iVRI Interface TLC-FI

IRS TLC-FI version 1.2

Over deze publicatie

De internationale ontwikkeling van Smart Mobility zorgt voor flinke vernieuwingen in verkeer, vervoer en mobiliteit. Dit raakt direct ook de verkeersregelinstallaties in de Nederlandse steden en provincies en op rijkswegen. Als verkeersregelinstallaties kunnen communiceren met voertuigen en weggebruikers kunnen weggebruikers worden geïnformeerd over actuele fasewisselingen van verkeersregelinstallaties en hierop hun rijgedrag vroegtijdig aanpassen, kunnen doelgroepen als openbaar vervoer, nood- en hulpdiensten en vrachtwagens conform beleidswensen van overheden worden geprioriteerd en kan data van voertuigen zelf worden gebruikt voor betere netwerkregelingen. Dit bevordert doorstroming, bereikbaarheid, verkeersveiligheid en duurzaamheid, legt de basis voor connected en automated driving en speelt in op een digitale samenleving waarin data en connectiviteit bijdragen aan economisch aantrekkelijke en duurzame steden.

Voor het effectief, veilig en leveranciers- en overheidsonafhankelijk communiceren van intelligente verkeersregelinstallaties (iVRI's) met voertuigen en weggebruikers hebben bedrijven en overheden in het Innovatiepartnership Talking Traffic binnen internationale standaarden gezamenlijk specificaties en koppelvlakken voor iVRI's vastgelegd. Eenduidig gebruik door alle overheden en betrokken bedrijven van deze uniforme afspraken binnen internationale standaarden is noodzakelijk voor interoperabiliteit en een goede en betrouwbare werking. Deze standaarden zijn daarom vastgesteld door de landelijke publiek private Strategic Committee 'Borgen en beheren iVRI standaarden en producten'. Na vaststelling gelden deze standaarden voor alle bedrijven en overheden die in Nederland (willen gaan) werken aan iVRI's t.b.v. intelligente mobiliteit. Vanuit de rol van onafhankelijk en landelijk kennisinstituut verzamelt CROW deze landelijk vastgestelde standaarden en stelt deze transparant ter beschikking aan overheden, adviesbureaus en leveranciers.

About this publication

The international developments in Smart Mobility technology are boosting innovations for traffic, transportation and mobility. This has a direct effect on traffic control systems in Dutch cities and provinces, as well as national highways. When traffic controllers are able to communicate with vehicles and road users, the latter can be informed about real-time phase changes in traffic lights, enabling them to anticipate and adjust driving behaviour accordingly. Also, special interest groups, such as emergency services, public transport and freight carriers, can be prioritized in line with public policy guidelines. The data provided by vehicles themselves can be utilised to improve network-based traffic control programmes. This has a positive effect on flow, accessibility, traffic safety and sustainability, laying out the fundamentals for connected and automated driving and preparing for a digital society in which data and connectivity contribute to economically viable and sustainable cities.

In order to let intelligent traffic controllers (iVRI) communicate with vehicles and road users in an effective, safe and platform independent way, businesses and governments have created and recorded common specifications and interfaces for iVRI technology. These are compliant to international standards and developed within the framework of the Talking Traffic Innovation partnership. The unambiguous use of these uniform agreements, within international standards, by all governmental bodies and businesses is necessary for interoperability and a good and reliable operation. These standards are adopted by the national public-private Strategic Committee 'Ensuring and maintaining iVRI standards and products'. After adoption, these standards apply to all businesses and governmental bodies in the Netherlands that work, or plan to work, on iVRI technology for intelligent mobility purposes. Being an independent national knowledge institute, CROW collects these national standards and provides them to governments, consultants and suppliers in a transparent way.

Praktische kennis direct toepasbaar

iVRI Interface TLC-FI

Voorwoord

In juni 2015 is opdracht verstrekt door het Ministerie van Infrastructuur en Milieu via het Beter Benutten Vervolg (BBV) programma aan vier VRA leveranciers om te komen tot een gezamenlijke definitie van VRA standaarden ten behoeve van connected en coöperatieve functionaliteit.

Dit document vormt Deliverable G2 van de afgesproken leverdelen in de opdrachtverstrekking, omschreven als "IRS TLC-FI".

Deze deliverable beschrijft in het Engels het koppelvlak van het verkeersregeltoestel naar de verschillende mogelijke C-ITS-applicaties.

Dit document is tot stand gekomen door samenwerking van de vier leveranciers in de werkgroep bestaande uit:

Inge Fløan

Hans Looijen

Peter Smit

Jeroen Hiddink

NB. De rest van dit document is geschreven in het Engels om internationale uitwisseling te ondersteunen.

