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SMART MOBILITY PLATFORMS

The SI interface – a new standard for long-range C-ITS communication with roadside equipment

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Abstract

One of the fruits of the Dutch Talking Traffic program is the realisation of a standard for exchanging C-ITS messages with Traffic Light Controllers (TLCs). The standard was developed in a workgroup including the leading European Union TLC vendors Dynniq, Swarco, and Yunex and has been implemented on a large scale in The Netherlands. This standard has been created to facilitate the large-scale rollout of TLC use cases based on long-range communication. It is now also adopted by the region of Flanders (Belgium) in their large-scale C-ITS deployment initiative Mobilidata as well as studied in the NordicWay 3 program. In the meantime, the Netherlands is looking at expanding the scope of the interface to other types of road equipment, such as RoadSide Units (RSUs), electronic signs, access barriers, sensors, etc. This standard facilitates the large-scale deployment of many day 1 and day 1.5 C-ITS use cases.

Keywords:

Interfacing and architecture, From large-scale trials to deployment, C-ITS, CCAM, V2X

1 INTRODUCTION

The Dutch Talking Traffic program (2016-2020) was a major and successful effort to get C-ITS services to large-scale deployment in The Netherlands. The rollout of smart traffic light controller (iTLCs) use cases such as GLOSA, Priority for designated traffic, and optimising traffic flow was an important part of the project. As such, a standard interface was defined for communication with TLCs.

2 CREATION OF THE C-ITS SUBJECT INTERFACE (SI)

At the start of the Talking Traffic project, the involved stakeholders took it upon themselves to create a standard interface for the exchange of C-ITS messages such as SPAT, MAP, CAM, SRM, and SSM between Traffic Light Controllers (TLCs) and the national iTLC datahub ("iVRI overnamepunt"). The workgroup comprised a broad group of industry stakeholders, including representatives from Dynniq, KoHartog, Swarco, Sweco, Vialis, and Yunex. The group was led by the team of Monotch, who created the initial design.

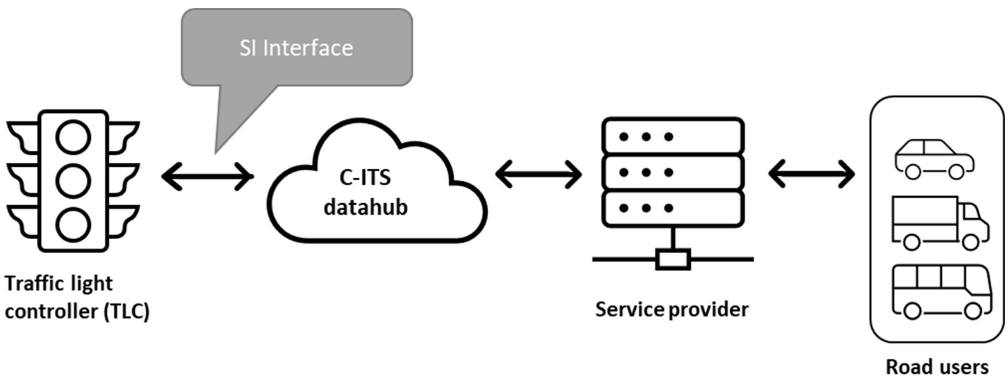

Figure –SI interface deployment in Talking Traffic

The standard was initially named TLEX-TLC and was later renamed UDAP-TLC. However, in this paper, we refer to the interface as the C-ITS subject interface (SI) as this is the proposed definitive name for the standard.

3 OBJECTIVES OF THE SI INTERFACE

The overall objective of the SI interface is to facilitate the large-scale deployment of C-ITS use cases that require communication between road users and roadside equipment independent of the equipment manufacturer.

The SI interface enables TLCs, and other roadside equipment, to communicate with road users in a standardised way. This enables the TLC application to integrate C-ITS use cases into adaptive traffic control algorithms. Also, the SI interface supports C-ITS services to perform independently from the brand of TLC.

In more detail, the SI interface has been defined with the following objectives in mind:

- Facilitate (ultra) low latency, high volume data exchange;
- Facilitate bi-directional data exchange;
- Function data (message) agnostic;
- Support singleplex and multiplex connections (between a central C-ITS datahub and roadside equipment);
- Provide the possibility to monitor roundtrip latency and clock difference detection (between central C-ITS datahub and roadside equipment);
- Provide the possibility to govern and manage connections on an individual (roadside) object level.

4 DEPLOYMENT / ADOPTION

To date, approximately 1,200 TLCs in The Netherlands are continuously exchanging data through the SI interface with the national UDAP platform ("Urban Data Access Platform") operated by Monotch. UDAP is part of the National Access Point managed by the NDW ("National Dataportal Road traffic"). All vendors supplying TLCs and/or TLC applications in The Netherlands have implemented the interface (Dynniq, Swarco, KoHartog, and Vialis). Currently, over a billion ETSI messages are exchanged daily in The Netherlands between iTLCs and road users through the SI interface.

