

SWP 3.2 - Roadside ITS Station

R-ITS-S Functional Definition

WP3 - Functional Specification & Development

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Overview of changes

No.	Version	Status	Date	Type of Change
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	2016-07-15	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:

Take 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

Table of Content

R-ITS-S Functional Definition	1
WP3 - Functional Specification & Development	1
1 Document Information	5
1.1 Purpose of this document	5
1.2 Definitions, Terms and Abbreviations	5
2 References	7
3 General overview	8
4 Functionalities	9
5 Operation modes R-ITS-S	11
5.1 Stand-alone mode (without R-ITS-S connection to the C-ITS-S)	11
5.1.1 Mobile R-ITS-S at the RWW-Trailer (stand-alone safety trailer).....	11
5.1.2 R-ITS-S at the TLC.....	12
5.2 Connected mode (connection to the C-ITS-S).....	13
6 Detail specification	14
6.1 R-ITS-S management / maintenance (Device management).....	14
6.1.1 Device Management	14
6.1.2 Message Management.....	15
6.1.3 Configuration	15
6.1.4 Logging.....	16
6.1.5 Monitoring.....	17
6.1.6 Performance.....	17
6.2 Data processing	18
6.2.1 CAM aggregation	18
6.2.2 DENM	18
6.2.3 IVI	19
6.2.4 SPAT / MAP	19
6.3 Interfaces.....	20
6.3.1 R-ITS-S ↔ C-ITS-S (IF3).....	20

6.3.2	R-ITS-S ⇔ V-ITS-S (IF4)	20
6.3.3	R-ITS-S ⇔ TLC (IF6)	21
6.3.4	R-ITS-S ⇔ Trailer (IF7)	22
6.4	Security	22
6.5	Co-existence	23
7	Informative Annex	24
7.1	C-ITS-S - IP address discovery mechanism used by the R-ITS-S	24
7.2	Connection Establishment by R-ITS-S (Inform)	24
7.3	Inform Retry Policy	25
7.4	Use of random source port	26

List of Tables

<i>Table 1: Document History</i>	2
Table 2: Definitions, Terms and Abbreviations	5
Table 3: Overview of R-ITS-S functionalities	9
Table 16 Inform Retry Wait Intervals	26

1 Document Information

1.1 Purpose of this document

This document describes the functionality in detail, which will be relevant for the R-ITS-S development. The document contains a detailed functional description of the R-ITS-S based on the general requirements of WP2 documents. It will be not a detailed document for the development department. (UML Format ...) It clarifies and addresses the following issues:

- Description of the Interfaces to Trailer, V-ITS-S, TLC (Interface to C-ITS-S will be described in a separate document. The interfaces to trailer and TLC are proprietary and only possible data elements are described in this document.)
- Description of the data processing and management
- Description of the security

1.2 Definitions, Terms and Abbreviations

Table 2: Definitions, Terms and Abbreviations

Abbreviation / Term	Definition
ASF	ASFINAG
BÜS	Betriebsüberwachungssystem (operations monitoring system)
C2C-CC	CAR 2 CAR Communication Consortium
CAM	Cooperative awareness message
C-ITS	Cooperative ITS – C-ITS is a “subset of overall ITS that communicates and shares information between ITS stations to give advice or facilitate actions with the objective of improving safety, sustainability, efficiency and comfort beyond the scope of stand-alone systems” (ISO/TR 17465-1)
C-ITS-S	Central ITS station
DENM	Dezentralized environmental notification message
ETSI	European Telecommunications Standards Institute
GNSS	Global navigation satellite system
GPS	Global positioning system
IP	Internet protocol
ISS	Intersection Safety

Abbreviation / Term	Definition
ITS	Intelligent Transport Systems – systems that use information and communication technology to improve transport systems
IVI	In-Vehicle Information
MAP	Message to convey local, detailed network topology in specific areas, as specified in ISO/PDTS 19091
NTP	Network time protocol
OCIT-C	Open communication interface for road traffic control systems – center to center
PKI	Public Key Infrastructure
PVD	Probe Vehicle Data
R-ITS-S	Roadside ITS station
RWW	Road Works Warning
SFTP	SSH File Transfer Protocol or Secure File Transfer Protocol
SNMP	Simple Network Management Protocol
SPAT	Signal Phase & Timing
SSH	Secure shell
SWP	Subworkpackage
TCC	Traffic Control Center
TLC	Traffic light controller
TLS	„Technische Lieferbedingungen für Streckenstationen“ (German technical terms of delivery for outstations)
UC	Use case
UTC	Coordinated Universal Time
V-ITS-S	Vehicle ITS station
VMS	Variable Message Sign
VPN	Virtual private network
WP	Work package

2 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.