The rest of this deliverable has been written in English to facilitate international exchange.

Document control sheet

Document versions:

Version	Date	Author	Comment
1.0	2015-12-14	WG3	Initial draft
1.1	2016-01-20	WG3	Final draft
1.2	2016-01-27	WG3	Final draft (tekstual updates)

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Contents

1 Introduction

1.1 System overview

The iTLC architecture defines several interfaces of the iTLC. One of these interfaces is the so called: TLC-FI, Traffic Light Controller Facilities Interface. In Figure 1 the position of the TLC-FI is shown within this architecture. Interfaces and functional elements - that are not in scope - are faded.

ITS Applications use the TLC-FI to obtain information from the TLC Facilities such as actual signal group states and detection activations, as well as to provide requests for changing signal group states and priority. The functional description of the information and services offered by the TLC Facilities by the TLC-FI is described in the iTLC Architecture [Ref 1].
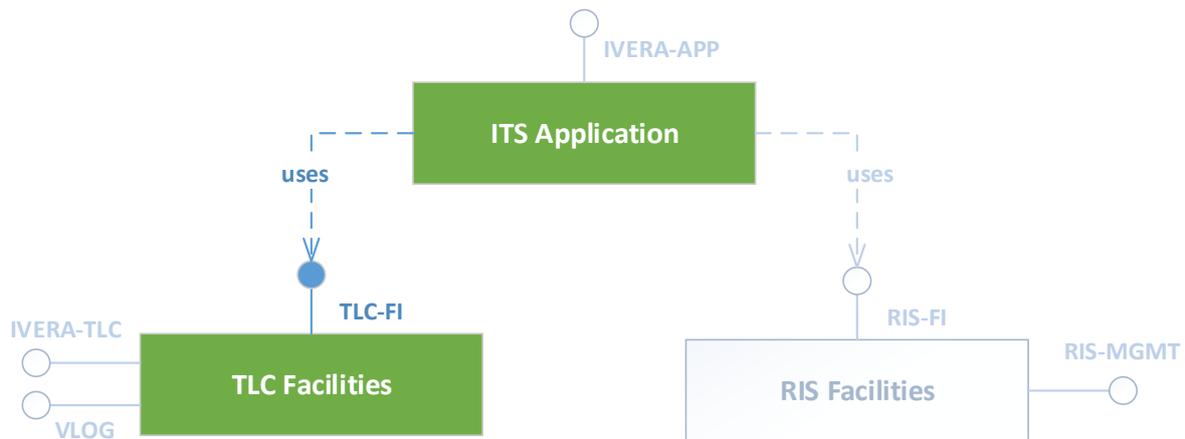

Figure 1 TLC-FI in System overview

The TLC-FI is to be considered as a robust interface between (external) ITS-Applications and the TLC. The TLC provides information through the TLC-FI and guarantees a safe operation of the traffic lights based on requests from the TLC-FI.

1.2 Document overview

1.2.1 Purpose and scope
This document provides specifications of the requirements of the TLC-FI.

1.2.2 Document structure
Chapter 1 contains system overview and background information.
Chapter 2 contains references to external and internal documents.
Chapter 3 contains a list of acronyms, abbreviations and concepts essential to the understanding of this document.
Chapter 4 contains formal requirements resulting from the use case and functional specification discussions and architecture description [Ref 1], a list of these requirements is provided in 0

1.3 Advise for the reader

It is advised that the reader understands the iTLC Architecture as described in [Ref 1] *iTLC Architecture WG3 (Deliverable F) v 1.2, jan. 2016*

2 References

ID	Reference
[Ref 1]	*iTLC Architecture WG3 (Deliverable F) v 1.2, jan. 2016*
[Ref 2]	*Beter Benutten Vervolg, project iVRI, Deliverable G2, IRSIDD TLC Facility Interface*
[Ref 3]	*Beter Benutten Vervolg, project iVRI, Deliverable G1, IRSIDD RIS Facility Interface*
[Ref 4]	*TLC Object Dictionary v1.0.xlsx*
[Ref 5]	*SAE-J2735, Dedicated Short Range Communications (DSRC) Message Set Dictionary, SAE International - 2015-09*
[Ref 6]	*ETSI EN 302 665, V1.1.1*

