo-AT SWP2.1 UC ISS].						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_071	R-ITS-S Overall system security	0.1	shall	agreed	2.3.2015		
	Description: R-ITS-S shall fulfill the overall system security.						
	Guidance:						



Qualification:

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_028	CAM Data Processing	0.2	shall	agreed	10.2.2015		
	Description: The R-ITS-S shall process the CAM data which were received from V-ITS-Ss into aggregated CAM data as described in Ref. [ECo-AT SWP2.1 UC CAM aggr].						
	Guidance: the resultant aggregated CAM data will be forwarded to the C-ITS-S.						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_076	Self-configuration of detection zones	0.1	Shall	agreed	11.2.2016		
	Description: The R-ITS-S shall be able to self-configure the detection zones for CAM aggregation.						
	Guidance: Details can be found in Ref. [ECo-AT SWP2.1 UC CAM aggr].						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_062	CAM aggregation parameters	0.3	shall	agreed	15.2.2016		
	Description: The parameters of CAM aggregation shall be configurable.						
	<i>Guidance:</i> The CAM aggregation parameters shall be configurable from the C-ITS-S, see Ref. [ECo-AT SWP2.1 UC CAM aggr].						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_075	Single vehicle data CAM filter	0.1	Shall	agreed	11.2.2016		
	<i>Description:</i> The R-ITS-S shall forward only the single vehicle data from the first received CAM of a vehicle to the C-ITS-S. All further CAMs from the same vehicle (stationID) shall be filtered out.						

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<i>Guidance:</i> Details how the CAMs shall be filtered out are described in Ref. [ECo-AT SWP2.1 UC CAM aggr].
Qualification: Testing

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_080	R-ITS-S Message Management for DENM	0.1	Shall	agreed	16.2.2016		
	Description: The R-ITS-S shall periodically send out, update or terminate ITS-G5 DENMs on IF4 based on input from the C-ITS-S on IF3.						
	Guidance: The C-ITS-S provides the time scheme for message management on the R-ITS-S.						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_082	V-ITS-S DENM filtering	0.1	shall	agreed	16.2.2016		
	Description: The R-ITS-S shall forward only the first received DENM from a V-ITS-S. All DENM duplicates shall be eliminated, i.e., originated by the same V-ITS-S AND containing the same event information (updates from a DENM containing new/changed information shall not be eliminated).						
	Guidance: Details can be found in Ref. [ECo-AT SWP3.1 C-ITS-S].						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_083	V-ITS-S DENM storage duration	0.1	shall	agreed	5.3.2015		
	Description: The R-ITS-S shall store the relevant DENM information (in order to distinguish between DENM duplicates and new DENMs) for minimum 300s.						
	<i>Guidance:</i> Details can be found in Ref. [ECo-AT SWP3.1 C-ITS-S]. This storage duration value will be verified in the Living Lab and possibly updated afterwards.						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC
R_R_087	R-ITS-S DENM broadcast: IF3	0.1	shall	agreed	24.3.2016



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connection lost/resumed					
<i>Description:</i> The R-ITS-S is responsible for message management (e.g. cancel or run out DENM) when it is broadcasting a DENM (other DENM applications or "triggerable RWW from TCC") and loses or resumes the IF3 connection.					
Guidance: Details about this behavior are described in Ref. [ECo-AT SWP3.1 C-ITS-S].					
Qualification: Testing					

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_070	Generate "stand-alone RWW at R-ITS-S" DENM	0.2	shall	agreed	24.2.2016		
	<i>Description:</i> The R-ITS-S mounted on a RW trailer in the "stand-alone mode" shall be able to generate a "stand-alone RWW at R-ITS-S" DENM for transmission over IF4 and a "basic RWW from R-ITS-S" DENM (same message as the "stand-alone RWW at R-ITS-S" DENM but on another interface) for transmission over IF3. Both DENMs are generated from R-ITS-S data and RW trailer data.						
	Guidance: : Details can be found in Ref. [ECo-AT SWP2.1 UC RWW] and Ref. [ECo-AT SWP3.1 C-ITS-S]						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_086	Triggering conditions for transmission of "stand-alone RWW at R-ITS-S" DENM	0.1	shall	agreed	21.3.2016		
	Description: The R-ITS-S mounted	ed on a RV	/ trailer shall st	art broadcasting "st	and-alone RWW		
	at R-ITS-S" DENM when it receives an indicator that the trailer is activated.						
	The "stand-alone RWW at R-ITS-S" DENM shall be broadcasted with a repetition interval and						
	repetition duration as defined in R	Ref. [ECo-A	T SWP3.1 C-I	TS-S].			
	The R-ITS-S mounted on a RW trailer shall stop broadcasting "stand-alone RWW at R-ITS-S" DENM when it receives an indicator that the trailer is deactivated or if it receives an "augmented RWW" DENM from C-ITS-S with an "augmentation FLAG" is true.						
	Guidance: Details can be found in Ref. [ECo-AT SWP3.1 C-ITS-S].						
	Qualification: Testing						



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R. ID	Requirement Title	Version	Criticality	Status	LDoC			
R_R_088	R-ITS-S "augmented RWW" DENM broadcast: IF3 connection lost/resumed	0.1	shall	agreed	24.3.2016			
	<i>Description:</i> The R-ITS-S is responsible for message management (e.g. cancel DENM, run out DENM, store DENM info) when it is broadcasting an "augmented RWW" DENM and loses or resumes the IF3 connection.							
	Guidance: Details about this behavior are described in Ref. [ECo-AT SWP3.1 C-ITS-S].							
	Qualification: Testing							

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_089	R-ITS-S in "stand-alone mode"	0.1	shall	agreed	24.3.2016		
	Description: The R-ITS-S mounter In the "stand-alone mode", withou "stand-alone RWW at R-ITS-S" vi with connection to the C-ITS-S, the IF4 if the RW trailer is activated and is activated.	d on RW tr at connection a IF4 if the ne R-ITS-S nd transmi	railers shall be on to the C-ITS RW trailer is a shall broadcas t "basic RWW	by default in the "st S-S, the R-ITS-S sha activated. In the "sta st "stand-alone RW\ from R-ITS-S" via IF	and-alone mode". all broadcast nd-alone mode", W at R-ITS-S" via F3 if the RW trailer		
	Guidance: Details about this behavior are described in Ref. [ECo-AT SWP3.1 C-ITS-S].						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_090	R-ITS-S in "augmented mode"	0.1	shall	agreed	24.3.2016		
	Description: The R-ITS-S mounter an "augmented RWW" DENM wit connection to C-ITS-S). In the "au RWW at R-ITS-S" DENM on IF4, ITS-S if the RW trailer is activated	d on RW tr h "augmen igmented r but shall tr d.	ailers shall be tation FLAG" s node" the R-IT ansmit "basic I	in the "augmented r et to true from the C S-S shall not broade RWW from R-ITS-S	mode" if it receives C-ITS-S (only with cast "stand-alone " via IF3 to the C-		
	Guidance: Details about this behavior are described in Ref. [ECo-AT SWP3.1 C-ITS-S].						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC
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R_R_085	Access to RW trailer data	0.1	shall	agreed	24.2.2016			
	<i>Description:</i> The R-ITS-S shall have local access to relevant RW trailer data (e.g. activation of the RW trailer, arrow position).							
	<i>Guidance:</i> Details can be found in Ref. [ECo-AT SWP3.1 IF3 comm]. The interface itself is not specified in ECo-AT.							
	Qualification: Testing							

R. ID	Requirement Title	Version	Criticality	Status	LDoC			
R_R_084	R-ITS-S Message Management for IVI	0.1	Shall	agreed	16.2.2016			
	Description: The R-ITS-S shall periodically send out, update or terminate ITS-G5 IVIs on IF4 based on input from the C-ITS-S on IF3.							
	Guidance: The C-ITS-S provides the time scheme for message management on the R-ITS-S.							
	Qualification: Testing							

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_091	R-ITS-S IVI broadcast: IF3 connection lost/resumed	0.1	shall	agreed	24.3.2016		
	Description: The R-ITS-S is responsible for message management (e.g. cancel or run out IVI) when it is broadcasting a IVI and loses or resumes the IF3 connection.						
	<i>Guidance:</i> Details about this behavior are described in Ref. [ECo-AT SWP3.1 C-ITS-S] – specifications will be available in a later release.						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC			
R_R_050	R-ITS-S Time Synchronization	0.2	shall	agreed	10.2.2015			
	Description: R-ITS-S time shall be synchronized to a common time reference.							
	<i>Guidance:</i> All components of the ECo-AT system shall use the same time base. This can be a common NTP server or a GNSS source.							
	Qualification: Testing							



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R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_058	R-ITS-S position	0.2	shall	agreed	10.2.2015		
	Description: Any R-ITS-S shall have knowledge about its exact geographical position when operational, no matter how it is connected to the network.						
	<i>Guidance:</i> Fixed R-ITS-S connected to the C-ITS-S can get their position information from manual configuration at the C-ITS-S or from a GNSS receiver. Mobile R-ITS-S can get their position information from GNSS receiver.						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
	Remote Configuration of R-ITS-						
R_R_068	S	0.3	shall	agreed	10.2.2015		
	<i>Description:</i> All R-ITS-Ss shall be configurable by an operator located at the TCC (C-ITS-S) facility. Configuration shall include updating the R-ITS-S firmware.						
	<i>Guidance:</i> It will be possible to manage the R-ITS-S configurations without traveling the rem locations.						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC			
R_R_100	R-ITS-S basic initialization	0.1	shall	in progress	24.3.2016			
	Description: The basic initialization of an R-ITS-S (deployment of a new R-ITS-S) shall be supported by the C-ITS-S with following tasks							
	Guidance: The REQ has to be defined in detail in a later release.							
	Qualification: testing							

R. ID	Requirement Title	Version	Criticality	Status	LDoC			
R_R_094	IF3 logging in R-ITS-S	0.1	shall	agreed	24.3.2016			
	Description: The R-ITS-S shall be able to log type and time of received and sent messages over IF3.							
	Guidance:							



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R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_095	Logging type and time availability on IF3	0.1	shall	agreed	24.3.2016		
	<i>Description</i> : The R-ITS-S shall provide a rolling log mechanism to keep the type/time log on IF3 for minimum of 2 days.						
	Guidance:						
	Qualification: testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_096	IF4 logging in R-ITS-S	0.1	shall	agreed	24.3.2016		
	<i>Description</i> : The R-ITS-S shall be able to log start and end time of continuous send messages on IF4 and messages received on IF4.						
	Guidance:						
	Qualification: testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_097	Logging availability for IF4	0.1	shall	agreed	24.3.2016		
	<i>Description</i> : The R-ITS-S shall provide a rolling log mechanism to keep the type/time log on IF4 for minimum of 2 days. The R-ITS-S shall provide a possibility to keep messages received on IF4 for minimum of 1 hour.						
	Guidance:						
	Qualification: testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_098	IF3 content logging in R-ITS-S	0.1	should	agreed	24.3.2016		
	Description: The R-ITS-S should be able to log full message content for messages received and sent on IF3.						
	Guidance:						



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	Qualification: testing			
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R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_099	R-ITS-S full message content log availability on IF3	0.1	should	agreed	24.3.2016		
	Description: The R-ITS-S should provide a possibility to keep the full received and sent message logging on IF3 for minimum of 2 hours.						
	Guidance:						
	Qualification: testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC			
R_R_059	CEN-DSRC Coexistence	0.3	shall	agreed	22.12.2015			
	<i>Description:</i> All R-ITS-S shall use the techniques described in the ECo-AT coexistence description document, Ref. [ECo-AT SWP3.5 coexistence] and in Ref. [ETSI 102 792], in order to avoid interference with CEN-DSRC tolling stations on the 5.8 GHz band.							
	Guidance: R-ITS-S shall adapt ITS-G5 radio Ref. [ECo-AT SWP3.5 coexistend • Tx-power • Duty cycle • Synchronization with tollin • Using directional antenna ITS-S installed in the area	communic ce] to mitigang station (as that redu a of a CEN	ation settings ate interference for R-ITS-S ins ices the transn -DSRC gantry)	in the CEN-DSRC p to CEN-DSRC stalled on a CEN-DS	orotected zones, SRC gantry) tolling zone (for R-			
	Qualification:							

R. ID	Requirement Title	Version	Criticality	Status	LDoC
R_R_078	CEN-DSRC protected zone data in CAM	0.1	Shall	agreed	22.12.2015
	Description: CAMs from R-ITS-Ss shall conta ITS-S) according to Ref. [ETSI 30	in CEN-DS)2 637-2] (F	SRC protected	zone information (i HighFrequency).	f received from C-



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Guidance:
Qualification: testing

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_102	RWW transmission indication	0.1	shall	new	27.07.2016		
	Description: The R-ITS-S mounted on a RW trailer shall indicate (e.g. with a light) if "stand-alone RWW at R-ITS-S" DENM or "augmented RWW" DENM with involvement of this RW trailer are currently broadcasted via IF4.						
	Guidance: -						
	Qualification: Testing						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_043	Outdoor usage	0.2	shall	in progress	5.03.2015		
	<i>Description:</i> The R-ITS-S shall be designed for outdoor usage in urban and highway environment. This includes protection class (IP67), vibration, UV resistant, and other environmental influences.						
	Guidance:						
	Qualification:						

R. ID	Requirement Title	Version	Criticality	Status	LDoC		
R_R_044	Temperature range	0.1	shall	agreed	11.02.2014		
	Description: The R-ITS-S shall be designed for European temperature range.						
	Guidance:						
	Qualification:						

R. ID	Requirement Title	Version	Criticality	Status	LDoC					
R_R_046	Market certifications	0.1	shall	in progress	11.02.2014					
	Description: The R-ITS-S shall fulfill the required certifications for the European market.									