3 General overview

The R-ITS-S is the interface between the C-ITS-S and the field equipment like trailer, TLC and vehicles ITS G5 (V-ITS-S). The R-ITS-S will receive and send data from and to the C-ITS-S and also from and to the field equipment. Some of the data will be processed and / or stored within the R-ITS-S, before they are transferred. The R-ITS-S can be installed at a road works safety trailer or any other mobile device (mobile solution), inside a TLC or inside the existing outstations at the gantries on the highway (fixed solution).

It communicates with vehicles passing by via ITS-G5. The R-ITS-S has the possibility to de- and encode C-ITS messages sent and received over the ITS-G5 link. The R-ITS-S has one interface (IF3) to the C-ITS-S that is specified in [ECo-AT SWP3.1 C-ITS-S], [ECo-AT SWP3.1 IF3 comm], [ECo-AT SWP3.1 IF3 management]. The interface to the V-ITS-S (IF4) is based on the C-ITS specifications, e.g. [ETSI 302 637-3], [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.

For the data transfer to the C-ITS-S an existing IP network (e.g. fiber optic- or cellular network) will be used.

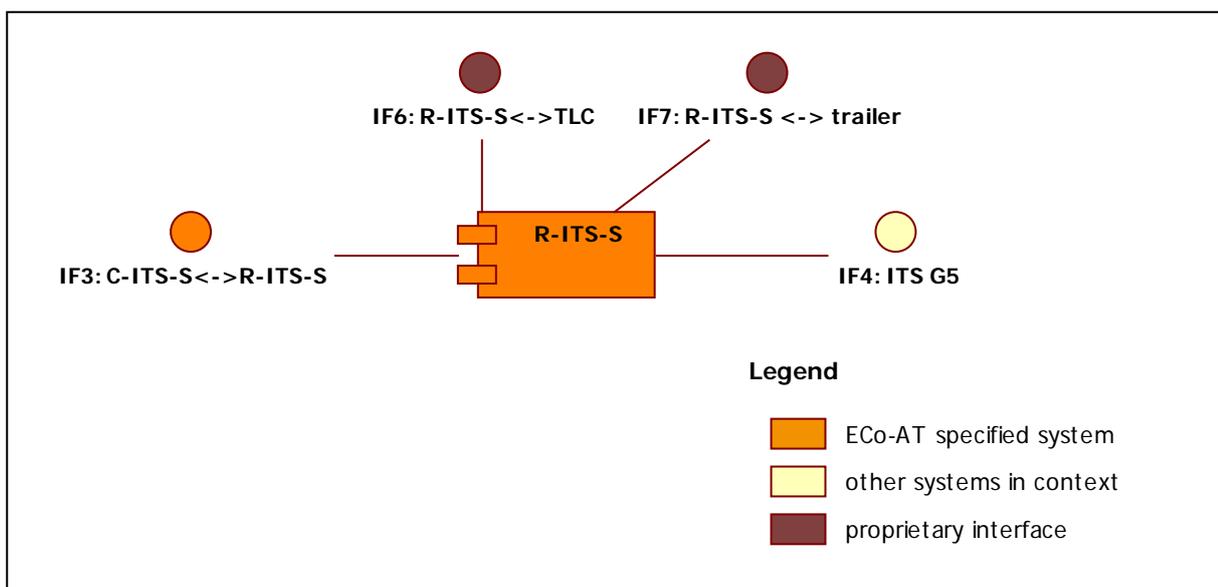


Figure 1: R-ITS-S and related interfaces

The R-ITS-S will contain the [ETSI 302 636-3] stack implementation (ITS access technology layer, ITS network & transport layer, ITS facility layer, ITS application layer). The application layer contains interfaces to the C-ITS-S, TLC and Trailer and applications which are defined in the use case catalog of the ECo-AT project [ECo-AT SWP2.1 UC overview].