3 Acronyms, abbreviations and concepts

Acronyms and abbreviations

C-ITS	Cooperative ITS functionality for exchange of data between in-vehicle and or road side devices making use of either cellular or short range wireless communication
IDD	Interface Design Description
IRS	Interface Requirements Specification
iTLC	Intelligent TLC performing traffic light controller functions and allowing for ITS applications
ITS	Intelligent Transport Systems
ITS Station	Functional entity specified by the ITS station reference architecture (see [Ref 6] *ETSI EN 302 665, V1.1.1*)
IVERA	Management protocol for traffic light controllers in the Netherlands (An implementation of a TMS-IF)
LDM	Local Dynamic Map; Concept of data store containing a reflection of physical infrastructure and current on-street traffic and environment
RIS	See R-ITS-S
R-ITS-S	Roadside ITS Station, responsible for a geographic area.
TLC	Traffic Light Controller; controls the signal of one or more intersections
TMS	Traffic Management System
TMS-IF	TMS InterFace, an interface used by a TMS to manage an ITS Application
UTC	Coordinated Universal Time

Concepts

Traffic Control Application	Application which implements a traffic control algorithm and is able to request signal group states
ITS Control Application	A Traffic Control Application which uses TLC- and/or RIS-interfaces
ITS Application	An application which supports one or more ITS use-cases. Range of possible ITS Applications include an ITS Control Application
RIS Facilities	Component providing RIS Facilities to users (internal and/or external). Includes amongst others: – Access to information stored in the LDM – Services to trigger C-ITS messages
TLC Facilities	Component providing facilities of a TLC to users (internal and/or external). Includes amongst others: – Access to information from the TLC – Services to trigger actuators

4 Requirements

4.1 Introduction

This chapter contains requirements of the TLC Facilities Interface (TLC-FI). The position of the TLC-FI in the iTLC architecture is described in [Ref 1] and is summarized in section 1.1.

ITS Applications use the TLC-FI to request various information from the TLC Facilities as well as to provide information, this information is available in the form of TLC Objects with attributes. Changing an attribute of a TLC Object may result in changing of the external states of the TLC's functions such as signal groups and other outputs. Before being granted access to the various information, an ITS application must register itself. The process of registering an ITS Application is the current best judgement, but the outcome of the Security Architecture may change parts of these procedures.

4.1.1   Requirements notation format

The following format is used to define a requirement:

Req-ID	IRS-x-y-zzz
Title	
Description	
Source	
Comment	

- Req-ID: unique identification of the requirement according to the following format: 'IRS-x-y-zzz", where x is an identifier for the interface, y is a textual tag and zzz is a number of the requirement
- Title: a short description of the requirement
- Description: Formal and detailed description of the requirement
- Source: Reference to a source document used as input for the requirement
- Comment: Clarification of the requirement

4.2 General requirements

Req-ID	IRS-TLCFI-TIME-001
Title	UTC time
Description	All absolute time references of the TLC-FI shall be done using UTC time
Source	[Ref 1]
Comment	

4.3 Protocol

Req-ID	IRS-TLCFI-PROT-001
Title	IP based
Description	The protocol used when communicating with the TLC-FI shall be based on the Internet Protocol
Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-PROT-002
Title	Access channel – non secure
Description	The TLC-FI shall be accessible on a specific channel or port number for non-encrypted access
Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-PROT-003
Title	Access channel - encrypted
Description	The TLC-FI shall be accessible on a specific channel or port number for encrypted access
Source	[Ref 1]
Comment	

4.4 Communication patterns

Req-ID	IRS-TLCFI-COM-001
Title	Messaging pattern - Request response
Description	It shall be possible to execute a request on the TLC-FI, which results in a response containing the requested TLC Objects. Requests are handled asynchronously (see Concurrency view of Arch doc [Ref 1])
Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-COM-002
Title	Messaging pattern – Publish subscribe
Description	It shall be possible to subscribe to (attributes of) certain TLC Objects and be notified of their change by the TLC Facilities. It shall be possible to subscribe to – notification on change of (attributes of) TLC Objects – periodic notification of the status of (attributes of) TLC Objects The ITS application requesting the subscription shall be returned: – success / failure of the subscription – a unique subscription identifier – actual (attributes of) TLC Objects upon which future changes will be sent A subscriber shall be able to remove the subscription by using the subscription identifier.
Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-COM-003
Title	Subscriptions inactivity removal
Description	Subscriptions shall be removed by the TLC-FI whenever the subscriber is no longer active due to for instance a broken communication path or deregistration of a subscriber.
Source	[Ref 1]
Comment	Subscriptions are also removed after power interruption of the TLC Facilities.