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Guidance: Qualification:

R. ID	Requirement Title	Version	Criticality	Status	LDoC					
R_R_047	Mounting	0.1	shall	agreed	11.02.2014					
	Description: The R-ITS-S shall provide installation/mounting capabilities for poles, gantries, and other road operator infrastructure environment.									
	Guidance:									
	Qualification:									

5.2.4 Vehicle ITS Station (V-ITS-S)

5.2.4.1 Overview

The V-ITS-S is located in the vehicle and acts as receiver of the C-ITS services and traffic information sent out by the C-ITS system. Additionally, it delivers traffic data collected by the vehicle back to the C-ITS system. The V-ITS-S is not a direct part of the specifications in ECo-AT, it can rather be seen as the (pre-existing) receiver for the C-ITS services for the system.

The V-ITS-S has one interface (IF4) to the R-ITS-S via the ITS-G5 link. There is also a possible interface for a cellular connection to the C-ITS-S (IF5) that will not be specified in ECo-AT.





Figure 6: Integration of the V-ITS-S into the ECo-AT system

5.2.4.2 General V-ITS-S Requirements

Table 7 gives an overview about the general C-ITS-S requirements and their mapping to ECo-AT topics/scenarios.

					UC CAM aggregation scenarios	UC RWW scenarios	UC RWW scenarios	UC RWW scenarios	UC IVI scenarios	UC Other DENM scenarios	UC Other DENM scenarios	UC ISS scenarios	UC ISS scenarios	UC ISS scenarios	Coexistence scenarios	Coexistence scenarios	Coexistence scenarios	Coexistence scenarios	Management scenarios	Management scenarios	Management scenarios				
R. ID	Requirement Title	Version	Status	LDoC	1	2	3	4	5	1	2	3	1	1	2	1	2	3	1	2	3	4	1	2	3
V-ITS-S																									
R_V_002	V-ITS-S identification of CEN-DSRC protected zone	0.1	agreed	22.12.2015															Х						
R_V_003	CEN-DSRC Coexistence	0.1	agreed	22.12.2015															Х						

Table 7: General V-ITS-S requirements and mapping to ECo-AT topics/scenarios

R. ID	Requirement Title	Version	Criticality	Status	LDoC
R_V_002	V-ITS-S identification of CEN-	0.1	Shall	agreed	22.12.2015



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DSRC protected zone					
Description: V-ITS-S shall be able to identify if AT SWP3.5 coexistence]. If nor mode shall be used always.	f within a C ne of the p	EN-DSRC pro	tected zone as des implemented the	cribed in R special co	Ref. [ECo- existence
<i>Guidance:</i> Following possibilities ident implemented database, received	ifying C by CAM, d	EN-DSRC p etector	protected zones	are	available:
Qualification:					

R. ID	Requirement Title	Version	Criticality	Status	LDoC						
R_V_003	CEN-DSRC Coexistence	0.1	shall	agreed	22.12.2015						
	<i>Description:</i> All V-ITS-S shall use the techniques described in the ECo-AT coexistence description document, Ref. [ECo-AT SWP3.5 coexistence] and Ref. [ETSI 102 792], in order to avoid interference with CEN-DSRC tolling stations on the 5.8 GHz band										
	Guidance: V-ITS-S shall adapt ITS-G5 radio communication settings in the CEN-DSRC protected zones, Ref. [ECo-AT SWP3.5 coexistence], to mitigate interference to CEN-DSRC • Tx-power • Duty cycle										
	Qualification:										

5.3 Interfaces

5.3.1 Maintenance and Operations

Note that the system architecture of reference, see Figure 2, is an abstraction which does not show all elements and interfaces, e.g. those needed for technical maintenance and operations. In order to complement the architecture of reference with all needed operational aspects, the following operational scenarios are defined:



Operational Scenario 1: the operator of the ECo-AT system is responsible for maintenance of the R-ITS-S and the C-ITS-S; the manufacturer delivers functional units to the operator and further software updates when applicable, but is not responsible for the availability of the ITS-S' services. The manufacturer may be asked to give third level support at request of the operator, which then involves intervention of the manufacturer directly at the site of the R-ITS-S and the C-ITS-S.

Operational Scenario 2: the manufacturer is responsible for the availability of the services of the supplied equipment including its remote or on-site maintenance. Additionally the manufacturer needs to be sure that he is the sole entity being able to perform maintenance, so that other entities cannot negatively influence his duty.

For operational scenario 1, the following assumption is made:

- Manufacturer access to the R-ITS-S application interfaces is provided only directly at the R-ITS-S,
- Manufacturer access to the C-ITS-S is provided locally at the C-ITS-S, without use of the IF3 communication interface and includes similar application processes as the ones identified for R-ITS-S, see 5.3.1.1.

For Operational Scenario 2, the following assumptions are made:

- Manufacturer access to the R-ITS-S application interfaces is provided both remotely over the IF3 communication interface as well as directly at the R-ITS-S,
- Manufacturer access to the C-ITS-S is provided at the C-ITS-S, without use of the IF3 communication interface and includes similar application processes as the ones identified for R-ITS-S, see 5.3.1.1.

Note: this specification does not specify whether Operational Scenario 1 or 2 is going to be used, but leaves the choice open to a later decision.

5.3.1.1 IF3 (Internal Communication)

IF3 identifies both a communication interface (all 7 layers) as well as interfaces between application processes (application interfaces) on R-ITS-S and on C-ITS-S side. With regards to applications running at the Manufacturer, the C-ITS-S is logically acting as a proxy (those are shown as red arrows in Figure 7).

Use Case Name	Direction of the ITS-G5 Communication	Type of Message			
	Infrastructure to Vahiola (12)()	DENM (Day 1) / IVI			
Road Works Warnings (RWW)		(Day 2)			



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In-vehicle Information (IVI)	Infrastructure to Vehicle (I2V)	IVI
CAM Aggregation	Vehicle to Infrastructure (V2I)	CAM
Intersection Safety (ISS)	Infrastructure to Vehicle (I2V)	SPaT / MAP
Other DENM applications (TCC to V-ITS-S and V-ITS-S to TCC)	Vehicle to Infrastructure (V2I) Infrastructure to Vehicle (I2V)	DENM

Table 8: ECo-AT use cases

Figure 7 gives an overview of the interfaces between the identified application processes on R-ITS-S and C-ITS-S side. The red arrows show scenario 2, where the manufacturer is responsible of the services of the R-ITS-S:

- Use cases that transfer the application information, see Table 3.
- ITS-G5 security Management is the use case to manage the ITS-G5 certificates in the R-ITS-S,
- Status monitoring provides R-ITS-S health status information to the C-ITS-S, and from that to its operator, and to the manufacturer (in case of Operational Scenario 2),
- Configuration of application parameters allows the C-ITS-S to set defined parameter in the R-ITS-S that rules the application behavior;
- Configuration of system parameters allows the operator (in case of Operational Scenario 1) or the manufacturer (in case of Operational Scenario 2) to set all system parameters in the R-ITS-S;
- Security management allows the operator/manufacturer to manage the security objects related to access control at the R-ITS-S;
- SW update allows the operator (in case of Operational Scenario 1) or the manufacturer (in case of Operational Scenario 2) to update the SW on the R-ITS-S.



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Figure 7: Interfaces between the identified application processes in R-ITS-S and C-ITS-S

Figure 8 gives an overview of the interfaces between the identified application processes on C-ITS-S side that are available to the operator (in case of Operational Scenario 1) or the manufacturer (in case of Operational Scenario 2 – red arrows):



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Figure 8: interfaces on C-ITS-S side

The current results of TWG3 - Harmonization of C-ITS-S \leftrightarrow R-ITS-S and TCC \leftrightarrow C-ITS-S interfaces are described in the following.

5.3.2 Layered Communication Model

ECo-AT has defined a layered communication model based on the OSI model, which groups communication functions into logical layers. A layer serves the layer above it and is served by the layer below it. This basic



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principle – transparent abstraction of underlying layers – should be respected to the utmost possible extent. The scope of the model extends from the TCC to the C-ITS-S and the R-ITS-S. The interface from the R-ITS-S to the vehicle (V-ITS-S) over ITS G5 is already fully developed and standardized and out of the scope of this description.



Figure 9: Layered communication model of ECo-AT

5.3.3 Physical and Network Layer

The Physical and Network Layer shall be based on standard ICT technology, more precisely an IP based broadband network supporting both IPv4 and IPv6. It shall be bearer agnostic, different bearers should not affect the connection as long as functional requirements and a certain Quality of Service (QoS) are met. Constraints and restrictions (e.g. requiring a particular generation of the IP network layer protocol) are only acceptable if they are functionally justified.

5.3.4 Security Layer

Security in IP networks is standard in many application domains and should not require any ITS specific features; it should rather be a straight forward application of suitably chosen standard tools like SSL / TLS or IPsec on the proper OSI layers. C-ITS devices shall be connected to each other and to the TCC using strong crypto-technology based on digital certificates; the traditional approach of closed – "secure" – networks is no longer future-proof. It is however important to point out that the connection TCC \leftrightarrow C-ITS-S \leftrightarrow R-ITS-S, secured by standard PKI for IP, does not use the same security system as the ITS-G5 radio channel, which uses the C-ITS PKI.

5.3.5 Protocol Layer

There are various standard technologies that allow specifying the protocol layer, but there is no existing European ITS standard for this layer. Key requirements of ECo-AT are that the protocol needs to be payload



agnostic and that any protocol specification should be forwarded to SDOs doing international standardization (CEN / ISO). ECo-AT therefore shall use a SOAP / HTTP(S) based Web Service, with WSDL as interface specification language, based on the OCIT-C transport protocol.

This interface shall be used both for TCC \leftrightarrow C-ITS-S and C-ITS-S \leftrightarrow R-ITS-S communication. It shall be utilized and, if necessary, extended for the tasks of (payload agnostic) payload transfer, system management (between C-ITS components) and notification (between TCC \leftrightarrow C-ITS-S). In order to enable asynchronous (server push) behavior, the investigation of "long polling" techniques will be part of the Web Service / SOAP specification.

5.3.6 Data Layer

On the data layer, different XML based payload formats shall be utilized: Between TCC \leftrightarrow C-ITS-S, DATEX II shall be used. The connection between C-ITS-S \leftrightarrow R-ITS-S shall be based on ASN.1.

DATEX II provides a widely accepted European standard that does contain a lot of relevant data elements and allows for backwards compatible extensions with new content elements. Neither formal standards nor industry standards do have a comprehensive C-ITS data model tuned to the infrastructure already, so these elements have to be specified anyway. DATEX II is also stipulated by the European Commission's delegated acts for implementing the ITS Directive – the overlap of the scope is significant, especially for safety related messages. Therefore, ECo-AT decided to specify DATEX II payload data in UML and use DATEX II XML transfer encoding for the TCC \leftrightarrow C-ITS-S interface. Alternative encodings (like the OCIT-C data protocol) may be also possible, payload coding format negotiation has to happen between client and server in that cases. DATEX II is however the required minimum standard on that interface.

The C-ITS-S \leftrightarrow R-ITS-S interface definition shall be done in ASN.1, which seems natural because C-ITS messages are specified in ASN.1 and therefore, the data definition can be imported from the standards instead of being duplicated. The interface will be based on a specification in ASN1. That contains:

- "Metadata" to be used by the R-ITS-S to configure transmission behavior and protocol data
- "User data" that contains the information for the message payload

This specification can be prepared for transmission using the XML Encoding Rules offered by ASN.1. Alternatively, an implementation may specify its own XML schema (XSD) as a translation of the original ASN.1 specification.