4 Functionalities

Table 3: Overview of R-ITS-S functionalities

#	Functionality	Definition, Example
001	R-ITS-S management / maintenance	<ul style="list-style-type: none"> - Device Management (remote access, firmware update) - Message Management - Configuration - Logging - Monitoring - Performance
002	data processing	<ul style="list-style-type: none"> - Aggregation of: <ul style="list-style-type: none"> o CAM - Generation: <ul style="list-style-type: none"> o RWW-DENM based on data from trailer control unit o SPAT based on data from TLC - Filtering of: <ul style="list-style-type: none"> o Eliminate duplicated messages received from the V-ITS-S - Logical functionalities
003	Interfaces <ul style="list-style-type: none"> - R-ITS-S ⇔ C-ITS-S (IF3) - R-ITS-S ⇔ V-ITS-S (IF4) - R-ITS-S ⇔ TLC (IF6) - R-ITS-S ⇔ Trailer (IF7) 	<ul style="list-style-type: none"> - Receive DENM and CAM from V-ITS-S - Send aggregated CAM to C-ITS-S - Receive DENM data from C-ITS-S - Send DENM to the C-ITS-S - Receive data elements from trailer to generate a DENM

#	Functionality	Definition, Example
		<ul style="list-style-type: none"> - Send DENM to V-ITS-S - Receive IVI data from C-ITS-S - Send IVI messages to V-ITS-S - Receive SPAT Data from TLC - Send SPAT / MAP to V-ITS-S - Receive protected zone (CEN-DSCR) information from C-ITS-S - Send protected zones included in CAM to V-ITS-S
004	Security (PKI) management (autentification, anonymization, legitimation)	<p>The functionality of the system component PKI (certification authority) is not yet standardized. There is a proprietary PKI-server implementation existing within the C2C-CC. The usage of the C2C-CC pilot PKI server is reserved for C2C-CC members and needs special agreement if the manufacturer is not member of the C2C-CC.</p> <p>The PKI specification used in ECo-AT has to be based on a standard. No proprietary solutions are allowed.</p>

5 Operation modes R-ITS-S

5.1 Stand-alone mode (without R-ITS-S connection to the C-ITS-S)

5.1.1 Mobile R-ITS-S at the RWW-Trailer (stand-alone safety trailer)

GNSS and IF7 are the only source of information for DENM

Functionalities:

- Receive and collect information from control unit of road works trailer
- Generate autonomous RWW message (RWW-DENM)
- Send RWW-DENM to vehicles

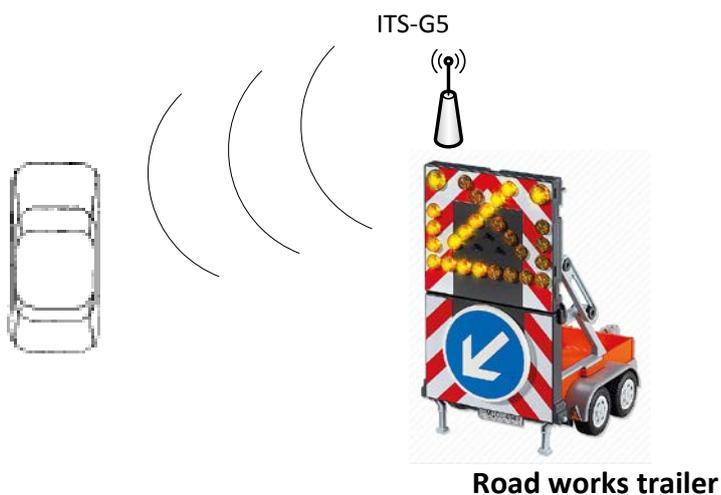
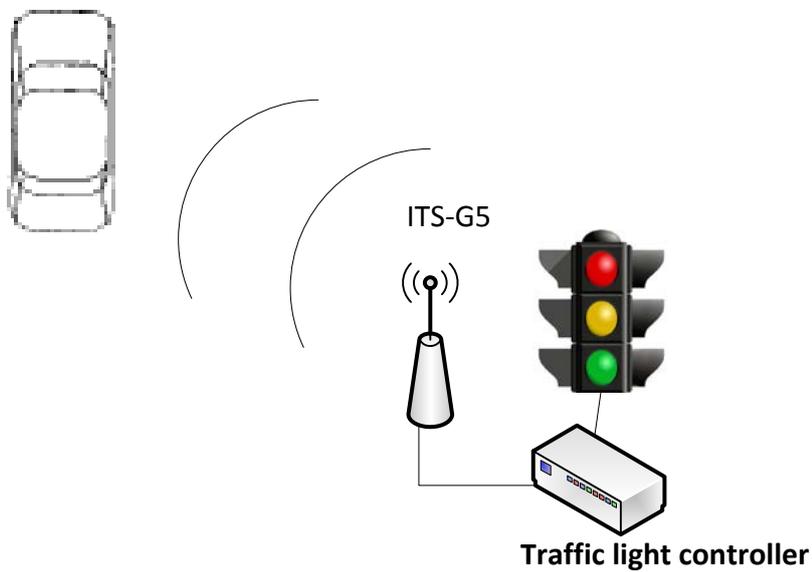


