Dutch Profile Part B - Requirements

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Document log

Version	Date	Comments	Name and organisation
0.3	27-01-2017	New structure, content taken from v0.2, minor update and new references	Jaap Vreeswijk, MAPtm

Writing team

The Dutch Profile is maintained by the Profile writing team, any questions, comments or suggested can be forwarded to the members of this writing team.

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Legal statement

The current release of the Dutch Profile is a theoretical version. To this release no legal claims can be extracted.

Executive summary

The Dutch Profile (PD) is to be the single point of reference in the Netherlands to secure the interoperability and conformity in the ITS system between solutions of the participating stakeholders. It contains an architectural system description with minimum requirements to support the deployment of ITS use-cases (in the current release: Traffic light optimal speed advisory, Traffic signal priority request, Road works warning and Prove vehicle data). The profile is aligned with Dutch ITS stakeholders and is supported by Rijkswaterstaat, I&M and Dutch industrial stakeholders.

The Dutch Profile includes the functional and technical specifications relevant for ITS systems realization in the Netherlands. It only specifies those ITS elements being found relevant to commonly agree among the stakeholders in the Netherlands and is harmonized with other profiles in Europe there where relevant. It realizes the specifications by normative referencing to standards mainly although for some it references to internal Dutch specifications in most cases provided by other Dutch organizations.

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1 Introduction

1.1 Objective

The aim of the Dutch Profile is to be the single point of reference in the Netherlands to secure the interoperability and conformity between ITS applications and system implementations to support stakeholder common and individual business cases. To that end the Dutch Profile contains an architectural system description with base requirements and profiling of base standards to support the deployment of selected ITS use-cases. Profiling intends to register the use of functional and technical standards required for implementation, if needed completed with additional (regional) specifications. The Dutch Profile considers existing systems as starting point for the additional ITS applications and functionalities.

1.2 Intended audience

This profile is aligned with Dutch ITS stakeholders at the Architecture and Interoperability Round Table and is supported by Rijkswaterstaat, I&M and Dutch industrial stakeholders to ensure conformity and interoperability required for the Dutch situation. Depending on the use cases, alignment with other European and World ITS deployments are considered.

This document provides insight for decision makers and is expected to be used as reference document for RFQ's (Requests For Quotations) by buyers and as a management tool by project managers. It is the reference for implementation of ITS use cases. It enables the realization of interoperable ITS products and services. The functional details, requirements, technical standards and profiles serve those with an interest to gain a deeper understanding in the implementation of these use cases. It serves as a directory for market players and technical specialists towards technical realization through interoperability and conformity.

1.3 Profile overview

This document is part B in a sequence of documents as is shown in the figure below.

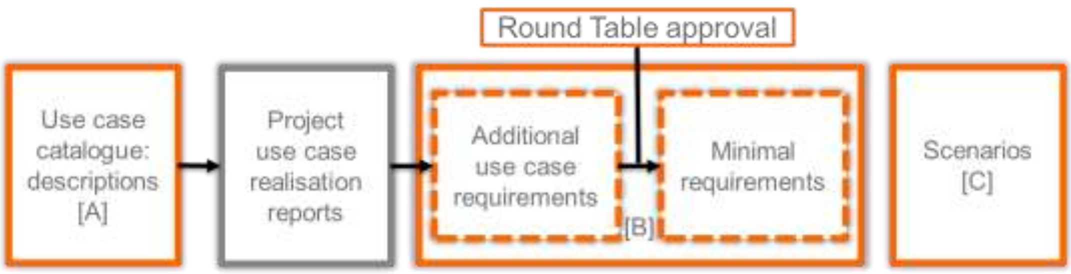

Figure 1: Overview of Dutch Profile documents

Part A: the use case catalogue contains high level and functional descriptions of use case, in an implementation neutral language, but with sufficient detail on expected behaviour, actors, roles and flow. The current version describes 18 use cases which are currently considered in the Netherlands.

Project reports of national deployment projects describe the technical implementations of these use cases. The existence of these deployments is noted in Part B, while their outcome is input for Part B.

Part B: describes minimum requirements which apply to all use cases (i.e. which are generic) and additional requirements which are specific to one single use case. It includes references to standards and profiles to serve as a library (a complete overview of standards can be found at [i.9]). Requirements identification is subject to approval by the Round Table Architecture and Interoperability.

Part C: scenarios describe the alternatives when multiple options are available and no uniform decision has been made by the Round Table (i.e. the topic at hand is subject to debate). For that reason it is not possible to formulate the corresponding principles and/or constraints as a binding requirement.

1.4 Structure of this document

The structure of this document is as follows. Chapter 2 provides the normative and informative references, while chapter 3 includes terms and abbreviations. Minimal ITS requirements are provided in chapter 4. These requirements and specifications are universal to all the use cases which are addressed in this document. Chapters 5-8 provide additional requirements and specifications for 4 different use cases, respectively Traffic light optimal speed advisory, Traffic signal priority request, Road works warning and Prove vehicle data.

The ETSI ITS communication protocol architecture has been used to structure this document. Minimum requirements are categorised according to the six layers of the architecture.