Req-ID	IRS-TLCFI-COM-004
Title	Subscription – update period
Description	When a subscription is requested for a TLC Object, it shall be possible to limit the frequency with which the updates must be provided to the ITS Application. A subscriber shall be able to do this by providing an **update-interval** parameter.
Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-COM-005
Title	Message filtering
Description	It shall be possible to request and subscribe on filtered TLC Objects. A filter can take place on - TLC Object type - TLC Object attributes A filter defines conditions a TLC Object must meet. When this TLC Object meets this condition, it is part of the result of the request or subscription.
Source	[Ref 1]
Comment	The exact nature of the filtering must still be defined, see also **Fout! Verwijzingsbron niet gevonden.**. An example of a filtered object is the actual detection status of the Detector object.

Req-ID	IRS-TLCFI-COM-006
Title	Message pre-defined filtering definitions
Description	For each TLC Object type, pre-defined filters shall be present. These shall be defined in the TLC Object dictionary.
Source	[Ref 1]
Comment	The exact nature of the filtering must still be defined, see also **Fout! Verwijzingsbron niet gevonden.**.

4.5 Registration and session

An ITS Application shall be able to connect to the TLC-FI and register itself as an ITS Application. The TLC Facilities is responsible for checking the identity of the ITS Application and check if the authenticated ITS Application is authorised to access the TLC-FI. Conceptually, the ITS Application will follow the state transitions as described in Figure 2.
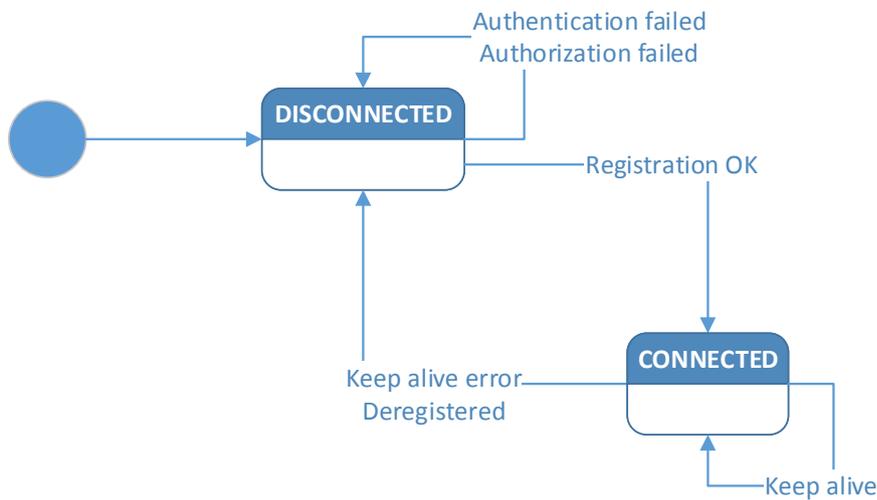

Figure 2 Session state diagram

Req-ID	IRS-TLCFI-REG-001
Title	ITS Application registration
Description	An ITS Application shall register itself at the TLC-FI before it can access any further services through the TLC-FI. The ITS Application at least provides the following information when registering: – Identification credentials (username and password) – Requested role (Application type) – Requested priority level The TLC-FI is responsible for checking the authenticity and to grant the ITS Application authorisation to access services for which the ITS Application is authorised. In case the ITS Application is either not authenticated or authorised, the TLC-FI will deny access to any further services and shall disconnect the ITS Application.
Source	[Ref 1]
Comment	The authorisation to access services of the TLC Facilities can be pre-configured in a TLC Facilities layer or it can be provisioned using a TMS-IF interface such as IVERA-TLC.

Req-ID	IRS-TLCFI-REG-002
Title	ITS Application registration – Application types
Description	An ITS Application shall be one of the following **application types** – ITS control application – ITS provider application – ITS consumer application
Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-REG-003
Title	ITS Application registration - priority levels
Description	An ITS Application shall be assigned a **priority level.** This priority level is managed by the TLC Facilities. The priority levels shall be relative values giving an ITS Application a unique priority within the set of ITS Applications registered with the TLC-FI. An ITS Application with a higher priority is served first when the TLC-FI has to make a choice between serving multiple ITS Applications.
Source	[Ref 1]
Comment	For instance, two ITS Applications subscribed to the same changes in TLC Objects will be provided this information in prioritized order. When manipulating a TLC object, the same priority is enforced. When multiple ITS Applications have rights to manipulate a single TLC object, access is handled at the organizational level.