Figure 2: Operation mode R-ITS-S: stand-alone mode

5.1.2 R-ITS-S at the TLC

Functionalities:

- Receive SPAT Data from the TLC.
- Send SPAT / MAP to vehicles



5.2 Connected mode (connection to the C-ITS-S)

- Fixed R-ITS-S at outstations or VMS
- Mobile R-ITS-S at trailer (Safety trailer augmented)

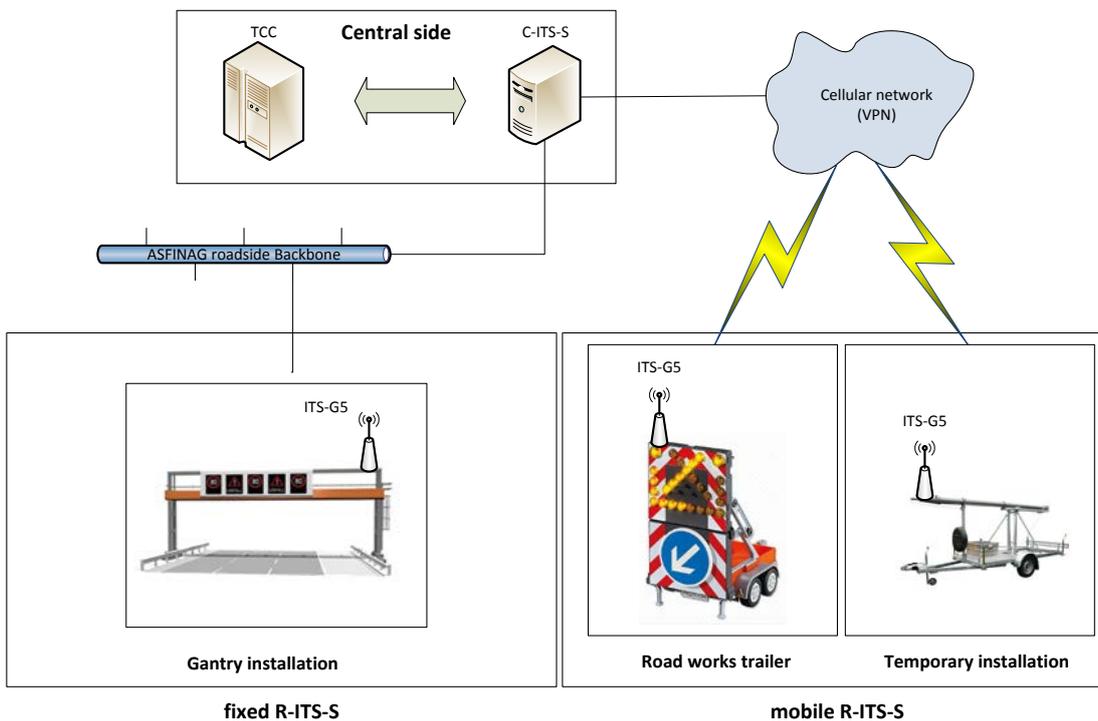


Figure 3: Operation mode R-ITS-S: connected mode

The description of the processes is in accordance to the document [ECo-AT SWP3.1 C-ITS-S]

The R-ITS-S functionalities:

- Receive and Collect information from control unit of road works trailer
- Send DENM, SPAT/MAP, IVI, message to vehicles
- Establish a connection to the C-ITS-S
- Receive RWW information from C-ITS-S
- Receive other DENM and IVI information from C-ITS-S
- Receive protected zone (CEN-DSCR) information from C-ITS-S
- Send protected zones included in CAM to V-ITS-S

- Collect CAM from vehicles
- Aggregate CAM to measurement data
- Send measurement data to C-ITS-S
- Send Single vehicles data to C-ITS-S
-

The initial operation of the R-ITS-S in the different modes will be in accordance to the document [ECo-AT SWP3.1 C-ITS-S] chapter sequence diagram.