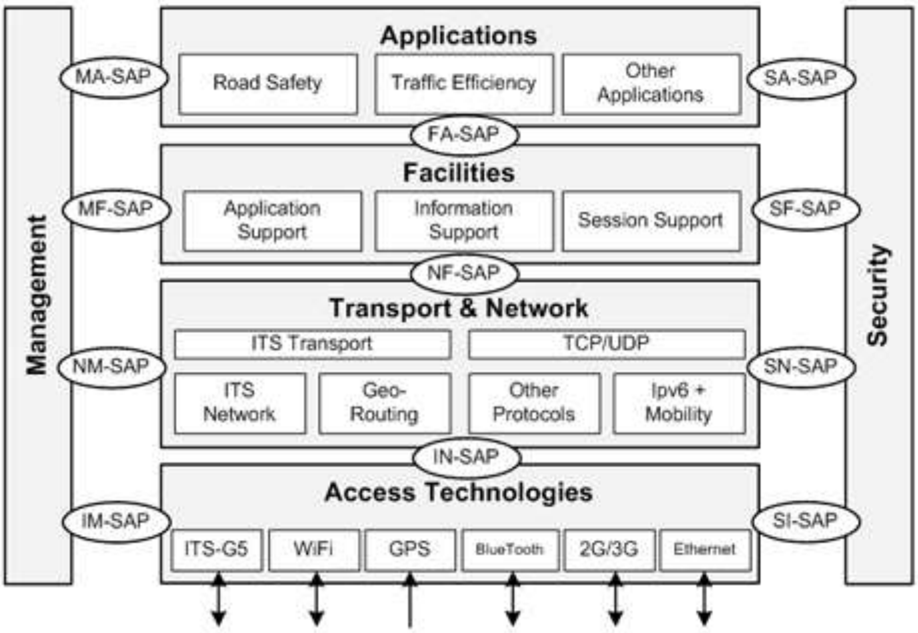

Figure 2: ETSI ITS communication protocol architecture

1.5 Current state of this document

This v0.3 of the Dutch Profile is a draft version. Many requirements are not yet at the required detail level or are currently still under discussion and may be changed or removed entirely, while new ones may be added. Some sections, which linked to one of the six layers of the communication protocol architecture, are still empty. This indicates that in this version requirements are not (yet) defined. The layers Applications, Security and Management are only considered at the generic level, in chapter 4 Minimal ITS Requirements. At present it is assumed that requirements apply to all use cases.

Ongoing work to progress to next versions of this Dutch Profile may specifically target sections which are currently empty.

2 References

2.1 Normative references

[1] ETSI TS 102 724 1.1.1; Intelligent Transport Systems (ITS); Harmonized Channel Specifications for Intelligent Transport Systems operating in the 5 GHz frequency band

[2] ETSI TS 102 894-2 V1.2.1: "Intelligent Transport Systems (ITS); Users and applications requirements; Part 2: Applications and facilities layer common data dictionary".

[3] ETSI EN 302 636-4-1 v1.2.1; Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 4: Geographical addressing and forwarding for point-to-point and point-to-multipoint communications; Sub-part 1: Media-Independent Functionality

[4] ETSI EN 302 636-5-1 v1.2.1; Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 5: Transport Protocols; Sub-part 1: Basic Transport Protocol

[5] ETSI EN 302 637-3 v1.3.2: Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service

[6] SAE J2735 (2015): Dedicated Short Range Communications (DSRC), Message Set Dictionary.

[7] ETSI EN 302 637-2 v1.3.2: Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service

2.2 Informative references

[i.1] Architecture for C-ITS applications in the Netherlands, Version 1.00, 03-2016

[i.2] ETSI EN 302 571 V2.0.2: Intelligent Transport Systems (ITS); Radio communications equipment operating in the 5 855 MHz to 5 925 MHz frequency band; Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive.

[i.3] ETSI TS 103 301 V0.0.12: Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services.

[i.4] ETSI TS 103 248 V0.0.4: Intelligent Transport Systems (ITS); GeoNetworking; Port Numbers for the Basic Transport Protocol (BTP)

[i.5] CEN ISO/TS 19091-3 (to be published): "Intelligent transport systems — Co-operative ITS - Using V2I and I2V Communications for Applications Related to Signalized Intersections.

[i.6] Kennisplatform Verkeer en Vervoer (KpVV), KAR'en maar!, Korte Afstand Radio voor prioriteit bij verkeerslichten (augustus 2010)

[i.7] C-ITS Corridor, Description of the System Concept, Version 1, Release 2, 04-06-2016

[i.8] Security National Round Table. URL: http://rondetafels.ditcm.eu/faq-security

[i.9] Overview C-ITS standards: http://extern.maptm.nl/standards/

[i.10] iTLC Architecture, version 1.2, January 2016, iVRI working group, URL: https://www.ivera.nl/downloads#beter-Benutten-ivri

[i.11] Interface requirements specifications (IRS) RIS-FI (version 1.2), TLC-FI (version 1.2), IDD iTLC ivera 4.00 (version 1.2) and IDD VLOG3 (version 1.1), iVRI working group. URL: https://www.ivera.nl/downloads#beter-Benutten-ivri

3 Terms and abbreviations

3.1 Terms and definitions

Connected	Connected means that non safety and less critical safety related data/information is exchanged between road users for information and advice by all means but mainly by cellular 3/4G/LTE/5G communication. The information received, in most cases is used by the road user itself.
Cooperative	Cooperative means that non safety, less critical and critical safety data/information, related data/information is exchanged between road users for control, less critical and critical safety as well as traffic management by all means but mainly by short/range V2X IEEE801.11p/ITS-G5 communication. The information received, can be used by the road users itself or via automation such as in vehicle systems (e.g. CACC).
Cooperative-ITS (C-ITS)	C-ITS systems that can bring intelligence for vehicles, roadside systems, operators and individuals, by creating a universally understood communications "language" allowing vehicles and infrastructure to share information and cooperate in an unlimited range of new applications and services
Eco-AT	European Corridor – Austrian Testbed for Cooperative Systems.
OCIT-C	Open Communication Interface for Road Traffic Control Systems, German-speaking countries Centre to Centre communication protocol. Used at least in German and Austria.
OCIT-O	Open Communication Interface for Road Traffic Control Systems, German-speaking countries Centre to Outstation (VRI) communication protocol. Used at least in German and Austria.
V-Log	Verkeerslogging in Verkeersregelautomaten. Open standard, providing Road Traffic light information to be open for traffic controller management.
V-Log-3	Streaming Data version of V-Log.