Req-ID	IRS-TLCFI-REG-004
Title	ITS Application deregistration request
Description	It shall be possible for an ITS Application to deregister itself from the TLC-FI. The TLC-FI shall inform the ITS Application about the result of the deregistration, after which the ITS Application may no longer use the services of the TLC-FI.
Source	[Ref 1]
Comment	The TLC-FI shall (by preference) gracefully terminate the sessions and therefore be conservative in closing any lower layer connection so that the ITS Application can properly receive feedback on its request.

Req-ID	IRS-TLCFI-REG-005
Title	ITS Application deregistration by TLC-FI
Description	It shall be possible for the TLC-FI to deregister an registered ITS Application, and thereby remove it from the list of registered ITS Applications. The TLC-FI shall inform the ITS Application about the deregistration, the ITS Application may no longer use the services of the TLC-FI. The TLC-FI may revoke the rights to access of the services prior to sending the notification.
Source	[Ref 1]
Comment	This may be used when an ITS Application is revoked access from to the TLC Facilities.

Req-ID	IRS-TLCFI-REG-006
Title	Alive Checking
Description	Both TLC-FI as well as registered ITS Applications shall be able to detect broken communication paths or not responding applications/interface.
Source	
Comment	

Req-ID	IRS-TLCFI-REG-007
Title	Alive Checking – TLC-FI actions
Description	If the TLC Facilities detects a not responding ITS Application or a broken communication path, the following actions are taken: – ITS Application is deregistered – Subscriptions are removed – Session is terminated – Entry added to system log
Source	
Comment	The ITS Application is responsible for re-establishing the connection. The TLC-FI will not attempt to restore the connection.

4.6 ITS control application

An ITS control application performs the current major use-case of a TLC: **regulating traffic flow** by means of requesting intersection-wide status changes such as amber flashing, dark, or all-red as well as requesting external signal group states. Specific requirements for this application type are described in this paragraph.

4.6.1 Registration

Prior to being allowed to control signal groups or intersection states, the ITS control application is assumed to have been properly registered according to the requirements in section 4.5. The ITS Control application requires additional registration with the TLC-FI to allow for actual control of the signal groups and intersection.

Req-ID	IRS-TLCFI-ICA-REG-001
Title	ITS Control application - specific registration
Description	An ITS control application which has been registered with the TLC-FI, shall proceed with a specific ITS **control** application **registration procedure** to be allowed to execute control of the intersection and its assigned signal groups. The ITS Application shall provide **configuration information** of the intersection of which it wants to take control to the TLC-FI so that the TLC-FI can decide if the ITS control application is configured correctly and is **allowed** to take control. The following information shall at least be provided: – Intersection ID to control – List of signal groups it requests to control for this intersection – List of detectors it will monitor for the intersection When the TLC-FI accepts the configuration, the ITS control application may be given the rights to actively control the intersection and its signal groups.
Source	[Ref 1]
Comment	The ITS Application can request meta information from the TLC-FI prior to the control specific registration, for instance for configuration of the ITS control application.

4.6.2 Activation and deactivation

Req-ID	IRS-TLCFI-ICA-AD-001
Title	ITS Control application - ready to control
Description	An ITS control application, which is allowed by the TLC-FI to be given active control of an intersection must, prior to being activated by the TLC-FI, indicate that it is **ready to control** the intersection.
Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-ICA-AD-002
Title	ITS Control application - activate control
Description	The TLC-FI is responsible for **activating** an ITS control application. It is the responsibility of the TLC-FI to only select an ITS control application which has explicitly indicated that it is ready to control. The ITS control application is said to be **in control** from this moment.
Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-ICA-AD-003
Title	ITS Control application - deactivate
Description	The TLC-FI shall be able to **deactivate** an ITS Control application which is in control. The TLC-FI shall inform the ITS Control application of the deactivation and the ITS control application shall be in control until the deactivation procedure is concluded. The TLC-FI is responsible for notifying the ITS control application being deactivated when it is no longer in control
Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-ICA-AD-004
Title	ITS Control application - abandon control
Description	An ITS control application which is **in control** shall be able to **abandon control**. The TLC-FI is then responsible for deactivating the ITS control application and selecting a new one. The ITS Control application which abandoned control shall only be allowed to control again after it requests control.
Source	[Ref 1]
Comment	The ITS control application may for instance perform such a request when it is scheduled to be terminated for maintenance.

Req-ID	IRS-TLCFI-ICA-AD-005
Title	Exclusive intersection control
Description	There shall be only one ITS control application in control for a specific intersection and its associated signal groups at a given moment in the time. The TLC-FI shall enforce this by selecting the ITS control application allowed to be in control of a specific intersection.
Source	[Ref 1]
Comment	There may be different sources selecting a specific program, such as IVERA-APP, time of day, manual panel etc.