6 Detail specification

6.1 R-ITS-S management / maintenance (Device management)

6.1.1 Device Management

Requirements:

- R_R_062** The parameters of CAM aggregation shall be configurable.
- R_R_068** 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.
- R_R_100** 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...(to be defined in detail in a later release)

The R-ITS-S is the OCIT-C client and the C-ITS-S the OCIT-C server.

- In case of link interruption, the initiator (R-ITS-S) tries to re-establish the connection.
- The R-ITS-S has the capability to detect a link disconnection.
- Transmit the stored aggregated CAM (long term) data in case of link re-establishment.
- Overloading of the communication channel has to be avoided, e.g. if the link between the C-ITS-S and all R-ITS-S is interrupted and if the link is re-established all R-ITS-Ss try to send their current state and collected data to the C-ITS-S at once.
- Logging of connection lost and discarded data
- Message management when links are interrupted
 - o [ECo-AT SWP2.3 system overview] (chapter 7.1, 7.2, 7.3) Location of data buffering / storage

- The aggregated CAM Data will be buffered at the R-ITS-S processor unit for 3 days.

6.1.2 Message Management

Requirements:

- R_R_080** 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.
- R_R_082** 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).
- R_R_083** The R-ITS-S shall store the relevant DENM information (in order to distinguish between DENM duplicates and new DENMs) for minimum 300s.
- R_R_084** 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.
- R_R_087** 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.
- R_R_088** 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.
- R_R_091** 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.
- R_R_093** The R-ITS-S shall periodically send out ITS-G5 SPAT/MAP on IF4 based on a predefined time scheme.

6.1.3 Configuration

The configuration of the R-ITS-S will be done by the C-ITS-S via OCIT-C, SNMP, SFTP or SSH, or via remote access.

Examples of Application parameters:

- CAM aggregation
- Detection zone

System parameters: vendor specific

- IP address
- Geoposition
 - o The position will be generated from the GNSS (GPS) receiver or from C-ITS-S.
- Time stamp
 - o Connected mode: NTP (network time protocol) or GPS can act as time source. Local mode: R-ITS-S took the time from GNSS (global navigation satellite system) receiver. The GNSS (GPS receiver) is part of the R-ITS-S
 - o Time base is UTC.

IP address and network settings (gateway, netmask) are described in chapter 7 Informative Annex.

Requirements:

- R_R_050** R-ITS-S time shall be synchronized to a common time reference.
- R_R_058** Any R-ITS-S shall have knowledge about its exact geographical position when operational, no matter how it is connected to the network.
- R_R_081** 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, R_R_017, and R_R_018. See Ref. [ECo-AT SWP3.1 IF3 comm] for communication mode negotiation.
- R_R_076** The R-ITS-S shall be able to self-configure the detection zones for CAM aggregation.
- R_R_089** The R-ITS-S mounted on RW trailers shall be by default in the “stand-alone mode”. In the “stand-alone mode”, without connection to the C-ITS-S, the R-ITS-S shall broadcast “stand-alone RWW at R-ITS-S” via IF4 if the RW trailer is activated. In the “stand-alone mode”, with connection to the C-ITS-S, the R-ITS-S shall broadcast “stand-alone RWW at R-ITS-S” via IF4 if the RW trailer is activated and transmit “basic RWW from R-ITS-S” via IF3 if the RW trailer is activated.
- R_R_090** The R-ITS-S mounted on RW trailers shall be in the “augmented mode” if it receives an “augmented RWW” DENM with “augmentation FLAG” set to true from the C-ITS-S (only with connection to C-ITS-S). In the “augmented mode” the R-ITS-S shall not broadcast “stand-alone RWW at R-ITS-S” DENM on IF4, but shall transmit “basic RWW from R-ITS-S” via IF3 to the C-ITS-S if the RW trailer is activated.