6 Description of Data Elements

The content of this chapter was created in ECo-AT WP2 to collect information about all data which shall be used in the system. When discussing the data elements and its meanings, the experts involved reflected many aspects of the system setup in general. As basis for the Day 1 data element descriptions the C-ITS standards (DENM, CAM, IVI, SPAT/MAP) are used. The tables define the usage of data elements in ECo-AT – they are not meant to be a data dictionary as, e.g. in ETSI (e.g. it does not aim to define data types or value ranges yet). The document structure follows the "types of information" handled in the entire system (e.g. information in DEN messages, information from CAM/aggregated CAM data, information in IVI messages, information on system operations monitoring).

Where applicable, Use Cases are distinguished inside each "type of information".

Normative references

Where applicable, definitions from standard specifications are used / quoted and the reference is indicated.

6.1 Decentralized Environmental Notification Message (DENM)

Decentralized Environmental Notification Messages (DENMs) are mainly used by the Cooperative Road Hazard Warning (RHW) application in order to alert road users of the detected events. The RHW application is an event-based application composed of multiple use cases, one of them being Roadworks Warning (RWW) as used in ECo-AT. The general processing procedure of a RHW use case like RWW is as follows:

- Upon detection of an event, the ITS station immediately broadcasts a DENM to other ITS stations located inside a geographical area and which are concerned by the event.
- The transmission of a DENM is repeated with a certain frequency.
- This DENM broadcasting persists as long as the event is present.
- The termination of the DENM broadcasting is either automatically achieved once the event disappears after a predefined expiry time, or by an ITS station that generates a special DENM to inform that the event has disappeared.
- ITS stations, which receive the DENMs, process the information and decide to present appropriate warnings or information to users, as long as the information in the DENM is relevant for the ITS station.

RWW scenarios considered:

- Scenario 1: Stand-alone safety trailer
- Scenario 2: Safety trailer augmented


• Scenario 3: TCC triggered

The RWW DENM data elements for Scenario 1 - 3 are specified in Ref. [ECo-AT SWP2.1 UC RWW]. An explanation of the specification of the setting of the data elements in the tables and open questions can be found in the Chapter 8 ANNEX DENM Parameter Usage in ECo-AT.

The data elements for the UC other DENM applications are described in Ref. [ECo-AT SWP2.1 UC other DENM].



6.2 CAM aggregation (PVD)

Basic concept: The R-ITS-S collects vehicle data (e.g., speed, traffic volume) during a collection interval. When the collection interval ends, the aggregated data will be sent to the C-ITS-S and TCC, and a new collection interval will begin. Further single vehicle data is forwarded from the R-ITS-S to the C-ITS-S and TCC (e.g., to estimate travel time).

The method of CAM aggregation and the data elements on aggregated vehicle data to be collected at R-ITS-S, processed and provided to the TCC, as well as the configuration data are described in the ECo-AT document Ref. [ECo-AT SWP2.1 UC CAM aggr].

6.3 In-vehicle Information (IVI)

In-Vehicle Information (IVI) denotes a data structure that is required by different ITS services to convey information into the vehicle. One of these services is In-Vehicle Signage (IVS) which provides static as well as dynamic road sign and message sign information. ECo-AT (i.e. Day 1 deployment) will focus on the In-Vehicle Signage (IVS) subset of IVI. IVS contains information about not only conventional road signs, but also variable message signs being used on motorways.

The IVI UC description and specification of the IVI data elements can be found in Ref. [ECo-AT SWP2.1 UC IVI].

6.4 Maintenance / Operations Monitoring

6.4.1 Monitoring via SNMP MIBs

In order to enable system maintenance and monitoring by the ASFINAG monitoring system (Betriebsüberwachungssystem / BüS), a system has to either implement standard SNMP MIBs (see below) or has to implement its own MIB based on ASFINAG guidelines (BÜS-SNMP-MIP / BSM) as outlined in the Document "BüS SNMP – Schnittstelle Richtlinie" Ref. [ASF BÜS].

Using BMS means that every data element and corresponding parameters to be monitored have to be defined between ASFINAG and potential vendors. Elements (SMEs) can either be Traps or values to be polled by BÜS, the latter being preferred. Each event has an unique OID which has a generic part A (1.3.6.1.4.1.9483.32.11) and a vendor selectable part B and part C (up to a maximum of 22 characters). Each OID can either be a value, a state or a text (127 character maximum). A value of 1 constitutes an error, a Value of 0 stands for proper operation.



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For ECo-AT, this means that a custom MIB has to be separately defined between ASFINAG and the industry partners providing equipment for the project. As a first step towards this MIB, the industry partners shall come up with a proposal of common data elements to be monitored via this MIB.

6.4.2 Standard MIBs supported by ASFINAG BüS

HostResources / RFC 2790

- hrProcessorLoad
- hrStorageSize
- hrStorageUsed
- hrStorageAllocationFailures

Interfaces / RFC 2863

- IfAdminStatus
- IfOperStatus
- ifLastChange
- LinkUp
- LinkDown
- ifInDiscards
- ifInErrors
- ifInUnknownProtos
- ifOutDiscards
- ifErrors
- ifHCInOctets
- ifHCInUcastPkts
- ifHCOutOctets
- ifHCOutUcastPkts
- ifHCOutUcastPkts
- ifHighSpeed

System / RFC 3418

- SysUpTime
- ColdStart
- WarmStart
- SysDescription
- SysLocation



7 General Message Management

7.1 Concept of message management

Message management procedures in ECo-AT are dependent on the use case, which kind of data is exchanged, which connection is interrupted, which protocol is used and which instance (part) of the ECo-AT project is affected.

The message management in the ECo-AT specification is described at the specific documents where the message management is relevant for. In the following all the topics of message management are summarized and references are given where the specific descriptions can be found.

Following management scenarios are defined:

Management scenario 1: logging

This scenario is used for the logging of all the interfaces covering the chain from the TCC towards the V-ITS-S, and the messages generated in each of the related components. An operator, accessing the logs generated should be in the position to understand what the whole C-ITS system has done over time for a pre-defined period of time according to the functionalities available in the components of the system.

Management scenario 2: device management

This scenario is used for the configuration of defined parameters, firmware upload of the R-ITS-S that rules the application behavior, failure management and initialization of a new R-ITS-S (C-ITS-S <--> R-ITS-S). Some of these tasks are done through the C-ITS-S GUI that provides an interface to perform such operations.

Management scenario 3: message management

This scenario deals with which kind of data is exchanged, which connection is interrupted, which protocol is used and which component is affected. The following situations are included in this scenario:

- R-ITS-S selection for message distribution
- Message management when connections are interrupted
- Location of data buffering / storage

7.1.1 Overall system message management

- R-ITS-S selection for message distribution (C-ITS messages shall be sent to a selected subset of messages)
 - Description available in Ref. [ECo-AT SWP3.1 C-ITS-S]
 - Message management when links are interrupted
 - Description available in Chap. 7.2, Chap. 7.3, and Chap. 7.4



- Location of data buffering / storage
 - Specifications are included in the requirements in this document
- Failure management
 - Specifications for IF3 can be found in Ref.[ECo-AT SWP3.1 IF3 management]
- 7.1.2 UC related message management

Use Case RWW

- Activation of RW trailer
 - Description available in Ref. [ECo-AT SWP2.1 UC RWW] and Ref. [ECo-AT SWP3.1 C-ITS-S]
- Switching between standalone operational mode and augmented operational mode of a mobile R-ITS-S
 - Description available in Ref. [ECo-AT SWP2.1 UC RWW]] and Ref. [ECo-AT SWP3.1 C-ITS-S]
- Setting of message validity time and message update for the standalone operational mode (configuration at the R-ITS-S)
 - Description available in Ref. [ECo-AT SWP2.1 UC RWW], data element description,] and Ref. [ECo-AT SWP3.1 C-ITS-S]
- Setting of message validity time and message update for the augmented operational mode (TCC acts as source and messages are distributed to relevant R-ITS-Ss)
 - Description available in Ref. [ECo-AT SWP2.1 UC RWW], data element description,] and Ref. [ECo-AT SWP3.1 C-ITS-S]
- Augmentation of RWW data at the C-ITS-S(the C-ITS-S combines multiple basic RWW data received from the mobile R-ITS-S and augments it with further information from the TCC)
 - o Description available in Ref. [ECo-AT SWP3.1 C-ITS-S]

Use Case IVI

- Setting of message validity time (message cancellation not necessary) available in Ref. [ECo-AT SWP2.1 UC IVI] and Ref. [ECo-AT SWP3.1 C-ITS-S]
- IVI message management at C-ITS-S is described in Ref. [ECo-AT SWP3.1 C-ITS-S]
- System component where the generation of ITS-G5 messages is located
 - Description available in Ref. [ECo-AT SWP3.1 C-ITS-S] and Ref. [ECo-AT SWP3.1 IF3 comm]

Use Case CAM aggregation

• General process of CAM aggregation and forwarding to C-ITS-S and TCC are descripted in Ref. [ECo-AT SWP2.1 UC CAM aggr] and Ref. [ECo-AT SWP3.1 C-ITS-S]

Use case ISS

- General process of SPAT/MAP message generation is described in Ref. [ECo-AT SWP2.1 UC ISS]
- Setting of message validity time, and repetition rate available in Ref. [ECo-AT SWP2.1 UC ISS]



Use Case other DENM applications

- DENM triggered by TCC
 - Setting of message validity time, message update, and message cancellation
 - The general concept will follow the description from UC RWW (augmented operational mode)
 - Description available in Ref. [ECo-AT SWP3.1 C-ITS-S]
 - System component where the generation of ITS-G5 messages is located
 - Description available in Ref. [ECo-AT SWP3.1 C-ITS-S] and Ref. [ECo-AT SWP3.1 IF3 comm]
- DENM triggered by V-ITS-S
 - o V-ITS-S DENM data filtering
 - Description available in Ref. [ECo-AT SWP3.1 C-ITS-S]

7.2 Message management when links between system components are interrupted

Assumptions towards the system architecture are defined in chapter 7.2.3.

Focus and requirements for the following sections are:

- Description of the message management in the overall system in the case when an existing link is interrupted
- All cases shall be considered (e.g. what happens when the R-ITS-S loses the connection to the C-ITS-S and vice versa, ...)
- List all possible cases of interrupted link scenarios TCC <-> C-ITS-S <-> R-ITS-S
- Preparation of concepts for message management for the described interrupted link scenarios
- Chapter 7.4 can be understood as input for the definition of the protocols. It can be used as a check list for the definition of the communication protocols. If the listed requirements are fulfilled, then the message management concept is properly implemented by the protocol implementation.

7.2.1 Use Cases data

- Data from RWW trailer sent by mobile R-ITS-S to C-ITS-S
- Data needed for sending DENM and IVI message from TCC via C-ITS-s to an stationary R-ITS-S
- Data of received DENM (R-ITS-S via C-ITS-S to TCC)
- Data of aggregated CAMs (probe vehicle data) (R-ITS-S to C-ITS-S)
- SPAT (Traffic Controller to R-ITS-S)



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Figure 10: Communication links within the ECo-AT system architecture

7.2.2.1 Links considered by the message management concept

There are two types of R-ITS-S, stationary and mobile R-ITS-S.

- link TCC <-> C-ITS-S
- link C-ITS-S <-> R-ITS-S

Note: The separation of mobile and stationary R-ITS-S will be discussed in the following sections. Mobile solutions cover stand-alone or linked R-ITS-S.

7.2.2.2 Links not considered by the message management concept

link C-ITS-S <-> G5-PKI

The concept of the G5-PKI does not require a permanent link.

link R-ITS-S <-> V-ITS-S

This is covered in the ITS-G5 networking standards and not ECo-AT specific.



Link R-ITS-S <-> Traffic Light Controller See remark chapter 7.3.5.

7.2.3 Assumptions

- The architecture should not differ in handling of mobile and stationary R-ITS-S. The only difference here is the possibility to switch a mobile R-ITS-S mounted on trailers from "stand-alone mode" to "augmented mode" for sending out DENM with trailer information (position, sign information, etc.). The connection to the mobile R-ITS-S needs to be considered as less reliable than a stationary R-ITS-S and the mechanisms have to fulfill the needs of a mobile link.
- The message management concept has the target to enable the ECo-AT system to work as robust as possible if certain links are interrupted. A loss of statistical data (outdated information) in case of connection loss is acceptable.

7.3 Examination of the use-cases in the case of interrupted links

7.3.1 General

In case of detecting a communication link loss, the initiator of this link should try to re-establish the communication.

Connection establishment:

This needs to be defined generally for all use-cases.

We assume bidirectional asynchronous communication is possible.

The R-ITS-S will periodically establish a connection to the C-ITS-S and asks for changes, important for mobile R-ITS-S.

7.3.2 Road works warning

The road works warning use case can be divided in two functionalities (protocols).