3.2 Abbreviations

COTS	Common Of The Shelf
ITS	Intelligent Transport Systems
TCC	Traffic Control Centre
TIS	Traffic Intersection System

TMS	Traffic Management System
C-ITS-S	Central ITS Station
P-ITS-S	Personal ITS Station
R-ITS-S	Roadside ITS Station
V-ITS-S	Vehicular ITS Station
GN	GeoNetworking
CAM	Cooperative Awareness Message
DENM	Decentralized Environmental Notification Message
SP BO	Service Provider Back-Office

4 Minimal ITS Requirements

This chapter provides the minimum ITS requirements which apply to all use cases described in this document. The next chapters provide additional requirements (if any) which are specific to these use cases.

4.1 System, data and interface requirements

The system boundaries, system decomposition and associated interfaces are described in the 'Architecture for C-ITS applications in the Netherlands' [i.1]. Figure 3 shows the functional view of this architecture.

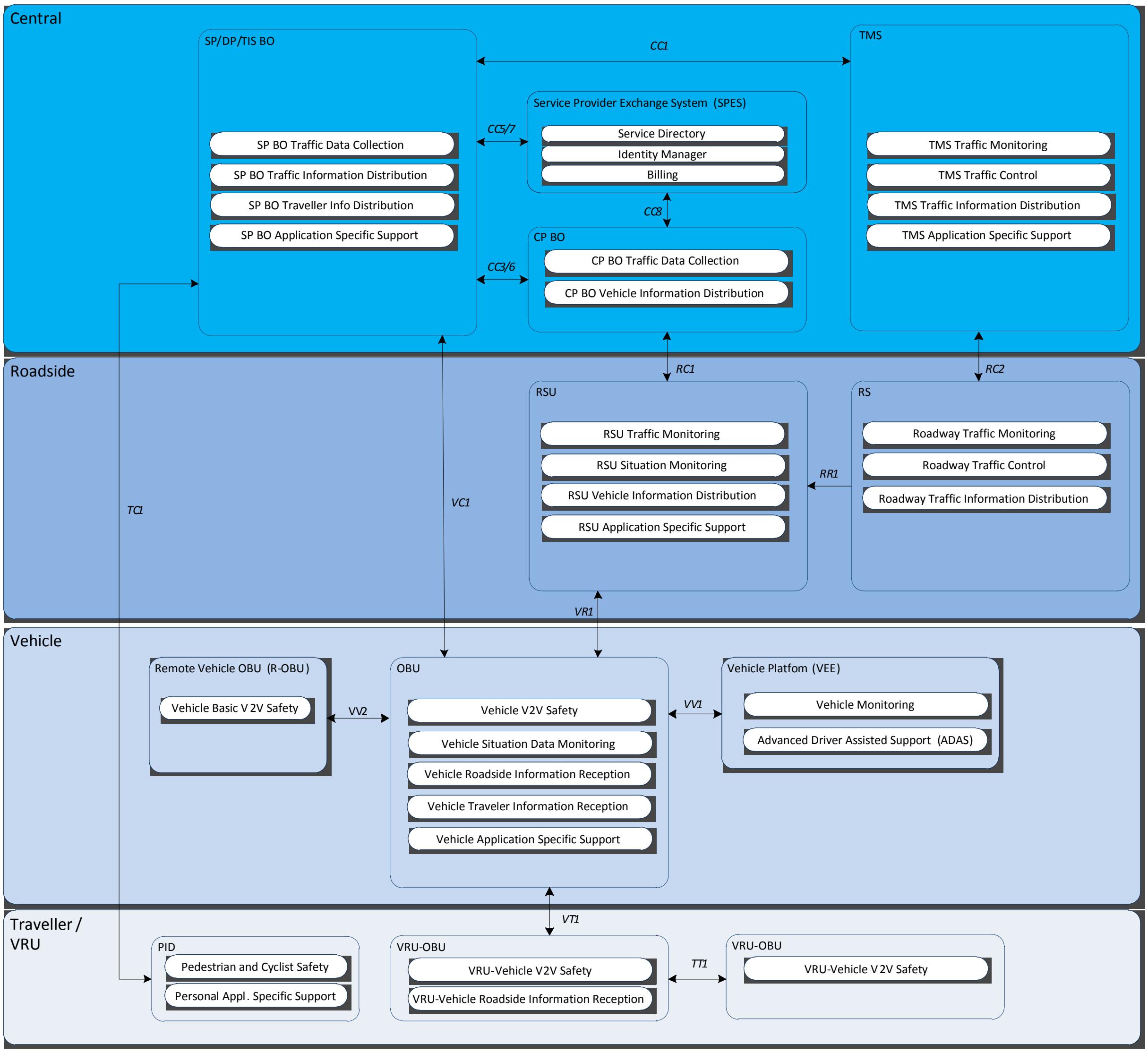

Figure 3: DITCM reference Architecture Functional View Fout! Verwijzingsbron niet gevonden.

4.2 Communication protocol requirements

Below, the minimal requirements per ETSI stack layer are described.

4.2.1 ITS Access technologies

In this paragraph requirements with respect to the Access layer are specified.

ACC 1: Roadside units shall be able to receive and transmit messages on the CCH channel specified in EN 302 571 **Fout! Verwijzingsbron niet gevonden.**.

Reasoning: Roadside units shall be able to communicate on the Control channel (CCH).

ACC 2: Roadside units shall be able to receive and transmit messages on the SCH channel specified in EN 302 571 **Fout! Verwijzingsbron niet gevonden.**.

Reasoning: Roadside units shall be able to communicate on the service channel (SCH)

ACC 3: R-ITS-Ss shall implement DCC methods as specified in TS 102 724 [**Fout! Verwijzingsbron niet gevonden.**.

Reasoning: The current EN 302 571 **Fout! Verwijzingsbron niet gevonden.** does not require DCC implementation. The new version will require DCC implementation and will turn into law as soon as the standard turns into an HEN (Harmonized European Norm).

4.2.2 ITS Transport & network

In this paragraph requirements with respect to the Transport & network layer are specified. First, a number of performance requirements are listed.