The SI standard has proven to be a secure, highly scalable, and extremely well-performing interface equipped to exchange C-ITS messages such as SPAT, MAP, CAM, SRM, and SSM bi-directionally between TLCs and C-ITS service providers. Therefore the SI standard has been formally adopted as the standard

C-ITS interface for TLCs in The Netherlands. Also, it has been decided that all new or replaced TLCs in The Netherlands will be iTLCs using the SI interface to exchange C-ITS messages.

This success caught the attention of the joint Flemish road authorities as they adopted the standard in their large-scale C-ITS deployment initiative Mobilidata. This program includes the rollout of approximately 800 smart intersections. Combined, the existing and planned Dutch and Flemish efforts will lead to a geographically closely-knit cluster of approximately 4,000 smart TLCs.

The SI interface has also been presented in the workgroup for smart intersections in the NordicWay 3 program. It is considered one of the options for standardised communication with TLCs in the future.

5 TECHNICAL OVERVIEW SI INTERFACE

5.1 TECHNICAL INTRODUCTION

Data exchange sessions are managed using an Application Programming Interface (API) based on the widely recognised JSON-REST principles. A connection can be established with a single roadside object (singleplex) or with a system aggregating information from several roadside objects (multiplex).

The SI interface uses Internet Transmission Control Protocol (TCP) streaming to exchange C-ITS messages between subjects and the data exchange platform for the actual data exchange. TCP streaming is a commonly used method for exchanging data over the internet, which makes the development of connections to new types of subjects easier.

Security is managed through the use of authorisation tokens.

When a new Administrator account is created, they are issued with an authorisation token by the administrator of the data exchange platform. The Administrator is then able to issue and manage authorisation tokens for subjects.

The interface is “message agnostic,” i.e. any type of message payload can be sent once the connection has been established. This allows additional security measures, such as the signing of messages, to be used if required. Encoding and decoding messages using ASN.1 UPER is supported, which enables message sizes to be kept as small as possible, allowing high-frequency data exchange.

Each subject is identified using a unique subject ID, which allows messages from multiple subjects to be sent using the same connection. The use of a unique subject ID also supports advanced management and governance possibilities, facilitating tasks such as:

- controlling access to information;
- determining data ownership;
- quality monitoring (and alerting owners) on individual equipment level;
- maintaining advanced KPIs;
- filtering or blocking data from individual objects in multiplex connections (e.g. because of misbehaviour or for governmental reasons).

The key components of the subject interface are shown in the diagram below.

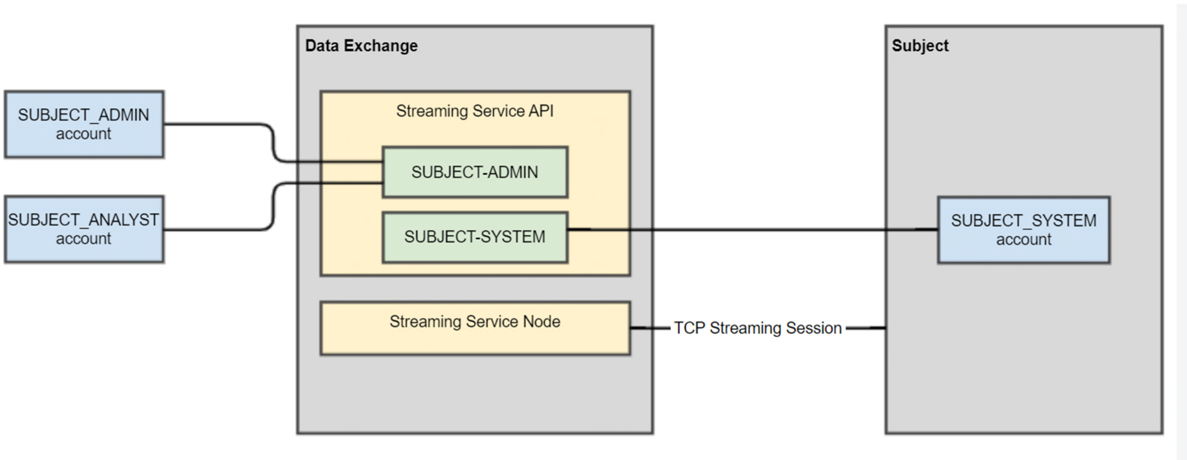

Figure –Diagram key components SI Interface

5.2 THE FUNCTIONALITY OF THE STREAMING SERVICE API

To establish a new TCP streaming session, the subject makes a request to the Streaming Service API. The API responds with connection details for the streaming session. The subject can then use these details to contact the Streaming Service Node and begin exchanging data.