7.3.2.1 Road works warning trailer information



Figure 11: Sequence road works warning trailer

Normal case:

C-ITS-S can configure R-ITS-S

R-ITS-S will send periodical data trailer information (position, time, ...) to C-ITS-S

C-ITS-S to R-ITS-S

C-ITS-S:

- Log connection termination
- Try to re-establish connection periodically

R-ITS-S:

- Log connection termination
- Try to re-establish connection periodically
- Store last data-sets in buffer (maximum number needs to be defined)

7.3.2.2 Send Road works warning (DENM) to V-ITS-S via R-ITS-S



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Figure 12: Send road works warning to traffic

Normal case:

TCC will send new warning events to C-ITS-S. The new DENMs will be sent from C-ITS-S to R-ITS-S event driven.

Connection termination or link interruption:

C-ITS-S to TCC

Client tries to re-establish the connection

TCC:

- Log connection termination
- Store success rate of distribution of warnings to R-ITS-S (map of active vs pending warnings) for system monitoring
- On link re-establishment send new warning events

C-ITS-S:

Log connection termination

C-ITS-S to R-ITS-S



C-ITS-S:

- Store warning events for R-ITS-S until reconnection to R-ITS-S
- Log connection termination

R-ITS-S:

- Log connection termination
- Try to re-establish connection periodically
- Send out buffered DENMs for which the validity time did not expire.

R-ITS-S trailer

- Same like R-ITS-S but additionally
- Switch to "augmented mode" and send configured DENM
- The switching between "stand-alone mode" and "augmented mode" has to be specified

7.3.3 Receive warnings from V-ITS-S



Figure 13: Receive warnings from V-ITS-S

Normal case:

R-ITS-S will receive new DENM and send warning events to C-ITS-S. The warning events will be sent from C-ITS-S to TCC.

Connection termination or link interruption:

C-ITS-S to TCC



TCC:

• Log connection termination.

C-ITS-S:

- Log connection termination
- Store DENM information received from R-ITS-S

C-ITS-S to R-ITS-S

C-ITS-S:

• Log connection termination

R-ITS-S:

- Log connection termination
- Try to re-establish connection periodically
- Store DENM until the validity Duration (Default 600 sec) of the DENM expires

7.3.4 Receive CAM from V-ITS-S



Figure 14: Receive CAM from V-ITS-S

Normal case:

R-ITS-S will receive new CAM and according to the configured collection period send CAM aggregated (Probe vehicle) data to C-ITS-S.



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The CAM aggregated (Probe vehicle) data will be sent from C-ITS-S to TCC.

Connection termination or link interruption:

C-ITS-S to TCC

TCC:

• Log connection termination.

C-ITS-S:

- Log connection termination
- Store CAM aggregation (Probe vehicle data) information received from R-ITS-S

C-ITS-S to R-ITS-S

C-ITS-S:

• Log connection termination

R-ITS-S:

- Log connection termination
- Try to re-establish connection periodically
- The aggregated data processing algorithm continues. When the configured aggregation time period ends, the R-ITS-S tries to send the data to the C-ITS-S. Data sets can be deleted after successful transmission but need to be temporarily buffered in case of short network failures.

7.3.5 Signal Phase and timing

As signal phase and timing is a local use case, which does not require a connection to the TCC or the C-ITS-S, no special message management mechanism needs to be defined.

7.4 Resulting requirements for protocols of C-ITS components in the case of interrupted links

The requirements in this section are representing the current status of the project and is not a complete list of requirements.



7.4.1 General

- Every protocol needs an initiator (usually covered by client / server type protocols where the initiator is the client)
- In case of link interruption the initiator tries to re-establish the connection
- Both sides of the protocol should have the capability to detect a link disconnection.
- Care has to be taken not to transmit too much data in case of link re-establishment. Spamming of information has to be avoided, e.g. if the link between the C-ITS-Ss and all R-ITS-Ss is interrupted and if the link is re-established all R-ITS-Ss try to send their actual state and collected data to the C-ITS-S at once.
- Logging of connection loss and discarded data

7.4.2 TCC

- Provide and transmit validity information of event data
- Provide and transmit updates of events
- Receive information from R-ITS-S via C-ITS-S

7.4.3 C-ITS-S

- Receive and forward validity information of event data to R-ITS-S
- Delete/Cancel of events for R-ITS-S in case of failure (in case of connectivity loss to TCC the trust in validity of information is also lost)
- Update of event data
- Buffer information from R-ITS-S with limits.
- Interruptions of links to R-ITS-S has to be considered in the dissemination algorithm

7.4.4 R-ITS-S

- Switch between "stand-alone mode" and "augmented mode" of mobile R-ITS-S on trailers
- Store Road works warning data information to a certain extent
- Send Events (DENM) until validity expires. Take care the validity time is not too long. E.g. RWW with a long validity time (days) and the connection is interrupted, then the warning messages should not be sent out too long (exact values have to be defined)



8 ANNEX: DENM Parameter Usage in ECo-AT

Roadworks (RW) scenario

Figure 15 shows the scenario for road works (RW). The RW starts at the black cross described with eventPosition and has an extension to the east until the green half circle. The parameters (trace, relevanceDistance, relevanceTrafficDirection, eventPosition, eventHistory) are data elements from DENM. Examples of information that is available at the ASFINAG TCC are summarized in the black cloud. This scenario is used in the following for the description of the usage of the DENM data elements. Two cases are distinguished:

- Road works warning (RWW) triggered by the TCC
- RWW triggered by the trailer ("stand-alone mode")



Figure 15: RW scenario, DENM data elements

Figure 16 and Figure 17 show the DENM timing parameters for the sender side and the receiver side, respectively.



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Figure 16: DENM timing parameters, sender

Processing (receiver)		
	actionID, reference Time	
	actionID+referenceTime new? ==> new message actionID same, new referenceTime? ==> update message	t>detectionTime+validityDuration ==> discard message
	CANCELLED or NEGATED	
	actionID same, new referenceTime, isCancelation / isNegation	¥ ¥





8.1 detectionTime (ManagementContainer)

8.1.1 ETSI DENM standard

Content of this sub-chapter is taken from Ref. [ETSI 302 637-3].

Description	Time at which the event is detected by the originating ITS-S. For the DENM repetition, this DE shall remain unchanged.
	For the DENM update, this DE shall be the time at which the event update is detected.
	For the DENM termination, this DE shall be the time at which the termination of the event is detected.
Data setting and presentation requirements	This DE shall be presented as specified in ETSI TS 102 894-2 [5] <i>TimestampIts</i> .

8.1.2 TCC triggered RWW

- 8.1.2.1 Informative
- 8.1.2.2 Source in the ECo-AT system

C-ITS-S (if available based on TCC data)

8.1.2.3 Usage in the ECo-AT system

detectionTime shall be set based on C-ITS-S system time. If the TCC provides time information the *detectionTime* is set accordingly.

If the RW duration exceeds the validity duration the C-ITS-S shall update the DENM with a new detectionTime. There shall be no time gaps in the distribution of DENM.



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- 8.1.3 If the RW is finished the C-ITS-S shall not send an updated DENM and the R-ITS-S will run out the DENM until the repetitionDuration expires. With this set up there is no need for a DENM cancellation.Trailer triggered RWW (stand-alone trailer, no connection to C-ITS-S)
- 8.1.3.1 Informative
- 8.1.3.2 Source in the ECo-AT system
- R-ITS-S
- 8.1.3.3 Usage in the ECo-AT system

detectionTime shall come from local time source of R-ITS-S. It shall be set upon the system activation. Trailer is acting as a trigger.

If the RW duration exceeds the validity duration the R-ITS-S shall update the DENM with a new *detectionTime*. There shall be no time gaps in the distribution of DENM.

8.1.4 Related DENM parameters

The *validityDuration* is based on the detectionTime.

8.2 referenceTime (ManagementContainer)

8.2.1 ETSI DENM standard

Content of this sub-chapter is taken from Ref. [ETSI 302 637-3].

6.1.2.2 DENM update

The parameter *referenceTime* is the identifier for DENM update referring to a specific *actionID*. The *referenceTime* represents the time at which a DENM is generated by the DEN basic service, after receiving the application request. For each DENM update, the *referenceTime* shall be updated and the value shall be greater than the *referenceTime* value of the previous DENM update for the same *actionID*.

B.37 referenceTime

Die / Tererenee Time	
Description	This DE refers to the time at which a new DENM, an update DENM or a cancellation DENM is generated.
	This DE is maintained by the DEN basic service of the originating ITS-S.
Data setting and presentation requirements	The <i>referenceTime</i> is maintained by the originating ITS-S, the data setting rules are as specified in clause 8.2.1.3.
	This DE shall be presented as specified in ETSI TS 102 894-2 [5] Timestamplts.



- 8.2.2 TCC triggered RWW
- 8.2.2.1 Informative

Shall be set to the time at which the new DENM is generated by the DEN basic service.

8.2.2.2 Source in the ECo-AT system

Based on the component where the DENM is generated (R-ITS-S or C-ITS-S) the R-ITS-S or C-ITS-S shall set the *referenceTime*.

The *referenceTime* is mandatory.

8.2.2.3 Usage in the ECo-AT system

referenceTime shall be the time the DENM is encoded either in C-ITS-S or R-ITS-S.

8.2.3 Trailer triggered RWW (stand-alone trailer, no connection to C-ITS-S)

8.2.3.1 Informative

Shall be set to the time at which the new DENM is generated by the DEN basic service.

8.2.3.2 Source in the ECo-AT system

R-ITS-S shall set the referenceTime

The *referenceTime* is mandatory.

8.2.3.3 Usage in the ECo-AT system

referenceTime shall be the time the DENM is encoded in R-ITS-S.

8.2.4 Related DENM parameters

repetitionInterval and repetitionDuration



8.3 relevanceDistance (ManagementContainer)

8.3.1 ETSI DENM standard

Content of this sub-chapter is taken from Ref. [ETSI 302 637-3].

6.1.3.1 DENM relevance area

A DENM should be disseminated to as many ITS-Ss as possible located in an area of relevance, denoted as relevance area. This includes ITS-Ss entering the relevance area until the *validityDuration* and ITS-Ss that have no connectivity to the originating ITS-S when the DENM is transmitted.

The relevance area is set by the ITS-S application of the originating ITS-S and shall be included in the DENM when the information is available. A receiving ITS-S may make use of the relevance area information to realize the relevance check.

According to the event type and the event location, the size and the shape of the relevance area varies. In the present document, following information shall be used as the relevance area information:

- relevanceDistance: The distance within which the event is considered relevant to the receiving ITS-S.
- *relevanceTrafficDirection*: The traffic direction along which the receiving ITS-Ss may encounter the event. Therefore, it is also the direction along which the DENM should be disseminated. As an example, for an accident on a motorway, the relevant traffic direction of a DENM related to the event may be the upstream direction of the accident location. While for the accident occurred in rural two-way roads, the *relevanceTrafficDirection* may be both traffic directions (including also the opposite carriageway).

The *relevanceDistance* and the *relevanceTrafficDirection* shall be as specified in Annex A.

relevanceDistance: As specified in clauses 6.1.3.1 and B.38. This DE is optional. If the ITS application of the originator ITS-S provides such information to the DEN basic service, the *relevanceDistance* shall be present.

B.38 relevanceDistance

Description	The distance in which event information is relevant for the receiving ITS-S, starting from the event position as defined in clause 6.1.3.1.
Data setting and presentation requirements	This DE is OPTIONAL. It shall be present when the information is required by the ITS application.
	This DE shall be presented as specified in ETSI TS 102 894-2 [5] RelevanceDistance.

8.3.2 ETSI CDD standard

Content of this sub-chapter is taken from Ref. [ETSI 102 894-2].

RelevanceDistance ::= ENUMERATED {lessThan50m(0), lessThan100m(1), lessThan200m(2), lessThan500m(3), lessThan1000m(4), lessThan5km(5), lessThan10km(6), over10km(7)



- 8.3.3 TCC triggered RWW
- 8.3.3.1 Informative
- 8.3.3.2 Source in the ECo-AT system

The *relevanceDistance* shall be generated in the TCC and delivered to the C-ITS-S.

The relevanceDistance is optional (in the DENM standard), but we define a default value for ECo-AT.

8.3.3.3 Usage in the ECo-AT system

The distance within which the RW event is considered relevant to the receiving V-ITS-S, starting from the event position.

Open Questions:

- It shall be checked if the setting of *relevanceDistance* is a reasonable setting at the application side (V-ITS-S)
- Is there any relation between trace and relevanceDistance at the receiving V-ITS-S?

Setting in ECo-AT:

Since there is only a set of possible values valid for the *relevanceDistance* (*lessThan50m(0*), *lessThan100m(1*), *lessThan200m(2*), *lessThan500m(3*), *lessThan100m(4*), *lessThan5km(5*), *lessThan10km(6*), *over10km(7*)) the value greater or equal to the length of the *trace* shall be chosen. E.g. if the *trace* length is 2000m the value of *relevanceDistance* is *lessThan5km*.