PERF 1: R-ITS-Ss shall be able to decode and process XX messages per second.

Reasoning: R-ITS-S should be able to handle a minimum amount of traffic. A clear definition of observable interfaces and testing methodology is needed to measure conformance.

PERF 2: R-ITS-Ss performing security validation shall be able to validate XX messages per second.

Reasoning: R-ITS-S should be able to handle a minimum amount of traffic.

PERF 3: R-ITS-Ss shall be able to transmit messages to vehicles within a range of XX m with a PER < X%.

Reasoning: A R-ITS-S should be reachable from a minimum distance to support a minimum set of use cases. A clear measurement scenario (e.g. Relative humidity, rain etc.) needs to be specified and parameters need to be adjusted. Additionally, R-ITS-Ss should not have unreasonable high coverage ranges as this will result in the hidden terminals on the network (which results in packet loss and congestion) and will break Geo-forwarding with the greedy forwarding algorithm. Currently, the distance is limited by the maximum output power as stated in EN 302 571 **Fout! Verwijzingsbron niet gevonden.**.

Below, requirements regarding positioning and time aspects are enumerated.

POTI 1: The difference between the actual R-ITS-S position and the transmitted R-ITS-S position shall be below XX m.

Reasoning: The transmitted position information is used for GeoNetworking forwarding decisions and possibly for plausibility checking.

Note: Positioning for R-ITS-Ss is an open issue; which position do we advertise, the ITS-G5 antenna position, the GPS antenna position, the median position measured over multiple ITS-G5 antennas in a multi-transceiver system? In some deployments, distances might become significant.

> **POTI 2:** The R-ITS-S clock shall not drift more than XX ms. from ITS time **Fout! Verwijzingsbron niet gevonden.**.

Reasoning: R-ITS-S clock drift could cause un-deterministic behaviour of both R-ITS-Ss and V-ITS-Ss and therefore needs to be limited as this will break most safety applications.

Next several requirements regarding the relation between the roadside unit and the vehicle are described.

> **NET1:** Roadside units shall implement GeoNetworking as specified in EN 302 636-4-1 **Fout! Verwijzingsbron niet gevonden.**.

Reasoning: n/a.

> **NET2:** Roadside units shall implement BTP as specified in EN 302 636-5-1 **Fout! Verwijzingsbron niet gevonden.**.

Reasoning: n/a.

> **NET3:** GeoNetworking parameters not explicitly defined in the Dutch ITS profile shall be set as defined in annex G of EN 302 636-4-1 **Fout! Verwijzingsbron niet gevonden.**.

Reasoning: Annex G contains the default GeoNetworking parameters.

> **NET4:** R-ITS-Ss shall only participate in GeoForwarding if the POTI performance requirements specified above are met.

Reasoning: GeoNetworking relies on GPS position and accurate time information to function correctly.

> **NET5:** The GeoNetworking traffic class (TC) shall be equal to the DCC profile (DP) used at the access layer.

Reasoning: Currently there is no relation specified between the GN TC and the AL DP for traceability assume a one to one relationship for traceability.

> **NET6:** GeoNetworking security shall be set to enabled/disabled at all times.

Reasoning: The security-table has to provide input on this requirement; the standard does not require security to be enabled.

> **NET7:** itsGnStationType shall be set to 15 (RoadSideUnit).

Reasoning: n/a.

NET8: Fixed R-ITS-Ss shall set itsGNIsMobile to 0 (fixed).

Reasoning: n/a.

NET9: itsGnMaxPacketLifeTime shall be set to 600.

Reasoning: GeoNetworking contains functionality similar to the DENM keep alive function.

NET10: itsGnLocalAddrConfMethod shall be set to 1 (MANAGED).

Reasoning: R-ITS-Ss are expected to use a preconfigured (static) GN address.

4.2.3 ITS Facilities

In this paragraph requirements on the Facilities layer.

FAC1: Roadside units shall implement DENM as specified in ETSI EN 302 637-3 **Fout! Verwijzingsbron niet gevonden.**.

Reasoning: DENM messaging shall be used to transmit events to align with the current developments within the Car industry.

FAC2: DENM keep Alive Forwarding shall be disabled.

Reasoning: DENM keep alive forwarding results in repetition of DENMs within their validity period. Events that are canceled via a cancelation DENM might still be repeated by stations that did not receive the cancellation further propagating an invalidated event. Note that this subject needs further investigation.

FAC3: The DENM repetition interval shall not be set lower than 100ms.

Reasoning: Prevent DENM from creating transmit queues on the ITS station. The message rate should nog exceed the rate permitted by DCC.

FAC4: Roadside units shall implement CAM as specified in ETSI EN 302 637-2 **Fout! Verwijzingsbron niet gevonden.**.

Reasoning: CAM messaging shall be used to transmit awareness messages to align with the current developments within the Car industry.

FAC5: Roadside units shall not generate more than 10 CAMs per second (i.e. max cam rate is set to 10Hz).

Reasoning: Prevent CAM from creating queues on the ITS station. The message rate should nog exceed the rate permitted by DCC .

FAC6: Fixed Roadside units shall not generate more than 1 CAM per second (i.e. max cam rate is set to 1Hz) as defined in TS 103 301 **Fout! Verwijzingsbron niet gevonden.**.

Reasoning: Fixed roadside systems do not require a high update rate.

FAC7: R-ITS-S facilities shall use the *well known* BTP port numbers for BTP packet transport as defined in **Fout! Verwijzingsbron niet gevonden.**.

Reasoning: Fixed roadside systems do not require a high update rate.

FAC8: R-ITS-S supporting the GLOSA use case shall implement SPaT and MAP by a combination of **Fout! Verwijzingsbron niet gevonden.**, **Fout! Verwijzingsbron niet gevonden.**, **Fout! Verwijzingsbron niet gevonden.**.

Reasoning: Fixed roadside systems do not require a high update rate.