The Subject Interface has two API components used to manage streaming connections.

The SUBJECT-ADMIN component is used for:

- registering roadside subjects with a central C-ITS datahub;
- managing account authorisations;
- managing authorisation tokens for security;
- requesting information on active TCP streaming sessions;
- requesting TCP streaming session logs.

The SUBJECT -SYSTEM component is used for:

- requesting and starting a TCP streaming session, and
- updating a TCP streaming session.

Three roles are associated with the interface:

SUBJECT_ADMIN is used to register new subjects and create accounts for other roles.

SUBJECT_SYSTEM is used by the subject to request and update TCP streaming sessions.

SUBJECT_ANALYST can view session logs and TLC registrations.

The Streaming Service Node is a highly resilient and scalable service designed to manage large volumes of data from multiple connections. This type of TCP streaming service is ideal for C-ITS as it can handle the exchange of high-frequency C-ITS messages from many different sources with a low latency cost and a high degree of reliability.

6 HOW IS THE SI DIFFERENT FROM TYPICAL EXISTING TLC INTERFACES

Examples of these interfaces are IVERA (Netherlands), RSMP (Nordics), OCIT (Germany) etc. These interfaces are designed for maintenance and/or traffic control purposes and therefore support very specific functionality for the type of the device (TLC). These interfaces are, for that matter, also less equipped for low latency high-frequency data exchange.

This separation of functionality (C-ITS vs management) delivers the best results in the separate fields of interest.

7 HOW IS THE STREAMING PROTOCOL DIFFERENT FROM ALTERNATIVES SUCH AS AMQP/ MQTT

Both AMQP and MQTT[1] are widely known and used to exchange streaming data. However, the SI streaming protocol offers several advantages that are of specific benefit for the designated purpose. Specifically, this concerns the following:

- The protocol has minimum overhead making it more efficient than AMQP and MQTT (smaller messages);

[1] AMQP is a standard protocol often used for the exchange of messages. MQTT is a standard messaging protocol for the Internet of Things.

- The protocol is easier to implement in devices/equipment;
- The protocol supports exactly the meta-information needed for the specific purpose of the protocol.

Table 1 provides a further comparison of the protocols.

Table – AMQP vs MQTT vs SI

	AMQP 1.0	**MQTT**	**SI-TCPStreaming**
Scopes	Wire level message protocol Messaging pattern	Wire level message protocol	Wire level message protocol
Network protocol	TCP	TCP	TCP
Protocol overhead	Medium	Low	Low
Protocol complexity (measured by the amount of datagrams)	High	Medium	Low
Encryption	TLS	TLS	TLS
Authentication	Username/password	SASL	Session token (additional API required)
State	Stateful May span multiple sessions	Stateful Single session	Stateless
Feature set	Big	Small	Purpose specific
Message filtering	Yes (though link source configuration at the receiving end)	Yes (through topic subscriptions with wildcards)	No
Meta information on top of payload	Yes, pre-defined and free-definable	No	Yes, but only: “origin timestamp” and “payload type” In case of “Multiplex” also “subject”
Native time difference detection	No	No	Yes

8 FURTHER DEVELOPMENTS

Deploy interface for connection with other roadside equipment (than TLCs)

While the SI interface was initially developed for the connection with TLCs, in the past years, other roadside equipment has also been connected using the SI interface, such as:

- Highway RSUs (in the EU ITS Corridor project);
- City access barriers/bollards (in the City of Deventer, NL);
- Bike counting radar systems (in the city of Utrecht, NL) and camera systems (Province Noord-Holland, NL);
- Tire pressure systems (Province Noord-Brabant, NL).

The Dutch Ministry of Infrastructure expects to further expand the usage of the SI interface, e.g. for height meters and air quality sensors (www.talking-traffic.com/en/urban-data-access-platform).

New message types

From a technology perspective, the SI interface is data agnostic. However, when used in practice, parties need to define the message types and formats for obvious reasons. In current deployments, ETSI standardised messages (SPAT, MAP, CAM, SRM, SSM) are exchanged through the SI interface with, in addition, messages for measuring round trip latency and clock time difference.

Starting Q3 2022, TLCs in The Netherlands will also share configuration information in a new message type. And in the Mobilidata project, the aim is to add 'weather messages' so TLCs can adapt their traffic control to the actual weather.

9 REFERENCES

1. SI Interface documentation: (page 25 and onwards) https://www.crow.nl/getmedia/8357ee79-ed56-4fe4-8894-8b18cdf26665/D3047-14_UDAP-TLC.pdf.aspx (to be updated before congress)
2. Talking Traffic program: https://www.talking-traffic.com/en/
3. Mobilidata program: https://mobilidata.be/en