If TCC does not provide this data a default value of *lessThan5km(5)* is used, as proposed by the Amsterdam Group

8.3.4 Trailer triggered RWW (stand-alone trailer, no connection to C-ITS-S)

- 8.3.4.1 Informative
- 8.3.4.2 Source in the ECo-AT system

The relevanceDistance source is the R-ITS-S.

The relevanceDistance is optional (in the DENM standard), but we define a default value in ECo-AT.



8.3.4.3 Usage in the ECo-AT system

The distance within which the RW event is considered relevant to the receiving V-ITS-S, starting from the *eventPosition*.

Open Questions:

- It shall be checked if the setting of *relevanceDistance* is a reasonable setting at the application side (V-ITS-S)
- Is there any relation between trace and relevanceDistance at the receiving V-ITS-S?

Setting in ECo-AT:

The default value of the *relevanceDistance* is *lessThan5km(5)*, as it is proposed by the Amsterdam Group

8.3.5 Related DENM parameters

There is a possible relation to the *trace* (see open questions above).

8.4 relevanceTrafficDirection (ManagementContainer)

8.4.1 ETSI DENM standard

Content of this sub-chapter is taken from Ref. [ETSI 302 637-3].

6.1.3.1 DENM relevance area

• *relevanceTrafficDirection*: The traffic direction along which the receiving ITS-Ss may encounter the event. Therefore, it is also the direction along which the DENM should be disseminated. As an example, for an accident on a motorway, the relevant traffic direction of a DENM related to the event may be the upstream direction of the accident location. While for the accident occurred in rural two-way roads, the *relevanceTrafficDirection* may be both traffic directions (including also the opposite carriageway).

7.1.3 DENM management container

• *relevanceTrafficDirection:* As specified in clauses 6.1.3.1 and B.39. If the ITS application of the originator ITS-S provides such information to the DEN basic service, the *relevanceTrafficDirection* shall be present.

Description	The traffic direction along which the event information is relevant for the receiving ITS- S, as defined in clause 6.1.3.1
Data setting and presentation requirements	This DE is OPTIONAL. It shall be present when the information is required by the ITS application.

B.39 relevanceTrafficDirection



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This DE shall be as presented as specified in ETSI TS 102 894-2 [5]
RelevanceTrafficDirection.

8.4.2 ETSI CDD standard

Content of this sub-chapter is taken from Ref. [ETSI 102 894-2].

Descriptive Name	RelevanceTrafficDirection	
Identifier	DataType_1	
ASN.1 representation	RelevanceTrafficDirection ::= ENUMERATED {allTrafficDirections(0), upstreamTraffic(1), downstreamTraffic(2), oppositeTraffic(3)}	
Definition	DE describing a traffic direction that is relevant to information indicated in a message.	
	For exam	ple, it may be used to describe traffic direction which is relevant to an event
	indicated by a DENM as defined in ETSI EN 302 637-3 [i.3], The terms "upstream",	
	"downstream" and "oppositeTraffic" are relative to the event position.	
	NOTE:	Upstream traffic corresponds to the incoming traffic towards the event position, and downstream traffic to the departing traffic away from the event position.
Unit	N/A	
Category	GeoReference information	

8.4.3 TCC triggered RWW

8.4.3.1 Informative

8.4.3.2 Source in the ECo-AT system

The TCC shall provide the *relevanceTrafficDirection*.

The *relevanceTrafficDirection* is optional (in the DENM standard), but it will be mandatory in ECo-AT.

8.4.3.3 Usage in the ECo-AT system

Considering Figure 15 a DENM for RW starts always at *eventPosition* followed by the length of the RW (*eventHistory*). So if the RW is valid for both directions the *eventPosition* would be different for the traffic in opposite directions. Further usually the situation for the traffic in the two directions is different (closed lanes, ...). Therefore there shall be always one DENM for a RWW in each direction and the *relevanceTrafficDirection* shall be set to *upstreamTraffic*



Setting in ECo-AT:

relevanceTrafficDirection: upstreamTraffic

- 8.4.4 Trailer triggered RWW (stand-alone trailer, no connection to C-ITS-S)
- 8.4.4.1 Informative
- 8.4.4.2 Source in the ECo-AT system

The R-ITS-S is the source of the relevanceTrafficDirection (fixed configuration).

8.4.4.3 Usage in the ECo-AT system

Same as in the TCC triggered RWW, chapter 8.4.3.3.

The *relevanceTrafficDirection* is fixed configured in the R-ITS-S.

Setting in ECo-AT:

relevanceTrafficDirection: upstreamTraffic

8.4.5 Related DENM parameters

8.5 validityDuration (ManagementContainer)

8.5.1 ETSI DENM standard

Content of this sub-chapter is taken from Ref. [ETSI 302 637-3].

6.1.3.1 DENM relevance area

A DENM should be disseminated to as many ITS-Ss as possible located in an area of relevance, denoted as relevance area. This includes ITS-Ss entering the relevance area until the *validityDuration* and ITS-Ss that have no connectivity to the originating ITS-S when the DENM is transmitted.

7.1.3 DENM management container

• *validityDuration*: Shall be as defined in clause B.55. This DE is optional. If this information is provided by the application layer, the *validityDuration* shall be present. The *validityDuration* value may be updated or



extended by the ITS-S application of the originating ITS-S. At the end of this *validityDuration*, the event is regarded as terminated, and all information related to the event may be deleted by the DEN basic service.

8.2.1.5 T_O_Validity, T_RepetitionDuration and T_Repetition

The timer $T_O_Validity$ is the time that indicates the end of the DENM validity for the originating ITS-S protocol operation. Its expiration time shall be set to:

- the offset of the *validityDuration* starting from the *detectionTime*, if the *validityDuration* is provided by the application;
- the default offset of 600 s starting from the *detectionTime*, if the *validityDuration* is not provided by the application.

8.4.1.5 T_R_Validity

 T_R _Validity is the time that indicates the end of DENM validity. It is used in the receiving ITS-S message table for keeping up-to-date DENM information. Its expiration time may be set to:

- the offset of the *validityDuration* starting from the *detectionTime*, if the *validityDuration* is present in the received DENM;
- the default offset of the *validityDuration* of 600s starting from the *detectionTime*, if the *validityDuration* is not present in the received DENM.

B.55 validityDuration

D.55 valuatyDuration	
Description	Validity duration of a DENM.
	The <i>validityDuration</i> is set by the originating ITS-S. Therefore it represents an estimation of how long the event may persist. It implies the duration over which the DENM should be kept at the DEN basic service of the receiving ITS-S and the DENM dissemination be maintained in the relevance area or destination area, until the expiration of <i>validityDuration</i> .
	In case the expiry time of the event cannot be estimated at the originating ITS-S, a default value is used for the DENM protocol operation.
	This DE may be renewed by the originating ITS-S, if the pre-set expiry time has reached to its limit and the originating ITS-S detects that the event persists.
Data setting and presentation requirements	The DE is represented as a time offset in the unit of second since <i>detectionTime</i> .
p	This DE is optional. It shall be present if the information is required by the ITS application. If the DE is not present in DENM, a default value <i>defaultValidity</i> is assumed.
	This DE shall be presented as specified in ETSI TS 102 894-2 [5] <i>ValidityDuration</i> .

8.5.2 TCC triggered RWW

8.5.2.1 Informative

- the V-ITS-S keeps the DENM until the offset of validityDuration starting from the detectionTime
- range from DENM standard: 0..86400s (= 24h) (default value = 600s)



• Therefore it represents an estimation of how long the event may persist.

8.5.2.2 Source in the ECo-AT system

The C-ITS-S sets the validityDuration

The *validityDuration* is mandatory.

8.5.2.3 Usage in the ECo-AT system

Following questions for setting the *validityDuration* have to be answered:

- Shall the validityDuration be short or long?
 - o shall it be based on the RW duration (long validityDuration)?
 - o shall it be based on the disseminationRadius (short to medium validityDuration)?

Considerations for choosing the right value for the validityDuration:

- for long *validityDurations* a cancel/negation of the DENM or an updated DENM with the updated *detectionTime* and minimum *validityDuration* has to be considered
- for short *validityDurations* the *detectionTime* has always to be updated (responsibility: C-ITS-S)
- The *validityDuration* depends on the length of the *trace* (the DENM shall not be outdated before arriving at the *eventPosition*)
- the *validityDuration* shall be at least as long as the travel time from the beginning of the *trace* to the beginning of the RW (*eventPosition*). For the calculation of the travel time a minimum speed has to be chosen (TBD: minimum speed).
- the *validityDuration* shall be at least as long as the travel time from the beginning of the relevance area (*relevanceDistance*) to the beginning of the RW. For the calculation of the travel time a minimum speed has to be chosen (TBD: minimum speed).
- In the case of going out of the coverage range of the R-ITS-S for longer time (should be short *validityDuration*)

Setting in ECo-AT:

Based on pre-calculations and tests in the living lab during test cycle 3 the validityDuration shall be set to 720s. With the DENM update specification in ECo-AT the validity of the DENM in the vehicle (at reception time from R-ITS-S) can be half of the validityDuration (when the DENM at the R-ITS-S reaches half of the validityDuration the detectionTime will be updated). With this setting (min. validity in the vehicle = 360s) a vehicle can travel 5km (R-ITS-S to event) with a speed of 50km/h.



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8.5.3 Trailer triggered RWW (stand-alone trailer, no connection to C-ITS-S)

8.5.3.1 Informative

The Amsterdam Group proposes 60 s for the *validityDuration*

8.5.3.2 Source in the ECo-AT system

The R-ITS-S is the source of the validityDuration.

The *validityDuration* is mandatory.

8.5.3.3 Usage in the ECo-AT system

Setting in ECo-AT:

The validityDuration shall be set to 20s.

8.5.4 Related DENM parameters

The DENM is valid for *detectionTime* plus *validityDuration*. The *validityDuration* shall be at least as long as the travel time from the beginning of the relevance area (*relevanceDistance*) to the beginning of the RW.

8.6 stationType (ManagementContainer)

8.6.1 ETSI DENM standard

Content of this sub-chapter is taken from Ref. [ETSI 302 637-3].

B.49 stationType

Description	This DE provides the station type information of the originating ITS-S.
Data setting and	This DE shall be presented as specified in ETSI TS 102 894-2 [5] StationType.
presentation requirements	

8.6.2 ETSI CDD standard

Content of this sub-chapter is taken from Ref. [ETSI 102 894-2].

A.78 DE_StationType	
Descriptive Name StationType	
Identifier DataType_78	
ASN.1 representation StationType ::= INTEGER {unknown(0), pedestrian(1), cyclist(2),	



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moped(3), motorcycle(4), passengerCar(5), bus(6), lightTruck(7), heavyTruck(8), trailer(9), specialVehicles(10), tram(11), roadSideUnit(15)} (0..255) Definition The type of an ITS-S. The station type depends on the integration environment of ITS-S into vehicle, mobile devices or at infrastructure. Detailed definition of type is out of scope of the present document. The DE is used in *RestrictedTypes* DF as defined in clause A.125. Unit N/A Category Other information

- 8.6.3 TCC triggered RWW
- 8.6.3.1 Informative
- 8.6.3.2 Source in the ECo-AT system
- C-ITS-S or R-ITS-S in the case of fixed R-ITS-S
- 8.6.3.3 Usage in the ECo-AT system
- In the case of fixed R-ITS-S the stationType shall be set to roadSideUnit(15).

Setting in ECo-AT:

For fixed R-ITS-S: *stationType* = *roadSideUnit*(15)

For mobile R-ITS-S (Warnleitanhänger): *stationType = roadSideUnit*(15)

For mobile R-ITS-S (Vorwarner/pre-warner): *stationType* = *specialVehicle*(10) (the situation that the RWW pre-warner trailer is part of the ECo-AT C-ITS is an intended situation described in Ref. [ECo-AT SWP2.1 UC RWW], but is not further specified in ECo-AT)

8.6.4 Trailer triggered RWW (stand-alone trailer, no connection to C-ITS-S)

- 8.6.4.1 Informative
- 8.6.4.2 Source in the ECo-AT system

R-ITS-S is the source.

8.6.4.3 Usage in the ECo-AT system

Setting in ECo-AT:

For mobile R-ITS-S (Warnleitanhänger): *stationType = roadSideUnit*(15)



For mobile R-ITS-S (Vorwarner): *stationType* = *specialVehicle*(10) (the situation that the RWW pre-warner trailer is part of the ECo-AT C-ITS is an intended situation described in Ref. [ECo-AT SWP2.1 UC RWW], but is not further specified in ECo-AT)

Open question:

- Is this a meaningful setting?
- 8.6.5 Related DENM parameters

8.7 informationQuality (SituationContainer)

8.7.1 ETSI DENM standard

Content of this sub-chapter is taken from Ref. [ETSI 302 637-3].