FAC9: R-ITS-S supporting the Priority Request use case shall implement SPaT and MAP by a combination of **Fout! Verwijzingsbron niet gevonden.**, **Fout! Verwijzingsbron niet gevonden.**.

Reasoning: Fixed roadside systems do not require a high update rate.

Note: Additional profiling is needed for the transport of the different message sets. For example, which channel to use and which GeoNetworking traffic class.

4.2.4 ITS Applications

For now, there are no minimum requirements at the Application layer level.

4.2.5 ITS Security

In this paragraph the basic security requirements are specified. In future versions of this document references will be included to the output of the Security Round Table. Products of this Round Table can be found at [i.8].

SEC 1: R-ITS-Ss shall not change pseudonyms.

Reasoning: An R-ITS-S does not need privacy protection.

SEC 2: Private keys stored on a C-ITS-S or R-ITS-S shall be stored securely according to the hostility of the deployment environment.

Reasoning: The unauthorized acquisition of valid R-ITS-S private key material will allow attackers to transmit malicious information. *Note: On this subject input from the security-table is needed and requires analysis of the different deployment environments encountered (e.g. RWW-trailer, traffic light etc.).*

4.2.6 ITS Management

The R-ITS-S management interface exposes the following functions allows the control of C-ITS-S applications, e.g. starting / stopping the application, controlling the parameters send by the applications. The current standardization does not specify any of these functions. In the Eco-AT project, some effort has been done on the management interface.

Input from the architecture-table is needed to define the required functionality on this interface. Possibilities include but are not limited to: Remote updates, Statistics gathering, Configuration of data aggregation functionality, configuration of security functionality etc.

Additionally, already available (COTS) protocol implementations such as SNMP can be used to provide non-ITS specific management functionality.

R-MGMT1: A R-ITS-S implementing SNMP shall expose at minimum the following MIBs:

- IETF IF-MIB (RFC 2863)
- IETF Host Resources MIB (RFC 2790)

And optionally the:

- IEEE802dot11-MIB

Reasoning: Statistics on the number of packets and bytes on both the ITS-G5 and management interfaces ease the debugging of connectivity issues. Additionally, the Host resources MIB provides insight in the load experienced by the RSU.

R-MGMT2: A R-ITS-S implementing RFC 2863 shall provide statistics for management network interface(s), data interfaces(s) and ITS-G5 interface(s).

Note: The management interface and data interface might reside on the same logical or physical interface. In this case, statistics may be provided as a single interface in SNMP.

5 Traffic light optimal speed advisory additional requirements

See "*Part 1 - Use case catalogue*" for a description of this use case and Dutch realisations.

5.1 System, data and interface requirements

iTLC architecture and interface requirements specifications are provided in [i.10 and i.11].

Functional requirements for this use case are:

- R-ITS-S shall support I2V services and can send information on signal phases and timing and intersection topology.
- V-ITS-S shall support I2V services and can receive information on signal phases and timing and intersection topology.
- The static topology of the signalised intersection, including road segments, lanes and traffic light layout shall be available for the V-ITS-S.
- Reliable information on current and expected signal phase and timing shall be available from the TLC.
- V-ITS-S shall receive the signal phase and timing information timely.
- For ITS-G5:
  - R-ITS-S at the traffic light controller shall broadcast the Signal Phase and Timing (SPAT) message at 1 Hz (once per second). to indicate the current (and future) signal state information.
  - R-ITS-S at the traffic light controller shall broadcast at 0.5 Hz (once every two seconds). information that describes the geometrics of the intersection in MAP format. Changes to the base geometry are flagged, to allow a vehicle receiving the MAP information message to only process the changes if the version for the base geometric is different from what is currently stored in the vehicle.

5.2 Communication protocol requirements

5.2.1 ITS Access technologies

Currently no additional requirements.

5.2.2 ITS Transport & networking

Currently no additional requirements.

5.2.3 ITS Facilities

SPAT Data Frames

The main data frames and data elements used for the description of the traffic light signal phase and timing are shown in the figure below. For a detailed description see the documents [6, i5]. Due to publication restrictions of SAE-J2735 **Fout! Verwijzingsbron niet gevonden.** only a general description is provided below.

SPAT may contain the *IntersectionState* of up to 32 intersections. Each *IntersectionState* contains the *MovementState* for each manoeuvre. For each manoeuvre the *MovementState* contains a *SignalGroupID* and a *MovementEvent*. *SignalGroupID* is used to match the SPAT message data to the MAP message data. *MovementEvent* forms the core of the SPAT message by means of *eventState*, *timing* (TimeChangeDetails - optional) and *speeds* (AdvisorySpeed - optional). *evenState* includes the phase state (i.e. green, red or amber) as a directional, protected or permissive state. *Timing* consists of *TimeMarks*, at least the expected shortest end time of the phase (minEndTime) and optionally completed with the expected longest end time, the best predicted end time (including confidence value) and a rough estimate of time when this phase may next occur again. *Speeds* includes among others *SpeedAdvice* (optional) and the distance (described by *ZoneLength* - optional) for which the advised speed is recommended.

Additionally, the regional extension *activePrioritizations* as part of *IntersectionState* reflects the state of the priority request on each of the relevant signal groups which is how priority states can be acknowledged. *ManeuverAssistList* as part of either *IntersectionState* or *MovementState* contains information about the dynamic flow or traffic, e.g. the length of queues per lane (described as *ZoneLength*), for manoeuvres in question.