6.1.4 Logging

Requirements:

- R_R_094** The R-ITS-S shall be able to log type and time of received and sent messages over IF3.
- R_R_095** The R-ITS-S shall provide a rolling log mechanism to keep the type/time log on IF3 for minimum of 2 days.
- R_R_096** The R-ITS-S shall be able to log start and end time of continuous send messages on IF4 and messages received on IF4.
- R_R_097** 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.
- R_R_098** The R-ITS-S should be able to log full message content for messages received and sent on IF3.
- R_R_099** The R-ITS-S should provide a possibility to keep the full received and sent message logging on IF3 for minimum of 2 hours.

Will be realized in a proprietary way at the R-ITS-S => tbd with ASF.

6.1.5 Monitoring

Two different functionalities work independently:

- in accordance to the document [ECo-AT SWP2.3 C-ITS monitoring]
- The R-ITS-S provide the data to the C-ITS-S. The C-ITS-S send the data to the BÜS via SNMP for monitoring.

6.1.5.1 Independent system monitoring

Accountability logging will be integrated under the monitoring functionality because of security aspects.

6.1.5.2 Monitoring of systems components

Will be realized in accordance to the document [ECo-AT SWP3.1 C-ITS-S].

6.1.6 Performance

R_R_042 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)

6.2 Data processing

6.2.1 CAM aggregation

Will be realized in accordance to the document [ECo-AT SWP2.1 UC CAM aggr] and [ETSI 302 637-2]

Requirements:

- R_R_005** 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-CAM].
- R_R_020** The R-ITS-S shall transmit traffic information (aggregated CAM data) to the C-ITS-S.
- R_R_028** 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].
- R_R_074** The R-ITS-S shall forward single vehicle data from the first received CAM from a vehicle to the C-ITS-S.
- R_R_075** 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.

If the R-ITS-S is configured to aggregate incoming CAM it sends the aggregation result on a periodic basis [ECo-AT SWP3.1 IF3 comm].

Aggregation parameters and interval settings are part of the device management (DM) data model (see DM over OCIT-C specification [ECo-AT SWP3.1 IF3 management]). The R-ITS-S has already processed and aggregated the CAMs into traffic data so that this data can be sent to the TCC via C-ITS-S without further processing.

6.2.2 DENM

Will be realized in accordance to the document [ECo-AT SWP2.1 UC other DENM] and [ETSI 302 637-3]

Requirements:

- R_R_004** 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]
- R_R_017** The R-ITS-S shall forward traffic event information based on DENM to the C-ITS-S.

- R_R_018** 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.
- R_R_070** 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.
- R_R_069** The R-ITS-S shall forward the “basic RWW from R-ITS-S” DENM data to the C-ITS-S.
- The R-ITS-S will send the first DENM, received from V-ITS-S to the C-ITS-S (connected mode)
 - o The data from V-ITS-S will be transformed inside the R-ITS-S in accordance to the interface documents [ECo-AT SWP3.1 IF3 management] and [ECo-AT SWP3.1 IF3 comm].
 - The R-ITS-S will receive DENM from C-ITS-S and forwards them to the V-ITS-S (connected mode)
 - o The data from C-ITS-S will be transformed inside the R-ITS-S in accordance to the interface document [ECo-AT SWP3.1 IF3 management] and [ECo-AT SWP3.1 IF3 comm]
 - The R-ITS-S will receive Data from RWW and trailer, create a DENM and send to the V-ITS-S (standalone mode)

6.2.3 IVI

Will be realized in accordance to the document [ECo-AT SWP2.1 UC IVI]

Requirements:

- R_R_009** 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].
- R_R_019** The R-ITS-S shall be able to receive IVI content from the C-ITS-S.

6.2.4 SPAT / MAP

Will be realized in accordance to the document [ECo-AT SWP2.1 UC ISS].

Requirements:

- R_R_072** 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.

R_R_073 The R-ITS-S shall be able to receive SPAT content from the TLC.

SPAT / MAP will be used for urban uses cases.

The MAP information will be provided by configuration, TLC, external editor and/or C-ITS-S.

6.3 Interfaces

6.3.1 R-ITS-S ↔ C-ITS-S (IF3)

The interface will be realised in accordance to the documents [ECo-AT SWP3.1 C-ITS-S].