7.1.4 DENM situation container

The situation container includes information that describes the detected event. It shall include at least *informationQuality* DE and *eventType* DF, and may include *linkedCause* DF and *eventHistory* DF, as follows:

• *informationQuality*: Shall be as defined in clause B.23. The value ranges from lowest (1) to highest (7). The *informationQuality* value shall be provided by the application layer of the originating ITS-S. The value 0 shall be set when the information is unavailable.

B.23 informationQuality

Description	Quality level of the information provided by the ITS-S application of the originating ITS-S.
	It indicates the probability of the detected event being truly existent at the event position.
Data setting and presentation requirements	This DE is set according to the ITS application requirements.
	If the information is unknown, the DE shall be set to 0.
	This DE shall be presented as specified in ETSI TS 102 894-2 [5] InformationQuality.

8.7.2 TCC triggered RWW

8.7.2.1 Informative

The Amsterdam Group defines following *informationQuality* classes [AG: Message Set and Triggering Conditions for Road Works Warning Services]

Following options are determined as indicators for the quality of transmitted information:

- a) eventPosition: planned position (by road operator)
- b) eventPosition: simple GNSS
- c) eventPosition: differential GNSS
- d) eventPosition: validated position (e.g. map-matching)
- e) *traces*: planned position (by road operator)
- f) traces: simple GNSS
- g) traces: differential GNSS



h) traces: validated positions (e.g. map-matching)

The *informationQuality* value shall be set according to the following criteria:

Class	Criteria
1	a AND e (planned by road operator)
2	b AND f (simple GNSS)
3	c AND g (differential GNSS)
4	d AND h (validated position)
5	
6	
7	

8.7.2.2 Source in the ECo-AT system

The TCC is the source of the informationQuality.

8.7.2.3 Usage in the ECo-AT system

d) and h) (validated position (e.g. map-matching)) are not defined in detail in the Amsterdam Group document. For the TCC triggered case the location data is validated by the road operator on-site (d) and h) shall be used in ECo-AT)

Setting in ECo-AT:

For eventPosition: informationQuality = 4

For traces: informationQuality = 4

In the case the information source is a trailer (augmented RWW):

Position information is taken from a simple GNSS: informationQuality = 2

Position information is taken from a differential GNSS: informationQuality = 3

8.7.3 Trailer triggered RWW (stand-alone trailer, no connection to C-ITS-S)

8.7.3.1 Informative

See chapter 8.7.2.1



8.7.3.2 Source in the ECo-AT system

The *informationQuality* shall be a fixed configuration in the R-ITS-S.

8.7.3.3 Usage in the ECo-AT system

The information shall be set based on the definition from the Amsterdam Group, depending if the position information is taken from a simple GNSS or a differential GNSS.

Setting in ECo-AT:

Position information is taken from a simple GNSS: *informationQuality* = 2

Position information is taken from a differential GNSS: informationQuality = 3

8.7.4 Related DENM parameters

8.8 eventHistory (SituationContainer)

8.8.1 ETSI DENM standard

Content of this sub-chapter is taken from Ref. [ETSI 302 637-3].

7.1.4 DENM situation container

The situation container includes information that describes the detected event. It shall include at least *informationQuality* DE and *eventType* DF, and may include *linkedCause* DF and *eventHistory* DF, as follows:

• *eventHistory:* This DF indicates the list of positions that a plain event has been detected prior to the *eventPosition.* It shall be as defined in clause B.13. The *eventHistory* is an optional DF. It shall be present in the situation container, if the application provides such information to the DEN basic service.

B.13 eventHistory					
Description	The DF consists of a list of event points which represents the dimension of a plain event in a predefined order. In case that the plain event is detected by a vehicle ITS-S, the DF consists of a list of event detection points along the path that the detecting ITS- S has travelled over some past time and/or distance. Each event point corresponds to a point at which the same event was detected along the path.				
	In the present document up to 40 <i>EventPoint</i> may be added in this DF. The generation of each <i>EventPoint</i> is specified in the related ITS application requirements.				
Data setting and	The EventPoint closest to the current detected event point with respect to the				
presentation requirements	detectionTime or eventPosition shall be put as the first point. It represents an offset				
	delta position and optionally an offset delta detection time with regards to the current				



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detected event point. The delta detection time may not be present, in case the detecting plain event is pre-defined by the detecting ITS-S, e.g. a roadwork zone covering a certain distance along the road.
Other event points shall be structured in ascending order according to the <i>detectionTime</i> or <i>eventPosition</i> . Each event point represents an offset delta position with respect to the previous <i>EventPoint</i> .
This DF is OPTIONAL, it shall be present if required by the ITS application.
This DF shall be presented as specified in ETSI TS 102 894-2 [5] EventHistory.

8.8.2 ETSI CDD standard

Content of this sub-chapter is taken from Ref. [ETSI 102 894-2].

Descriptive Name EventHistory

Identifier DataType_ 110

ASN.1 representation EventHistory::= SEQUENCE (SIZE(1..23)) OF EventPoint

Definition The DF consists of a list of event points which represents the dimension of a plain event in a predefined order. In case that the plain event is detected by a vehicle ITS-S, the DF consists of a list of event detection points along the path that the detecting ITS-S has travelled over some past time and/or distance. Each event point shall be presented as defined in clause A.111 *EventPoint*.

Unit N/A

Category GeoReference information, Traffic information

8.8.3 TCC triggered RWW

8.8.3.1 Informative

A eventHistory may contain up to 23 eventPoints Ref. [ETSI 102 894-2]

8.8.3.2 Source in the ECo-AT system

TCC provides the *eventHistory* to the C-ITS-S.

The *eventHistory* is optional.



8.8.3.3 Usage in the ECo-AT system

As can be seen in Figure 15 the *eventHistory* describes the whole area on the road of the RW, starting from the *eventPosition* until the end of the RW.

Open questions:

- Number of eventPoints that shall be delivered?
- 8.8.4 Trailer triggered RWW (stand-alone trailer, no connection to C-ITS-S)

8.8.4.1 Informative

8.8.4.2 Source in the ECo-AT system

n.a.

8.8.4.3 Usage in the ECo-AT system

Not used in ECo-AT.

8.8.5 Related DENM parameters

8.9 trace (LocationContainer)

8.9.1 ETSI DENM standard

Content of this sub-chapter is taken from Ref. [ETSI 302 637-3].

6.1.3.2 Location referencing

Complementary to the relevance area, a DENM provides location referencing information of the event position. In the present document, the location referencing used by DENM is denoted as *traces*.

A trace contains a list of well-ordered waypoints that forms an itinerary approaching towards the event position.

NOTE 1: The present document specifies the data formatting rules for waypoints and traces to be included in DENM, as specified in Annex A. However, the total length covered by a trace or density of waypoints in a trace may vary depending on ITS application needs.

NOTE 2: Details of waypoints setting rules and the usage of traces at receiving ITS-Ss are out of scope of the present document.

A DENM shall include at least one trace. Multiple traces may be included in DENM, e.g. in case there are more than one possible paths in which a detected event may be approached, e.g. in an intersection area.

The *traces* location referencing is defined and provided by the ITS-S application of the originating ITS-S and shall be included in DENM.

A receiving ITS-S may compare its own itinerary with the trace in order to realize the relevance check. The *traces* shall be as specified in Annex A.

B.51 traces

Description	This DF is the location referencing information of <i>eventPosition</i> . It includes a group of traces as defined in clause 6.1.3.2.		
	Each trace describes a set of consecutive <i>PathPoint</i> positions leading to the event position.		
	ITS-Ss located near to or inside this trace path may be concerned by the event. Multiple traces may be defined in case multiple road sections or traffic flows are leading to the event position. In the present standards, up to seven traces may be added in a DENM.		
	For each trace, multiple PathPoint positions are provided to describe the trace path.		
Data setting and presentation requirements	Within one trace, the <i>PathPoint</i> closest to the event position shall be put as the first waypoint, it presents an offset delta position with regards to the <i>eventPosition</i> . Other <i>PathPoint</i> s shall be structured in ascending order according to the distance to the <i>eventPosition</i> along the trace path. Each <i>PathPoint</i> presents an offset delta position and optionally an offset travel time with regards to the previous <i>PathPoint</i> .		
	The DE <i>PathDeltaTime</i> as defined in <i>PathPoint</i> in ETSI TS 102 894-2 [5] is OPTIONAL, it shall be present if the information is required by the ITS application.		
	When the event position corresponds to the position of a vehicle ITS-S, the first trace in the DF shall be the <i>PathHistory</i> of the vehicle as defined in the CA basic service ETSI EN $302 637 - 27$.		
	The <i>traces</i> shall be presented as specified as in ETSI TS 102 894-2 [5] <i>Traces</i> . Each trace shall be presented as specified in ETSI TS 102 894-2 [5] <i>PathHistory</i> .		

8.9.2 RWW triggered by TCC

8.9.2.1 Informative

A trace may contain up to 40 path points Ref. [ETSI 102 894-2].

A DENM may contain up to 7 traces Ref. [ETSI 102 894-2].

A trace shall cover at least 600m (from draft C2C-CC Basic System Standards Profile)

A trace shall cover at most 1000m (from draft C2C-CC Basic System Standards Profile)

Considering the description in ETSI DENM standard "However, the total length covered by a trace or density of waypoints in a trace may vary depending on ITS application needs." the boundaries from the C2C-CC are not



limiting the *trace* in general. Traces beyond this boundaries can be set if the RWW UC (application) requires such lengths.

8.9.2.2 Source in the ECo-AT system

The trace shall be generated in the TCC and delivered to the C-ITS-S.

trace is mandatory in the ECo-AT system.

8.9.2.3 Usage in the ECo-AT system

A *trace* is included in the RWW DENM broadcasted by the R-ITS-S. It contains a list of well-ordered waypoints that forms an itinerary approaching towards the *eventPosition*, in order to inform the vehicle that is leading to the RW.

Following open questions of setting the *trace* have to be answered:

• length of the *trace*?

•

- Number of *traces* in the DENM?
 - o Only on the same road as the RW occurs
 - All roads (main ones up to 7, motorways) that are leading to the RW
 - Number of path points in one *trace* (distance of path points)?
 - Equidistant path points or various distant between them?
- The number of *traces* and number of path points shall be chosen that the size together with *eventHistory* and recommended path does not exceed a max. value (e.g. 900 Byte)

In order to support the answering of the questions above a scenario is drawn.

Following scenario is considered: There is RW on the motorway starting 1000m after a motorway junction in direction south-east. A travel speed of 90km/h is considered resulting in a travel time from the beginning of the trace to the beginning of the RW for each different scenario. Four different scenarios are depicted in Figure 18 - Figure 21 with 4 different *trace* lengths (1000m, 2000m, 3000m, and 8000m).

In scenario 1 the *trace* length is 1000m. Since the *trace* is starting after the motorway junction only one *trace* is included in the DENM. This length results in a travel time of 40s and a minimum of 25m between path points (considering a max. of 40 path point and equidistant path points).

In scenario 2 the *trace* length is 2000m. Since 3 ways on motorways are leading to the RW, 3 *traces* are included in the DENM. This length results in a travel time of 80s and a minimum of 50m between path points (considering a max. of 40 path point and equidistant path points).

In scenario 3 the *trace* length is 3000m. Since 3 ways on motorways are leading to the RW, 3 *traces* are included in the DENM. This length results in a travel time of 120s and a minimum of 75m between path points (considering a max. of 40 path point and equidistant path points).



In scenario 4 the *trace* length is 8000m. Since 3 ways on motorways are leading to the RW, 3 *traces* are included in the DENM. This length results in a travel time of 320s and a minimum of 200m between path points (considering a max. of 40 path point and equidistant path points).

	trace length	Travel time	Min. distance between path points
scenario 1	1000m	40s	25m
scenario 2	2000m	80s	50m
scenario 3	3000m	120s	75m
scenario 4	8000m	320s	200m

Table 9: Values for the four scenarios considering a speed of 90km/h, a max. of 40 equidistant path points



Figure 18: scenario 1, trace length 1000m


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Figure 19: scenario 2, trace length 2000m



Figure 20: scenario 3, trace length 3000m



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Figure 21: scenario 4, trace length 8000m

Pros for long *traces*:

• The driver is informed already in advance, in order to fell decisions about possible alternative route

Cons for long *traces*:

 Potential risk of false positive warnings in the vehicle if the vehicle can exit the highway before arriving at the RWW location

Pros for more *traces* than 1 (not only on the same road as the RW occurs):

• The driver has already the information about the road works, in order to take decisions about possible alternative route

Cons for more *traces* than 1 (not only on the same road as the RW occurs):

• Since in the Day 1 scenario the V-ITS-S is not connected to a navigation system the V-ITS-S has no knowledge about the route. Considering scenario 2-4 a vehicle going on the *trace* 2 in direction north would be informed of a RW on another motorway that is not its destination.