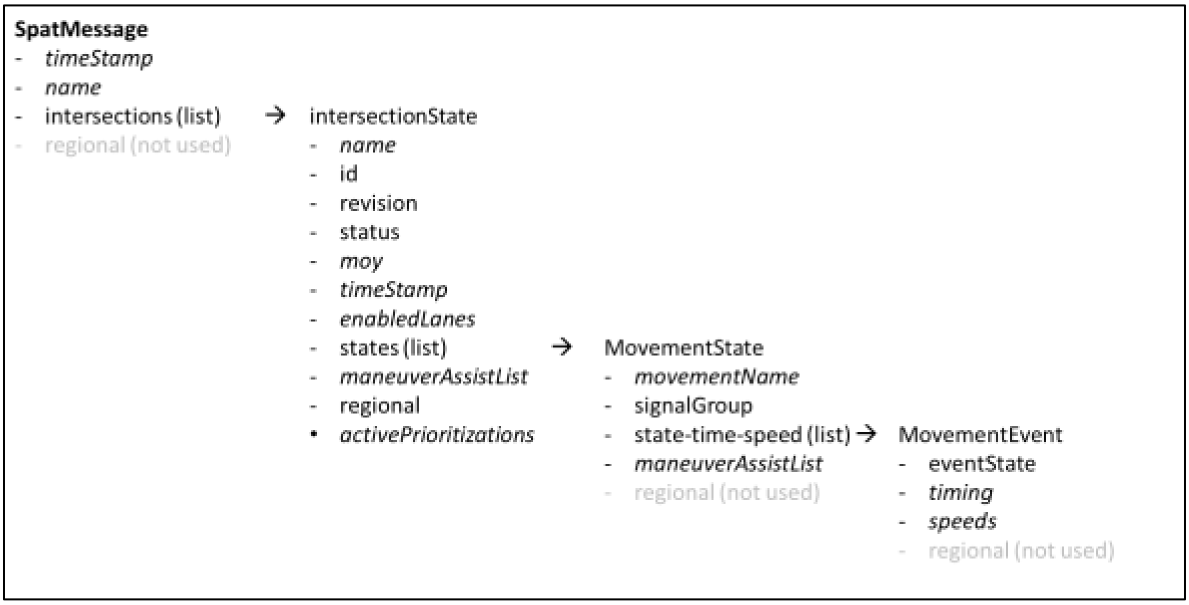

Figure 4: main DF and DE SPAT message

It is important to consider that the SPAT message is not designed to transmit time windows (e.g. the green window), but is designed to transmit the current state of each movement and the expected duration of this state until the next state. As such it provides a cross-cut of a signal phase diagram at the time it is transmitted. However, for each *SignalGroup* up to 16 *MovementEvents* can be included, which allows conveying multiple predictive phase and timing of the current signal group. For example, in the example below and assuming pre-timed control, if *MovementEvent* of signal group 5 would be transmitted at t = 15 seconds, the *eventState* would indicate ‘Movement-Allowed’ (either permissive or protected) and the *timing* would indicate a *minEndTime*, *maxEndTime* and *likelyTime* of 9 seconds (in *TimeMark* coding). A second *MovementEvent* would indicate: ‘protected-clearance’ for the amber phase and *minEndTime*, *maxEndTime* and *likelyTime* would indicate 12 seconds. Similarly, a third *MovementEvent* would indicate: ‘stop-and-remain’ and 38 seconds.

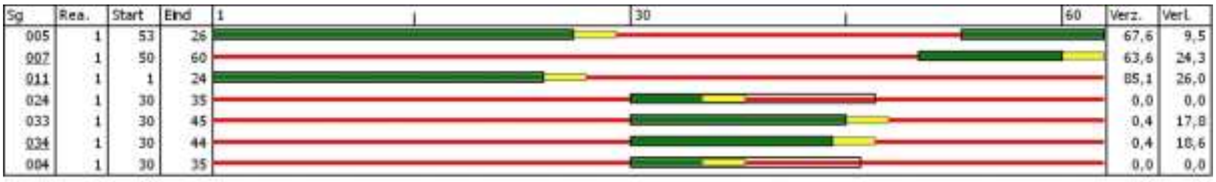

Figure 5: example phase diagram

Infrastructure services

In scope of the GLOSA use case, ETSI-TS103 301 [i.3] specifies the application support facilities provided by the facility layer that construct, manage and process messages distributed from infrastructure to end-users or vice-versa based on payload received from the application. Within the scope ETSI-TS103 301 [i.3], the term message refers to the facilities layer; the term payload refers to the applications layer. The payload is generated by the application and provided to the corresponding service of the Facilities layer. The Facilities service merges the "ItsPduHeader" (ETSI TS 102 894-2 **Fout! Verwijzingsbron niet gevonden.**) with the SPAT or MAP payload (as specified in CEN/ISO TS 19091-3 **Fout! Verwijzingsbron niet gevonden.**, in order to construct a message. These message are then referred to as “SpatMessage” or Intersection Status Service (ISS) and “MapMessage” or Road Topology Service (RTP) respectively (ETSI-TS 103 301 **Fout! Verwijzingsbron niet gevonden.**).

6 Traffic signal priority request additional requirements

See "*Part 1 - Use case catalogue*" for a description of this use case and Dutch realisations.

6.1 System, data and interface requirements

iTLC architecture and interface requirements specifications are provided in [i.10 and i.11].

Functional requirements for this use case are:

- R-ITS-S shall support I2V services and can send SPAT, MAP and SSM.
- V-ITS-S shall support I2V services and can send CAM and SRM.
- The static topology of the signalised intersection, including road segments, lanes and traffic light layout shall be available for the V-ITS-S.
- Reliable information on current and expected signal phase and timing, including prioritization status shall be available from the TLC.
- V-ITS-S shall receive the signal phase and timing information timely.
- For ITS-G5:
  - R-ITS-S at the traffic light controller shall broadcast the Signal Phase and Timing (SPAT) message at 1 Hz. (once per second) to indicate the current (and future) signal state information and priority response.
  - R-ITS-S at the traffic light controller shall broadcast at 0.5 Hz. (once every two seconds) information that describes the geometrics of the intersection in MAP format. Changes to the base geometry are flagged, to allow a vehicle receiving the MAP information message to only process the changes if the version for the base geometric is different from what is currently stored in the vehicle.
  - V-ITS-S shall broadcast CAM and/or SRM message to indicate vehicle identify, status and priority activation.