R_R_092 The BTP port numbers shall be used as specified in Ref. [ETSI EN 302 636 5] (CAM, DENM, SPAT, MAP) and Ref. [ECo-AT SWP3.1 IF3 comm] (IVI).

6.3.2 R-ITS-S ↔ V-ITS-S (IF4)

The interface will be realized in accordance to the following ETSI Standards:

- [ETSI 302 663-1]
- [ETSI 302 636-2]
- [ETSI 302 636-3]
- [ETSI 302 636-4-1]
- [ETSI 302 636-5-1]
- [ETSI 302 636-6]

Requirements:

- **R_R_001** The R-ITS-S shall communicate to the V-ITS-S using ITS-G5 communication as defined by Ref. [ETSI EN 302 663].
- **R_R_002** 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]
- **R_R_003** The R-ITS-S shall be able to encode/decode ITS-G5 messages using the Basic Transport Protocol (BTP) as defined by Ref. [ETSI EN 302 636 5].

6.3.3 R-ITS-S ↔ TLC (IF6)

This is a proprietary interface. This chapter describes the possible data elements and functionalities.

Request to TLC:

Name	Remark
Version	
Counter	
Station Id	
Priority State (see: SAE J 2735)	
Request Level (Bus, Emergency, ...)	
Number of Signal groups (0...n)	
Intersection Part Number 1	
Vt Number 1	
Intersection Part Number 2	
Vt Number 2	
Intersection Part Number n	
Vt Number n	
PublicTransportInfo Length (0...n)	
PublicTransportInfo VtR09_16 Byte-Array	

Response from TLC

Name	Remark
Version	
Counter (from Request)	
Priority State	
Number of Signal groups (1...n)	
Intersection Part Number 1	
Vt Number 1	
Intersection Part Number 2	
Vt Number 2	
Intersection Part Number n	
Vt Number n	
Signal group state	

Timestamp	Long (MSB first; 8 Bytes)
Current Signal Program Id	Integer
Next Signal program Id	Integer
Program Counter (**)	Integer

6.3.4 R-ITS-S ↔ Trailer (IF7)

Requirements:

R_R_085 The R-ITS-S shall have local access to relevant RW trailer data (e.g. activation of the RW trailer, arrow position).

R_R_086 The R-ITS-S mounted on a RW trailer shall start broadcasting “stand-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 [ECo-AT SWP2.1 UC RWW]

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.

As this interface is proprietary, only possible data elements and functionalities are described.

The R-ITS-S will be connected with a wired interface to the trailer controller unit.

The RWW trailer control unit sends data elements to the R-ITS-S, which creates the DENM.

R-ITS-S will be fully activated (R-ITS-S will start to send out available RWW DENM) by activating the trailer control unit.

Data elements of trailer status are described in [ECo-AT SWP3.1 IF3 comm].

6.4 Security

In accordance to the document [ECo-AT SWP3.4 security]

For R-ITS-S connected via a cellular interface to the C-ITS-S, IF 3 needs to be secured. An encrypted VPN tunnel should be used. This tunnel can be provided by the telecom provider with “closed user groups” or with a VPN client on the R-ITS-S

Requirements:

R_R_071 R-ITS-S shall fulfill the overall system security.

The functionality of the system component PKI (certification authority) is not yet standardized. There is a proprietary PKI-server implementation existing within the C2C-CC.

6.5 Co-existence

Will be realized in accordance to the document [ECo-AT SWP3.5 coexistence]

R_R_059 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.

R_R_077 The R-ITS-S shall be able to receive CEN-DSRC protected zone data from the C-ITS-S.

R_R_078 CAMs from R-ITS-Ss shall contain CEN-DSRC protected zone information (if received from CITS-S) according to Ref. [ETSI-CAM] (RSUContainerHighFrequency).

R_R_079 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.

7 Informative Annex

7.1 C-ITS-S - IP address discovery mechanism used by the R-ITS-S

The Device Management defines the following mechanisms that may be used by the R-ITS-S to discover the IP address of its associated C-ITS-S:

1. The R-ITS-S may be configured manually with the URL of the C-ITS-S. If necessary, the R-ITS-S would use DNS to resolve the IP address of the C-ITS-S from the host name component of the URL.
2. As part of the IP layer auto-configuration, a DHCP server on the access network may be configured to include the C-ITS-S URL as a DHCP option. If necessary, the R-ITS-S uses DNS to resolve the IP address of the C-ITS-S from the host name component of the URL.
3. The Host and Port information may be retrieved via a DNS server lookup of a locally configured Service Record.