Req-ID	IRS-TLCFI-ICA-AD-006
Title	Multiple intersection control
Description	It shall be possible for an ITS control application to control multiple intersections and their associated signal groups within one session.
Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-ICA-AD-007
Title	Multiple ITS control applications
Description	When a TLC is responsible for multiple intersections, it shall be possible that different ITS Control applications are in control of the different intersections.
Source	[Ref 1]
Comment	

4.7 ITS provider application

An ITS provider application is allowed to provide information to the TLC-FI. This includes adding and deleting specific TLC Object types, updating attributes of existing TLC Objects types. This is described in more detail in section 4.9.

4.8 ITS consumer application

An ITS consumer application is allowed to read and subscribe to changes of TLC Objects.

4.9 TLC Information

4.9.1 TLC Object dictionary

The information exchanged between ITS Applications and the TLC-FI are stored in TLC Objects. A TLC Object is of a specific type and contains attributes. TLC Objects and their attributes can be mandatory or optional. TLC Objects can be added, updated, read, deleted as well as subscribed for notifications when changes are made to them. This section provides description of the TLC Object types.

Req-ID	IRS-TLCFI-TIF-OD-001
Title	TLC Object dictionary
Description	The TLC Object dictionary shall contain – Version – TLC Objects with attributes – For each TLC Object and its attributes if it is mandatory or optional – For each TLC Object type and its attributes, what type of access rights can be assigned to it (Add, Update, Delete, Read) – For each TLC Object type, the pre-defined filters. The TLC Object dictionary is found in [Ref 4].
Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-TIF-OD-002
Title	TLC Objects
Description	All information accessible to ITS Applications on the TLC-FI is made available as TLC Objects. A TLC Object is of a specific type and can have several attributes. All TLC Object types are defined in [Ref 4], the TLC Object dictionary.
Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-TIF-OD-003
Title	TLC Object dictionary version
Description	The TLC Object dictionary shall be under version control and the version shall be made available as meta information on the TLC-FI
Source	[Ref 1] QA_EVO_001, QA_EVO_003
Comment	

Req-ID	IRS-TLCFI-TIF-OD-004
Title	TLC Object requirements
Description	For each TLC Object type and for each of its attributes it shall be identified if it is mandatory or optional.
Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-TIF-OD-005
Title	TLC Object access rights
Description	For each TLC Object type access rights shall be defined. The following access rights shall be assigned to objects and attributes of objects: – Add : add an instance of this object type with attributes – Update : Update this object's attributes – Read : Read the content of this object – Delete : Delete this object The access rights are defined per ITS Application type.
Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-TIF-OD-006
Title	TLC Object identification
Description	Each instance of a TLC Object shall be uniquely identified within the TLC-FI.
Source	
Comment	

4.9.2 TLC Object query and manipulation

Req-ID	IRS-TLCFI-TIF-OM-001
Title	Adding a TLC Object
Description	Authorized ITS Applications shall be able to add a TLC Object. The ITS Application adding this object shall by the TLC Facilities be provided with its unique (within the TLC Facilities) TLC Object identifier witch which it can identify subsequent accesses to this object.
Source	[Ref 1]
Comment	An ITS provider application may for instance add a TLC Object of type Multifunctional Variable.

Req-ID	IRS-TLCFI-TIF-OM-002
Title	Updating a TLC Object
Description	Authorized ITS Applications shall be able to update a TLC Object and its attributes.
Source	[Ref 1]
Comment	Updating attributes of TLC Objects may result in change of outputs of the TLC such as signal group external states.

Req-ID	IRS-TLCFI-TIF-OM-003
Title	Querying a TLC Object
Description	Authorized ITS Applications shall be able to query a TLC Object The result set contains the TLC-Objects with attributes requested. The querying of a TLC Object shall be subject to the filtering requirements.
Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-TIF-OM-004
Title	Deleting a TLC Object
Description	Authorized ITS Applications shall be able to delete a TLC Object based on its unique TLC Object identifier.
Source	[Ref 1]
Comment	

4.9.3 TLC Object types

As described in previous sections, the TLC Object types are described in the TLC Object dictionary. This is the authoritative source of the definition of the objects. This section provides the required types of objects from a functional level while the TLC Object dictionary describes the details.