6.2 Communication protocol requirements

6.2.1 ITS Access technologies

Currently no additional requirements.

6.2.2 ITS Transport & networking

Currently no additional requirements.

6.2.3 ITS Facilities

This use case strongly relates to the following 5 message sets:

- Cooperative Awareness Message (CAM, [7])
- Signal Phase and Timing message (SPaT, [6])
- MAP intersection topology message [6]
- Signal Request Message (SRM, [6])
- Signal Status Message (SSM, [6])

Priority request by CAM

For the request of signal prioritisation the CAM message contains the "publicTransportContainer" with the "ptActivation" data frame **Fout! Verwijzingsbron niet gevonden.**. This data frame is intended to include legacy prioritization protocols like the R09.16 used in Germany, Austria and Switzerland. As this data frame is defined as a "blob", other countries may include regional legacy protocols for public transport prioritization (e.g. KAR). In addition to the ptActivation data frame the CAM message also includes its ordinary data elements such as the position of the approaching vehicle its vehicle class, and its identity ("stationID").

* KAR (Korte Afstand Radio) – Current system usage in the Netherlands for priority requests for Public Transport and emergency vehicles **Fout! Verwijzingsbron niet gevonden.**. A short study comparing KAR and message sets mentioned here should indicate what aspects of KAR are already allocated within C-ITS and which are not. On the basis of this study further action should be taken to achieve this use-case.

Priority response by SPAT

In existing legacy public transport prioritization systems, based on analogue radio communication, the only way for a response to the driver is the traffic light signal. For bidirectional information exchange the data frame "PrioritizationResponse" has been included to the European content of the regional extension.

The "PrioritizationResponse" contains a list of prioritisation responses, which includes the information if the request is successfully assigned. The response contains the "stationID" of the requestor, the status of the traffic light prioritisation ("priorState") and the corresponding "signalGroupID" identifier, which relates to driving permission for the related manoeuvre.

Priority request by SRM

The Signal Request Message is a message sent by a V-ITS-S to the R-ITS-S at a signalized intersection. It is used for either a priority signal request or a pre-emption signal request depending on the way each request is set. Each request defines a path through the intersection, which is desired in terms of lanes and approaches to be used. Each request can also contain the time of arrival and the expected duration of the service. Multiple requests to multiple intersections are supported. The requestor identifies itself in various ways (using methods supported by the RequestorDescription data frame), and its current speed, heading and location can be placed in this structure as well. The specific request for service is typically based on previously decoding and examining the list of lanes and approaches for that intersection (sent in MAP messages). The outcome of all of the pending requests to a signal can be found in the Signal Status Message (SSM), and may be reflected in the SPAT message contents if successful. The main data frames and data elements of the SRM message are shown in the figure below.

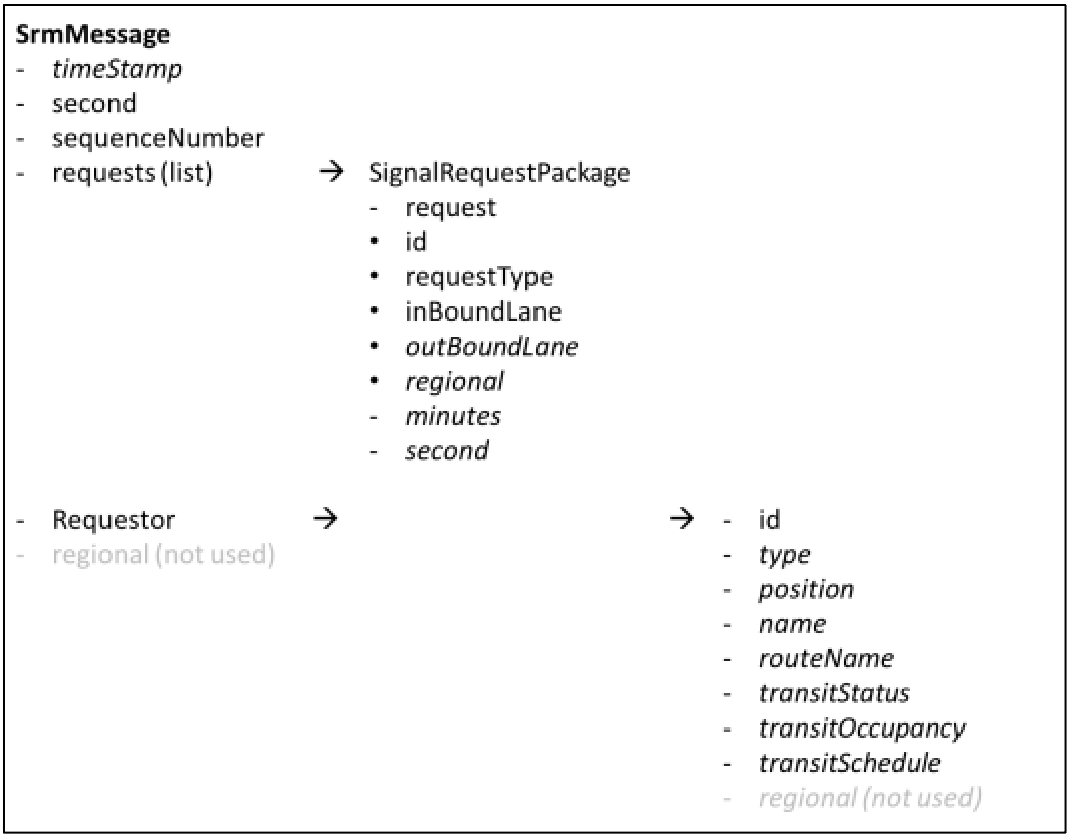

Figure 6: main DF and DE SRM message

Priority response by SSM

The Signal Status Message is a message sent by an R-ITS-S at a signalized intersection. It is used to relate the current status of the signal and the collection of pending or active pre-emption or priority requests acknowledged by the controller. It is also used to send information about pre-emption or priority requests which were denied. This in turn allows a dialog acknowledgment mechanism between any requester and the signal controller. The data contained in this message allows other users to determine their "ranking" for any request they have made as well as to see the currently active events. When there have been no recently received requests for service messages, this message is not sent. While the outcome of all pending requests to a signal can be found in the Signal Status Message, the current active event (if any) will be reflected in the SPAT message contents. The main data frames and data elements of the SRM message are shown in the figure below.