The size of one *pathPoint* (without optional elements) is 7 Byte. A *trace* with 40 *pathPoint*s has a size of 280 Bytes. The size of *traces*, *eventHistory* and *recommendedPath* together shall not exceed at value of 900 Byte.



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- Trace pathPoint (without optional elements): 7 Byte
- recommendedPath referencePosition: 16 Byte
- eventHistory eventPoint (without optional elements): 7 Byte

The number of points/positions shall satisfy the equation:

 n_{RP} *16Byte + (m_{TR} * n_{TR})*7Byte + n_{EH} *7Byte < 900 Byte

- n_{RP} number of *referencePositions* in a *recommendedPath* (1..40)
- m_{TR} number of *traces* (1..7)
- nTR number of *pathPoint*s in a *trace* (1..40)
- n_{EH} number of *eventPoint*s in a *eventHistory* (1..23)

Setting in ECo-AT:

The *trace* shall consist of at least 10 *pathPoints* with a distance of 50m.

8.9.3 RWW triggered by trailer (stand-alone trailer, no connection to C-ITS-S)

8.9.3.1 Informative

A trace may contain up to 40 path points Ref. [ETSI 102 894-2]

A DENM may contain up to 7 traces Ref. [ETSI 102 894-2]

A trace shall cover at least 600m (from draft C2C-CC Basic System Standards Profile)

A trace shall cover at most 1000m (from draft C2C-CC Basic System Standards Profile)

A typical travel distance of a safety trailer from the drive up or parked at the hard shoulder to the beginning of the RW is 300m-400m (information from SIE).

Considering the description in ETSI DENM standard "However, the total length covered by a trace or density of waypoints in a trace may vary depending on ITS application needs." the boundaries from the C2C-CC are not limiting the *trace* in general. *traces* beyond this boundaries can be set if the RWW UC (application) requires such lengths.

8.9.3.2 Source in the ECo-AT system

The *trace* shall be generated in the R-ITS-S or the trailer (without any manual interaction).

trace is mandatory in the ECo-AT system.



8.9.3.3 Usage in the ECo-AT system

A *trace* is included in the RWW DENM broadcasted by the R-ITS-S. It contains a list of well-ordered waypoints that forms an itinerary approaching towards the *eventPosition*, in order to inform the vehicle that is leading to the RW.

Following open questions of setting the *trace* have to be answered:

• length of the *trace*?

Following scenario is considered: There is RW on the motorway starting 1000m after a motorway junction in direction south-east. A travel speed of 90km/h is considered resulting in a travel time from the beginning of the *trace* to the beginning of the RW for each different scenario. The trailer that is broadcasting the RWW message is located at the beginning of the RW. It includes 1 *trace* with a length of 400m resulting in a travel time of 16s at 90km/h and a minimum of 10m between path points (considering a max. of 40 path point and equidistant path points).



Figure 22: RWW trailer scenario, trace 400m



Setting in ECo-AT:

Considering the prerequisite that there shall be no manual interaction at the trailer, in order to generate the *trace*, the mobile R-ITS-S at the trailer shall generate *traces* like a V-ITS-S. The functionalities of the mobile R-ITS-S in order to generate *traces* shall be switched on when the trailer is on the road. The functionality of sending RWW DENM at the mobile R-ITS-S shall be activated, when the trailer is activated (at the RW).

This results in a minimum length of the *trace* of 300m (typical travel distance from the trailer, see informative).

8.9.4 Related DENM parameters

validityDuration: the *validityDuration* shall be at least as long as the travel time from the beginning of the *trace* to the beginning of the RW. For the calculation of the travel time a minimum speed has to be chosen (TBD: minimum speed).

8.10 roadType (LocationContainer)

8.10.1 ETSI DENM standard

Content of this sub-chapter is taken from Ref. [ETSI 302 637-3].

B.42 roadType	B.42	roadType
---------------	------	----------

Description	The road type information at the event position.
Data setting and presentation requirements	This DE is OPTIONAL. It shall be present when this information is required by the ITS application.
	This DE shall be presented as specified in ETSI TS 102 894-2 [5] RoadType.

8.10.2 ETSI CDD standard

Content of this sub-chapter is taken from Ref. [ETSI 102 894-2].

```
A.65 DE_RoadType

Descriptive Name RoadType

Identifier DataType_65

ASN.1 representation RoadType ::= ENUMERATED {

urban-NoStructuralSeparationToOppositeLanes(0),

urban-WithStructuralSeparationToOppositeLanes(1),

nonUrban-NoStructuralSeparationToOppositeLanes(2),

nonUrban-WithStructuralSeparationToOppositeLanes(3)}

Definition Type of a road segment. Definition of road type is out of scope of the present

document.

Unit N/A

Category Road Topology Information
```



- 8.10.3 TCC triggered RWW
- 8.10.3.1 Informative
- 8.10.3.2 Source in the ECo-AT system n.a.
- 8.10.3.3 Usage in the ECo-AT system

Open questions:

Is there any usage and such an expectation towards this element in a roadworks use case at ٠ application side (V-ITS-S)?

Setting in ECo-AT:

roadType will be not used in ECo-AT

- Trailer triggered RWW (stand-alone trailer, no connection to C-ITS-S) 8.10.4
- 8.10.4.1 Informative
- 8.10.4.2 Source in the ECo-AT system n.a.
- 8.10.4.3 Usage in the ECo-AT system

Setting in ECo-AT:

roadType will be not used in ECo-AT

8.10.5 **Related DENM parameters**

8.11 closedLanes (RoadWorksContainerExtended)

ETSI DENM standard 8.11.1

Content of this sub-chapter is taken from Ref. [ETSI 302 637-3].

B.9 closedLanes

Description	This DF indicates whether the roadwork has caused the
	closure of one or several driving lanes. Optionally, the
	DF may indicate whether a hard shoulder lane is closed



	to traffic or may be used for specific usage (e.g. for stopping).
	This DF is included in <i>roadWorks</i> DF in the <i>alacarte</i> container.
Data setting and presentation requirements	This DF is OPTIONAL. It shall be present when the information is required by the ITS application.
	This DF shall be presented as specified in ETSI TS 102 894-2 [5] <i>ClosedLanes.</i>

8.11.2 TCC triggered RWW

8.11.2.1 Informative

8.11.2.2 Source in the ECo-AT system

The TCC shall be the source of the *closedLanes*.

closedLanes are optional.

8.11.2.3 Usage in the ECo-AT system

TCC shall provide information as precise as available. Will be only included, when TCC provides the information about closed lanes.

8.11.3 Trailer triggered RWW (stand-alone trailer, no connection to C-ITS-S)

- 8.11.3.1 Informative
- 8.11.3.2 Source in the ECo-AT system
- 8.11.3.3 Usage in the ECo-AT system

For day1 UC the standalone trailer has no information about the closed lanes. It has to be distinguished between the safety trailer and the pre-warner. The safety trailer is always parked on different lanes, therefore the *closedLane* information is not available. The pre-warning trailer is always parked on the hard shoulder.

Setting in ECo-AT:

Safety trailer: not used

Prewarner: not used



8.11.4 Related DENM parameters

8.12 incidentIndication(RoadWorksContainerExtended)

8.12.1 ETSI DENM standard

Content of this sub-chapter is taken from Ref. [ETSI 302 637-3].

B.22 incidentIndication

Description	This DF indicates the incident related to the roadworks to provide additional
	information of the roadworks zone.
	This DF is included in roadWorks DF in the alacarte container.
Data setting and	This DF is OPTIONAL. It shall be present when the information is required by the ITS
presentation requirements	application.
	This DF shall be presented as specified in ETSI TS 102 894-2 [5] CauseCode.

8.12.2 TCC triggered RWW

- 8.12.2.1 Informative
- 8.12.2.2 Source in the ECo-AT system

n.a.

8.12.2.3 Usage in the ECo-AT system

Open Questions:

• Is there any application usage (V-ITS-S) for this element?

Setting in ECo-AT:

incidentIndication will be not used in ECo-AT.

8.12.3 Trailer triggered RWW (stand-alone trailer, no connection to C-ITS-S)

- 8.12.3.1 Informative
- 8.12.3.2 Source in the ECo-AT system

n.a.



8.12.3.3 Usage in the ECo-AT system

Open Questions:

• Is there any application usage (V-ITS-S) for this element?

Setting in ECo-AT:

incidentIndication will be not used in ECo-AT.

8.12.4 Related DENM parameters

8.13 recommendedPath (RoadWorksContainerExtended)

8.13.1 ETSI DENM standard

Content of this sub-chapter is taken from Ref. [ETSI 302 637-3].

B.35 recommendedPath

Description	This DF indicates the recommended itinerary in order to contour the roadworks zone.
	A recommended path is presented with a list of path points in the order from the starting point closest to the roadworks zone to the end point of the recommended path.
	This DF is included in <i>roadWorks</i> DF in the <i>alacarte</i> container.
Data setting and presentation requirements	This DF is OPTIONAL. It shall be present when the information is required by the ITS application.
	This DF shall be presented as specified in ETSI TS 102 894-2 [5] ItineraryPath.

8.13.2 TCC triggered RWW

- 8.13.2.1 Informative
- 8.13.2.2 Source in the ECo-AT system

n.a.

8.13.2.3 Usage in the ECo-AT system

Open Questions:



• Is there any application usage (V-ITS-S) for this element?

Setting in ECo-AT:

Not used in ECo-AT.

8.13.3 Trailer triggered RWW (stand-alone trailer, no connection to C-ITS-S)

8.13.3.1 Informative

8.13.3.2 Source in the ECo-AT system

n.a.

8.13.3.3 Usage in the ECo-AT system

Setting in ECo-AT:

Not used in ECo-AT.

8.13.4 Related DENM parameters

8.14 impactReduction (AlacarteContainer)

8.14.1 ETSI DENM standard

Content of this sub-chapter is taken from Ref. [ETSI 302 637-3].

7.1.6 DENM à la carte container

impactReduction: This container may be added when potential collision is detected. It includes vehicle data for the collision mitigation. It shall be as defined in clause B.21.

Free Free Free Free Free Free Free Free

Description	DF included in the <i>alacarte</i> container of DENM to support the pre-crash use case.
	It contains the vehicle detailed information required for mitigating the consequences of a collision.
Data setting and presentation requirements	This DF is OPTIONAL. It shall be present when this information is required by the ITS application.
	This DF shall be presented as specified in Annex A.



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- 8.14.2.1 Informative
- 8.14.2.2 Source in the ECo-AT system

n.a.

8.14.2.3 Usage in the ECo-AT system

Open question:

• Is there any usage at the application (V-ITS-S) for these element?

Setting in ECo-AT:

Not used in ECo-AT.

- 8.14.3 Trailer triggered RWW (stand-alone trailer, no connection to C-ITS-S)
- 8.14.3.1 Informative
- 8.14.3.2 Source in the ECo-AT system

n.a.

8.14.3.3 Usage in the ECo-AT system

Open question:

• Is there any usage at the application (V-ITS-S) for these element?

Setting in ECo-AT:

Not used in ECo-AT.

8.14.4 Related DENM parameters



8.15 repetitionDuration ()

8.15.1 ETSI DENM standard

Content of this sub-chapter is taken from Ref. [ETSI 302 637-3].

Repetition duration	Duration of the DENM repetition in units of milliseconds,
	denoted as repetitionDuration.

6.1.2.3 DENM repetition

In between two consequent DENM updates, a DENM may be repeated by the DEN basic service of the originating ITS-S at a pre-defined repetition interval, in order that new ITS-Ss entering the destination area during the event validity duration may also receive the DENM. This process is referred to as DENM repetition.

The DENM repetition shall be activated under the request from the ITS-S application. If ITS-S application at the originating ITS-S requires the repetition of DENM, it shall provide following data in the application request as specified in clause 5.4.1:

- *repetitionInterval*.
- *repetitionDuration*.

If any of the above data are not provided by the ITS-S application, the DEN basic service shall not execute the DENM repetition. At the reception of the application request, the DENM repetition scheduling shall start from the *referenceTime*, corresponding to the time at which DENM is generated.

For one particular *actionID*, DENM repetition should apply to the most updated DENM.

8.2.1.5 *T*_O_Validity, *T*_RepetitionDuration and *T*_Repetition

The timer *T_RepetitionDuration* is the time that indicates the end of the DENM repetition by the DEN basic service of the originating ITS-S. Its expiration time shall be set to:

- the offset of the *repetitionDuration* starting from the *referenceTime*, if the *repetitionDuration* is provided by the application;
- an invalid value, if the *repetitionDuration* is not provided by the application.

NOTE 1: repetitionDuration is not included in DENM.

For all application request types, the *T_Repetition* and *T_RepetitionDuration* shall not be greater than the *validityDuration*.