Req-ID	IRS-TLCFI-TIF-OT-001
Title	TLC Object types
Description	The following TLC Object types shall be supported - Intersection - Detector - Signal group - Public transport / Emergency vehicle - Multifunctional digital input - Multifunctional digital output - Multifunctional variable - Meta information
Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-TIF-OT-002
Title	TLC Object – Intersection

Description	The *Intersection* object shall contain the following attributes:
	- Identification
	- Active state (state and source)
	- Requested state
	- Fault state
	- Special function variables
	   o Manual intervention request
	   o Manual control active
	- Active ITS control application
	- List of signal groups
	- List of detectors

Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-TIF-OT-003
Title	Intersection – requested state
Description	An authorized ITS control application shall be able to update the *Requested state* attribute of the *Intersection* object. The TLC-FI is then responsible for executing the transition from the current *active state* to the new *requested state*. In case a higher priority request is present which has selected the *active state*, the ITS control application must be informed of this.
Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-TIF-OT-004
Title	TLC Object – Signal group

Description	The *Signal Group* object shall contain the following attributes:
	- Identification
	- External state (functional and external)
	- Time in external state
	- Internal signal group state (including format)
	- Requested external state
	- Reason for deviation from external state
	- Time to activation of requested external state
	- Estimated time to external state change(s)
	- Fault state (deadlock, lamps)
	- Special function variables and status
	    o Priority request
	    o Priority request status
	    o Peloton presence
	    o Green wave status
	    o Heavy goods vehicle presence
	    o Magic green[1] status
	    o Reason for wait time
	- Meta information
	    o Type (vehicle, bicycle, pedestrian, tram)
	    o Timing (E.g. Minimum red, minimum green)
	    o Conflicts
	    o Related detectors

	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-TIF-OT-005
Title	Signal group – requested external state
Description	An ITS control application shall be able to change the *requested external state* attribute of a Signal group. The change may be a functional change (GO / STOP) or it may be an explicit external signal group state (Red, Green, Amber) A change of the *requested external state* shall have the following consequences: 1. The TLC-FI shall acknowledge the change and update attributes related to timing of this signal group state change 2. The TLC Facilities shall use the *requested external state* to perform an orderly transition to the requested state including safety times and transition states. External signal group states shall be based on the definitions of *SAE-J2735, Dedicated Short Range Communications (DSRC) Message Set Dictionary, SAE International - 2015-09*
Source	[Ref 1] QA_INTL_001, [Ref 5]
Comment	

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[1] Dutch: Tovergroen

Req-ID	IRS-TLCFI-TIF-OT-006
Title	Signal group – Estimated time to external state change
Description	An authorized ITS control application shall be able to change the *estimated time to external state change* attribute of a Signal group. These estimates may be a list of estimates describing the expected changes. The TLC Facilities is responsible for validation of these estimates and the estimates are made available (e.g. published to subscribers) only after such validation has taken place.
Source	[Ref 1]
Comment	The content of the validation is pending Safety analysis (see **Fout! Verwijzingsbron niet gevonden.**)

Req-ID	IRS-TLCFI-TIF-OT-007
Title	TLC Object – Detector

Description	The *Detector* object shall contain the following attributes:
	– Identification
	– Active state (Active, Inactive, Fault, SWICO ON, SWICO OFF)
	– Time in active state
	– Fault state (occupy timeouts , hardware error, flutter)
	– Speed
	– Length
	– Classification
	– Direction
	– Meta information
	   o Type
	   o Detector functions

Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-TIF-OT-008
Title	TLC Object – Public transport and Emergency Vehicle
Description	The *Public transport and Emergency vehicle* object shall contain the following attributes: – Identification – Vehicle type – Information type (checkin, checkout, etc.) – Location / Distance to stop line – Line number – Service number – Company number – Journey number – Journey category – Direction – Punctuality class – Punctuality – Priority class – Length – Speed – Vehicle status (Driving, halted, etc.)
Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-TIF-OT-009
Title	TLC Object – Multifunctional digital inputs
Description	The *Multifunctional digital inputs* shall contain the following attributes: – Identification – Value – Time since last change – Software switch status (SWICO ON, SWICO OFF)
Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-TIF-OT-010
Title	TLC Object – Multifunctional digital outputs
Description	The *Multifunctional digital output* shall contain the following attributes: – Identification – Value – Time since last change
Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-TIF-OT-011
Title	TLC Object – Multifunctional variable
Description	A *Multifunctional variable* can be created by an ITS application with the proper authorisation and this ITS application is responsible for cleaning up the variable if it is no longer needed. The object shall contain the following attributes: – Identification – Value – Lifetime When the *lifetime* has expired and the variable has not been changed or refreshed by the ITS application that created it, the TLC-FI shall remove the variable. It will become stop to exist as TLC Object instance. Any subscribed ITS Application shall be notified of the removal.
Source	[Ref 1] QA_AVAIL_007
Comment	