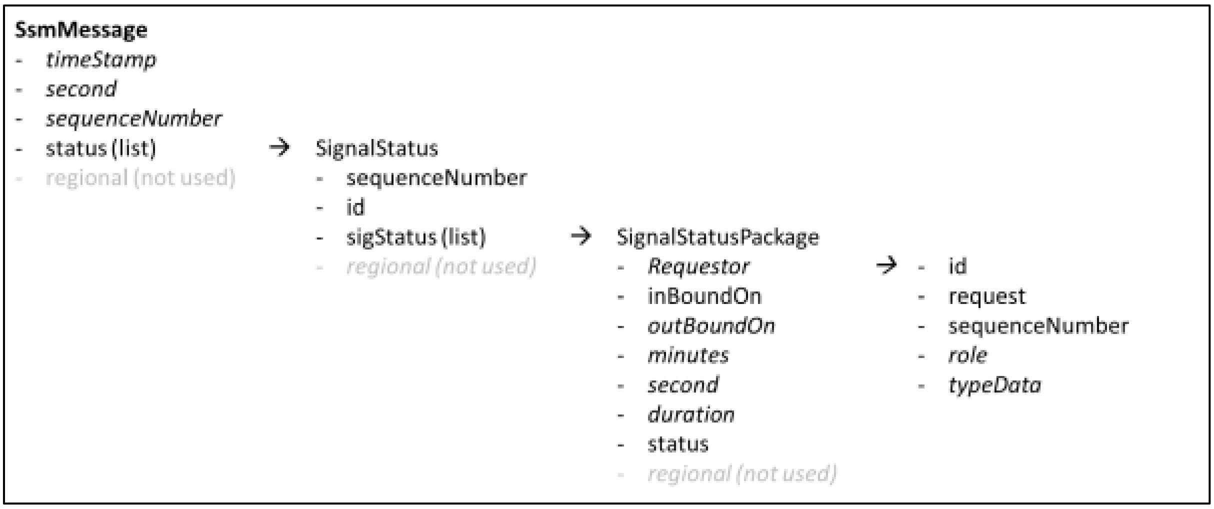

Figure 7: main DF and DE SSM message

Infrastructure services

In scope of the Priority Request use case, ETSI-TS 103 301 **Fout! Verwijzingsbron niet gevonden.** specifies the application support facilities provided by the facility layer that construct, manage and process messages distributed from infrastructure to end-users or vice-versa based on payload received from the application. Within the scope ETSI-TS 103 301 **Fout! Verwijzingsbron niet gevonden.**, the term message refers to the facilities layer; the term payload refers to the applications layer. The payload is generated by the application and provided to the corresponding service of the Facilities layer. The Facilities service merges the "ItsPduHeader" (ETSI-TS 102 894-2 **Fout! Verwijzingsbron niet gevonden.**) with the SPAT, MAP, SRM or SSM payload (as specified in CEN/ISO TS 19091-3 **Fout! Verwijzingsbron niet gevonden.**, in order to construct a message. These message are then referred to as “SpatMessage” or Intersection Status Service (ISS), “MapMessage” or Road Topology Service (RTP), “SrmMessage” or Intersection Signal Control Service (ISC) and “ SsmMessage” or Intersection Signal Status Service (ISS) respectively (ETSI-TS 103 301 **Fout! Verwijzingsbron niet gevonden.**).

7 Road works warning additional requirements

See "*Part 1 - Use case catalogue*" for a description of this use case and Dutch realisations.

7.1 System, data and interface requirements

The System, data and interface requirements are listed in the System Concept description of the Dutch C-ITS Corridor project. The latest version is: *Description of the System Concept, Version 1, Release 2, 04-06-2016* [i.7].

The description in that document must be harmonized with the *"Architecture for C-ITS applications, version 1.00, 03-2016"* [i.1].

7.2 Communication protocol requirements

7.2.1 ITS Access technologies

Currently no additional requirements.

7.2.2 ITS Transport & Networking

Currently no additional requirements.

7.2.3 ITS Facilities

The Road Works Warning (RWW) use case has been profiled using the DENM and IVI message sets in the Dutch C-ITS Corridor project. DENM is primarily used for essential safety related information regarding the road works, while IVI is primarily used to convey regulatory (e.g. changing speed limits) information. The Dutch C-ITS RWW profile is described in: *Dutch C-ITS Corridor Profile, version 2.1, Release 2, 28-10-2016* [i.7].

8 Basic probe vehicle data additional requirements

See "*Part 1 - Use case catalogue*" for a description of this use case and Dutch realisations.

8.1 System Data and interface requirements

The System, data and interface requirements are listed in the System Concept description of the Dutch C-ITS Corridor project. The latest version is: *Description of the System Concept, Version 1, Release 2, 04-06-2016* [i.7]

The description in that document must be harmonized with the *"Architecture for C-ITS applications, version 1.00, 03-2016*" [i.1].

8.2 Communication protocol requirements

8.2.1 ITS Access technologies

Currently no additional requirements.

8.2.2 ITS Transport & Networking

Currently no additional requirements.

8.2.3 ITS Facilities

The Basic Probe Vehicle Data (bPVD) use case has been profiled using the CAM message set in the Dutch C-ITS Corridor project. The use case basic PVD (bPVD) is currently [i.7] limited to only use CAM messages, from only those vehicles that are within range of the RSU and to information related to the moment the vehicle passes. There is no historic information on the road upstream of the point of reception. This is further described in the *Dutch C-ITS Corridor Profile, version 2.1, Release 2, 28-10-2016* [i.7].