8.15.2 TCC triggered RWW

- 8.15.2.1 Informative
- The *repetitionDuration* is not included in the broadcasted DENM.
- The DENM will be repeated until the repetitionDuration starting from the referenceTime.

The unit of *repetitionDuration* is milliseconds.

8.15.2.2 Source in the ECo-AT system

8.15.2.3 Usage in the ECo-AT system

Open questions:

- Shall the repetitionDuration be related to the validityDuration?
- A possible setting would be to set *detectionTime* equal to the *referenceTime* and the *repetitionDuration* equal to the *validityDuration*

Setting in ECo-AT:

Based on the DENM update process by the C-ITS-S defined in ECo-AT the *repetitionDuration* shall be set equal to the *validityDuration* (720s for TCC triggered RWW).

8.15.3 Trailer triggered RWW (stand-alone trailer, no connection to C-ITS-S)

8.15.3.1 Informative

The *repetitionDuration* is not included in the broadcasted DENM.

The DENM will be repeated until the *repetitionDuration* starting from the *referenceTime*.

The unit of *repetitionDuration* is milliseconds.

8.15.3.2 Source in the ECo-AT system

8.15.3.3 Usage in the ECo-AT system

Open questions:

- Shall the repetitionDuration be related to the validityDuration?
- A possible setting would be to set *detectionTime* equal to the *referenceTime* and the *repetitionDuration* equal to the *validityDuration*



Setting in ECo-AT:

Based on the DENM update process by the R-ITS-S defined in ECo-AT the *repetitionDuration* shall be set equal to the *validityDuration* (20s for trailer triggered RWW).

8.15.4 Related DENM parameters

repetitionInterval, referenceTime

possible relation to validityDuration and detectionTime

8.16 repetitionInterval ()

8.16.1 ETSI DENM standard

Content of this sub-chapter is taken from Ref. [ETSI 302 637-3].

Repetition interval	Interval of DENM repetition in units of milliseconds,
	denoted as repetitionInterval.

6.1.2.3 DENM repetition

In between two consequent DENM updates, a DENM may be repeated by the DEN basic service of the originating ITS-S at a pre-defined repetition interval, in order that new ITS-Ss entering the destination area during the event validity duration may also receive the DENM. This process is referred to as DENM repetition.

The DENM repetition shall be activated under the request from the ITS-S application. If ITS-S application at the originating ITS-S requires the repetition of DENM, it shall provide following data in the application request as specified in clause 5.4.1:

- repetitionInterval.
- repetitionDuration.

If any of the above data are not provided by the ITS-S application, the DEN basic service shall not execute the DENM repetition. At the reception of the application request, the DENM repetition scheduling shall start from the *referenceTime*, corresponding to the time at which DENM is generated.

For one particular actionID, DENM repetition should apply to the most updated DENM.

8.2.1.5 *T*_O_Validity, *T*_RepetitionDuration and *T*_Repetition

The timer *T_Repetition* schedules the DENM repetition. Its timeout value shall be set to:

- the *repetitionInterval*, if the parameter is provided by the ITS-S application;
- an invalid value, if the *repetitionInterval* is not provided by the ITS-S application.



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NOTE 2: If the *T_Repetition* is set to invalid, the DENM is transmitted only once. NOTE 3: *repetitionInterval* is not included in DENM.

For all application request types, the *T_Repetition* and *T_RepetitionDuration* shall not be greater than the *validityDuration*.

8.16.2 TCC triggered

8.16.2.1 Informative

The *repetitionInterval* is not included in the broadcasted DENM.

The unit of *repetitionInterval* is milliseconds.

8.16.2.2 Source in the ECo-AT system

8.16.2.3 Usage in the ECo-AT system

Because of the nature of wireless links messages can be lost by the transmission from the R-ITS-S to the V-ITS-S (fading, blocking, ...). Therefore it has to be ensured that a vehicle passing by the R-ITS-S has the possibility to receive the message several times in worst case scenarios (small coverage area at the R-ITS-S, fast vehicle).

Considering a scenario with a minimum coverage area of the R-ITS-S of 300m (150m in each direction), a maximum speed of the vehicle of 130km/h (36m/s), and a *repetitionInterval* of 1s. In this case each vehicle would receive the DENM 8 times passing by the R-ITS-S.

$$\frac{300m}{36m/s} \cdot \frac{1}{1s} = 8.3$$

Setting in ECo-AT:

repetitionInterval: 1s

8.16.3 Trailer triggered RWW (stand-alone trailer, no connection to C-ITS-S)

8.16.3.1 Informative

The *repetitionInterval* is not included in the broadcasted DENM.



The unit of *repetitioninterval* is milliseconds.

8.16.3.2 Source in the ECo-AT system

8.16.3.3 Usage in the ECo-AT system

Because of the nature of wireless links messages can be lost by the transmission from the R-ITS-S to the V-ITS-S (fading, blocking, ...). Therefore it has to be ensured the a vehicle passing by the R-ITS-S has the possibility to receive the message several times in worst case scenarios (small coverage area at the R-ITS-S, fast vehicle).

The trailer with the R-ITS-S is located at the beginning of the RW. Considering a scenario with a minimum coverage area of the R-ITS-S of 150m in each direction (in this scenario the coverage distance only in one direction counts – RW starts at trailer), a maximum speed of the vehicle of 130km/h (36m/s), and a *repetitionInterval* of 0.5s. In this case each vehicle would receive the DENM 8 times before passing the R-ITS-S.

$$\frac{150m}{36m/s} \cdot \frac{1}{0.5s} = 8.3$$

Setting in ECo-AT:

repetitionInterval: 0.5s

8.16.4 Related DENM parameters

repetitionDuration, referenceTime

8.17 Destination area (Geonetworking)

8.17.1 ETSI DENM standard

Content of this sub-chapter is taken from Ref. [ETSI 302 637-3].

destination area: geographical area for DENM dissemination

NOTE: The destination area is specified in ETSI EN 302 931 [4].



6.1.3.3 DENM destination area

The destination area is used by the ITS networking & transport layer for the DENM transmission. According to ETSI EN 302 931 [4], three geometric shapes are defined, each shape being represented by the combination of one or several geographical point and distance information:

- circular shape;
- rectangular shape;
- elliptical shape.

The DEN basic service of the originating ITS-S shall provide the destination area information to the ITS networking & transport layer.

The size and the shape of the relevance area are not necessarily identical to the destination area. The DEN basic service shall provide the destination area in the format compliant to the one as specified in ETSI EN 302 931 [4] to the ITS networking & transport layer.

6.1.4.1 Packet centric forwarding

DENM forwarding may be realized by the ITS networking & transport layer or the facilities layer.

The packet centric forwarding function refers to the ITS networking & transport layer functionality that forwards a DENM from the originating ITS-S to the destination area.

NOTE: The specification of this function is out of scope of the present document. When GeoNetworking/BTP stack is used, this functionality is specified in ETSI EN 302 636-4-1 [i.8].

5.4.2.2 Interface to the GeoNetworking/BTP stack

A DENM may rely on services provided by the GeoNetworking/BTP stack to disseminate a DENM to a geographic destination area. For ITS applications specified in ETSI TS 101 539-1 [i.4], ETSI TS 101 539-2 [i.5] and ETSI TS 101 539-3 [i.6], BTP header type B and GeoBroadcast protocol shall be used for the DENM dissemination.

8.17.2 TCC triggered RWW

8.17.2.1 Informative

As stated in the DENM standard Ref. [ETSI 302 637-3], the GeoBroadcast (GBC) shall be used for the DENM dissemination.

GeoBroadcast method overview (this is a quick management summary – the complete method is described in Ref. [ETSI 302 636-4-1]:

What the sender does

- Check if in destination area
 - o If in: broadcast the GBC packet
 - o If not: unicast the GBC packet to next hop



What the receiver does

- When receiving a broadcasted GBC:
 - Check if in destination area
 - If in, pass it for further processing
 - If out, drop it
- When receiving a unicasted GBC:
 - Check if in destination area
 - If out: select best node and unicast to it for further forwarding
 - If in: broadcast that GBC message

8.17.2.2 Source in the ECo-AT system

Fix configured for each R-ITS-S in the C-ITS-S or fix configured in the R-ITS-S (e.g. circle center: R-ITS-S location, circle radius: default value)

8.17.2.3 Usage in the ECo-AT system

For Day 1 we consider a sparse density of ITS-G5 equipped vehicles. Therefore multi-hop over several vehicles to a specific destination area will be rarely possible. In this case a setting of the destination area around the broadcasting R-ITS-S will ensure that the message is handed over to the facility layer in the V-ITS-S of the passing by vehicle. Assuming that an R-ITS-S on the way to the RW event is broadcasting the messages this makes sense. Furthermore this will avoid a very complex configuration of the destination area in the C-ITS-S or R-ITS-S around the RW event and will simplify this configuration for day1. For Day 2 UC (higher density of ITS-G5 equipped vehicles) a more complex configuration of the destination area can still be done.

Setting in ECo-AT:

Each R-ITS-S can have its own destination area, being more or less identical to the radio communication area. This would ensure that all vehicles passing by would be able to receive and decode messages sent from the R-ITS-S they are passing by.

- Destination area: circle around R-ITS-S (similar to radio communication range, e.g. 1000m)
 - Circular area (Ref. [ETSI 302 636-4-1] chapter 8.8.5.2)
 - HST=0
 - Distance a = radius
 - Distance b = 0
 - Angle = 0
- Maximum hop limit: MHL = 1



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8.17.3 Trailer triggered RWW (stand-alone trailer, no connection to C-ITS-S)

8.17.3.1 Informative See 8.17.2.1

8.17.3.2 Source in the ECo-AT system

Fix configured in the R-ITS-S (e.g. circle center: R-ITS-S location, circle radius: default value)

8.17.3.3 Usage in the ECo-AT system

Since the mobile R-ITS-S in the standalone trailer case is located directly at the RW event, the most reasonable setting for the destination area is around the R-ITS-S similar to the radio communication area. This would ensure that all vehicles entering the coverage area of the R-ITS-S would be able to receive and decode messages sent from the R-ITS-S. In this case the destination area is similar to the relevance area.

Setting in ECo-AT:

- Destination area: circle around R-ITS-S (similar to radio communication range, e.g. 1000m)
 Orcular area (Ref. [ETSI 302 636-4-1] chapter 8.8.5.2)
 - HST=0
 - Distance a = radius
 - Distance b = 0
 - Angle = 0
- Maximum hop limit: *MHL* = 1

8.17.4 Related DENM parameters



9 ANNEX: Geonetworking Profiling

Table 10 and Table 11 show the profiling of the GeoNeworking header for the ECo-AT UC messages. The GeoNetworking header information can be found in Ref. [ETSI 302 636-4-1].

UC message	GeoNetworking packet header type	Comment
RWW DENM	GBC	As described in Chapt. 8.17.2 (TCC triggered RWW) and Chapt. 8.17.3 (stand-alone RWW)
IVI	GBC	Similar to the specification of TCC triggered RWW, Chapt. 8.17.2
SPAT	TSB: SHB or optional "multi-hop TSB" (will be clarified in the next release)	
MAP	TSB: SHB or optional "multi-hop TSB" (will be clarified in the next release)	
DENM	GBC	Similar to the specification of TCC triggered RWW, Chapt. 8.17.2

Table 10: GeoNetworking header types for the ECo-AT UC messages

GeoNetworking packet header type	GeoNetworking parameters
GBC	Common Header: Header subtype = Cirlce (0) Common Header: Maximum Hop Limit = 1



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	GBC: Source Position Vector: GN Address: Station Type = Road Side Unit (15) GBC: Source Position Vector: GN Address: Country Code = 232 GBC: Source Position Vector: Lat/Long = "position of the R-ITS-S" GBC: Lat/Long = "position of the R-ITS-S" GBC: Distance A = 1000m GBC: Distance 0 = 0m GBC: Angle = 0°
SHB	Common Header: Header subtype = Single Hop (0) Common Header: Maximum Hop Limit = 1 TSB: Source Position Vector: GN Address: Station Type = Road Side Unit (15) TSB: Source Position Vector: GN Address: Country Code = 232 TSB: Source Position Vector: Lat/Long = "position of the R-ITS-S"
Multi-hop TSB (will be clarified in the next release)	Basic Header: Router Hop Limit = >1 (ISS UC dependent) Common Header: Header subtype = Multi-hop TSB (1) Common Header: Maximum Hop Limit = >1 (ISS UC dependent) TSB: Source Position Vector: GN Address: Station Type = Road Side Unit (15) TSB: Source Position Vector: GN Address: Country Code = 232 TSB: Source Position Vector: Lat/Long = "position of the R-ITS-S"

Table 11: GeoNetworking profiling

Table 11 shows the GeoNetworking parameters that have to be set for the ECo-AT system. All other GeoNetworking parameters have to be set in order to be conform with Ref. [ETSI 302 636-4-1].

(End of Document)