Req-ID	IRS-TLCFI-TIF-OT-012
Title	TLC Object – Meta information
Description	The *Meta information* object shall contain the following attributes: – TLC Object dictionary version – Manufacturer information – Intersection topology data – Clearance matrix – ITS Application status (list of all ITS applications active and their status information) – TLC Capabilities o Latency classes
Source	[Ref 1]
Comment	

4.10 Quality attributes

Several quality attributes have been identified in [Ref 1], *iTLC Architecture WG3 (Deliverable F) v 1.2, jan. 201*. This section provides the attributes which have an impact on the TLC-FI. Attributes that are addressed elsewhere in this IRS are not listed here, but the reference of the attribute is identified in the requirement itself.

4.10.1 Performance

Req-ID	IRS-TLCFI-QA-PERF-001
Title	Latency classes
Description	For a number of performance requirements different classes of latency can be used. The following list defines the different classes: Class 1 : 10ms Class 2 : 25ms Class 3 : 50ms Class 4 : 75ms Class 5 : 100ms Class 6 : 200ms Class 7 : 300ms
Source	[Ref 1], QA_PERF_002, QA_PERF_003
Comment	

Req-ID	IRS-TLCFI-QA-PERF-002
Title	Concurrent ITS Applications
Description	TLC-FI shall support at least 10 concurrent ITS Applications
Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-QA-PERF-003
Title	ITS Applications – number of subscriptions
Description	TLC-FI shall support at least 5 subscriptions per ITS application
Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-QA-PERF-004
Title	ITS Applications – number of requests / replies
Description	TLC-FI supports at least 10 request/replies per second per ITS Application
Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-QA-PERF-005
Title	ITS Applications – number of notifications
Description	TLC-FI supports at least 10 notifications per second per ITS Application
Source	[Ref 1]
Comment	

Req-ID	IRS-TLCFI-QA-PERF-006
Title	TLC-FI latency
Description	The latency between a request at TLC-FI and the resulting response shall comply to class 5 of Requirement IRS-TLCFI-QA-PERF-001.
Source	[Ref 1], QA_PERF_001
Comment	

Req-ID	IRS-TLCFI-QA-PERF-007
Title	Publish – subscribe latency
Description	When an ITS application has changed an (attribute) of a TLC Object, the changed object shall be published within 50ms in case the subscribing application has the highest priority and is subscribed to real-time updates.
Source	[Ref 1], QA_PERF_004
Comment	

4.10.2 Availability

Req-ID	IRS-TLCFI-QA-AVAIL-001
Title	Resilience against temporal network disruption
Description	It shall be possible for a TLC-FI to withstand temporal network disruption without major loss of function.
Source	[Ref 1], QA_AVAIL_002
Comment	For instance, the possibility for a functional request of signal group state without hard timing constraints make this possible.

Req-ID	IRS-TLCFI-QA-AVAIL-002
Title	ITS control application self-assessment
Description	It shall be possible for an ITS control application to provide the TLC-FI with its own quality self-assessment. This assessment will include the results from for instance – Excessive deviations between requested and actual signal group states – Internal processing failures – Restart attempts The TLC-FI shall receive this information and based on the information, the TLC facilities shall make a decision of the ITS control application must be deactivated and replaced with a new ITS control application.
Source	[Ref 1], QA_AVAIL_004
Comment	

Req-ID	IRS-TLCFI-QA-AVAIL-003
Title	Traffic control with relative timing
Description	It shall be possible for an ITS control application provide functional traffic control even if the ITS control application is not synchronized with the UTC time. The information exchanged between the ITS control application and TLC-FI shall therefore have no explicit dependency on the UTC time. Some attributes of TLC Objects such as the *estimated time to external state change* can therefore be updated using a relative time, while an ITS consumer application expects the TLC-FI to provide the values with absolute UTC time stamps.
Source	[Ref 1], QA_AVAIL_005
Comment	

Req-ID	IRS-TLCFI-QA-AVAIL-004
Title	Estimated signal group states – UTC time
Description	The Signal group – estimated time to external state change attribute shall be set to the value unknown by the TLC Facilities when the local time is not synchronized with the UTC time within 100ms.
Source	[Ref 1], QA_AVAIL_006
Comment	

4.10.3 Evolution

Req-ID	IRS-TLCFI-QA-EVO-001
Title	TLC-FI protocol backwards compatibility
Description	It shall be possible for an ITS application to use an older TLC Object dictionary than version used at the TLC-FI.
Source	[Ref 1], QA_EVO_004
Comment	

Appendix 1. Requirements overview

As a reference, all requirements are listed below.