7.2 Connection Establishment by R-ITS-S (Inform)

The R-ITS-S may at any time initiate a connection to the C-ITS-S using the pre-determined C-ITS-S URL. An R-ITS-S shall establish a connection to the C-ITS-S and issue a "DeviceInform" under the following conditions:

- The first time the R-ITS-S establishes a connection to the access network on initial installation
- On power-up or reset
- Once every "PeriodicInformInterval" (for example, every 4 hours)
- Whenever the URL of the C-ITS-S changes
- Whenever a download completes (either successfully or unsuccessfully)
- Whenever a device parameter is modified that is required to initiate an Inform on change.

Device parameter changes made by the C-ITS-S itself using the "RSU_Device_Parameter" object shall not cause a new "RSU_Device_Inform" to be initiated. If a device parameter is modified more than once before the R-ITS-S is able to initiate an Inform to perform the notification, the R-ITS-S shall perform only one notification.

If a device parameter is modified by an external source while "RSU_Device_Inform" is in progress, the change causes a new Inform to be established after the current "RSU_Device_Inform" is terminated (it shall not affect the current Inform).

In order to avoid excessive traffic to the C-ITS-S, a R-ITS-S may place a manually specified limit on the frequency of parameter change notifications. This limit shall be defined so that it exceeds only in unusual circumstances. If this limit is exceeded, the R-ITS-S may delay the sending of "RSU_Device_Inform" objects with ValueChange event code by a locally specified amount of time . After this delay, the R-ITS-S shall initiate

a "RSU_Device_Inform" to the C-ITS-S and indicating all relevant value changes (those parameters that have been marked for notification) that have occurred since the last notification.

7.3 Inform Retry Policy

An R-ITS-S shall retry to connect to a C-ITS-S after failure of delivering a "DeviceInforms". It shall retry to redeliver events that it has previously failed to deliver. The R-ITS-S shall keep track of the number of times it has attempted to retry a failed Inform.

An R-ITS-S shall retry to deliver a failed "RSU_Device_Inform" after waiting for an interval of time specified in Table 4 or when a new event occurs, whichever comes first. The R-ITS-S shall choose the wait interval by randomly selecting a number of seconds from a range given by the post-reboot Inform retry count.

When retrying to deliver a failed "RSU_Device_Inform" after an intervening reboot, the R-ITS-S shall reset the wait intervals it chooses from as though it were making its first Inform retry attempt. In other words, if a "RSU_Device_Inform" is retried to transmit when a new event other than boot occurs, it does not reset the wait interval, although the continued occurrence of new events might cause "RSU_Device_Inform" to be initiated more frequently than shown in the table.

Regardless of the reason a previous "RSU_Device_Inform" failed or the condition prompting Inform retry, the R-ITS-S shall communicate to the C-ITS-S the Inform retry count.

Beginning with the tenth post-reboot Inform retry attempt, the R-ITS-S shall choose from the fixed maximum range shown in Table 4. The R-ITS-S shall continue to retry to transmit a failed "RSU_Device_Inform" until successfully delivery to the C-ITS-S.

Once an "RSU_Device_Inform" terminates successfully, the R-ITS-S shall reset the "RSU_Device_Inform" retry count to zero and no longer apply "RSU_Device_Inform" retry policy to determine when to initiate the next "RSU_Device_Inform".

Post Reboot Inform RetryCount	Count Wait Interval Range (min-max seconds)
#1	5-10
#2	10-20
#3	20-40
#4	40-80
#5	80-160

#6	160-320
#7	320-640
#8	640-1280
#9	1280-2560
#10 and subsequent	2560-5120

Table 4 Inform Retry Wait Intervals

7.4 Use of random source port

Each time the R-ITS-S first connects to the C-ITS-S after rebooting, it shall use a different ephemeral TCP source port (short-lived) in order to avoid the possibility of reusing the same port that it used last time. Reuse of the same port could cause the C-ITS-S to reject the connection if the elapsed time since the previous connection is less than the C-ITS-S's configured TCP TIME_WAIT value.

In order to minimize the probability that the same ephemeral port number is used on successive occasions, the port shall be selected using a strong randomization mechanism.