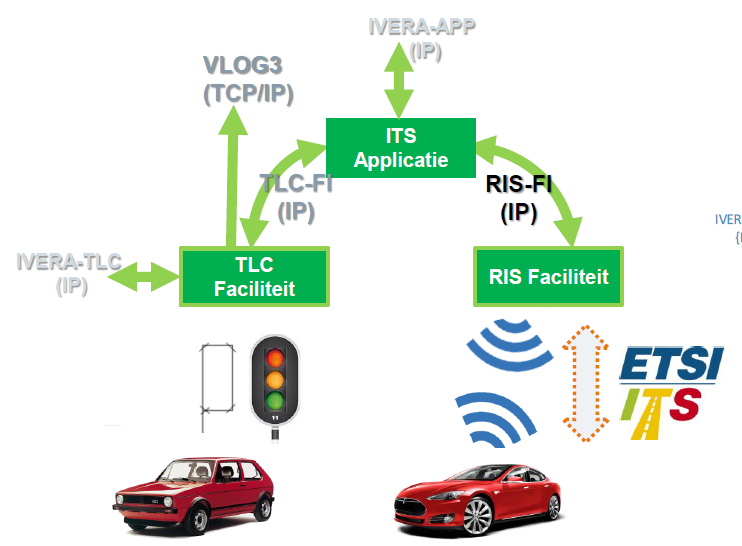
Intelligente Verkeers Regel Installatie

(iVRI) – Fase 1

Deliverable G2: IRS TLC-FI

Interface Requirements Specification TLC-FI





HomeImtech Traffic & Infra (The Netherlands)





Datum: 27 januari 2016

Versie: 1.2

**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:

Imtech Traffic & Infra (The Netherlands)

|  |  |
| --- | --- |
| Inge Fløan |  |
| Hans Looijen |  |
| Peter Smit | http://www.vialis.nl/images/vw_vialis/logo_nl.gifHome |
| 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) |

**Approval:**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Who** | **Date** | **Version** |
| Prepared |  |  |  |
| Reviewed |  |  |  |
| Approved |  |  |  |

**Publication level:** Public

**Version filename:** Deliverable G2 - IRS TLC-FI v1.2.docx

Content

1 Introduction 5

1.1 System overview 5

1.2 Document overview 5

1.2.1 Purpose and scope 5

1.2.2 Document structure 5

1.3 Advise for the reader 5

2 References 6

3 Acronyms, abbreviations and concepts 7

4 Requirements 9

4.1 Introduction 9

4.1.1 Requirements notation format 9

4.2 General requirements 9

4.3 Protocol 9

4.4 Communication patterns 10

4.5 Registration and session 11

4.6 ITS control application 15

4.6.1 Registration 15

4.6.2 Activation and deactivation 15

4.7 ITS provider application 17

4.8 ITS consumer application 17

4.9 TLC Information 17

4.9.1 TLC Object dictionary 17

4.9.2 TLC Object query and manipulation 19

4.9.3 TLC Object types 19

4.10 Quality attributes 25

4.10.1 Performance 25

4.10.2 Availability 26

4.10.3 Evolution 27

# Introduction

## 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.

## Document overview

### Purpose and scope

This document provides specifications of the requirements of the TLC-FI.

### 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 APPENDIX 1

## 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*

# References

**ID Reference**

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

# 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 |

# Requirements

## 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.

### 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

## 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 |  |

## 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 |  |

## 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 APPENDIX 1.  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 APPENDIX 1. |

## 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. |

## 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.

### 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 IDto 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. |

### 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 |  |

## 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.

## ITS consumer application

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

## TLC Information

### 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 |  |

### 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 |  |

### 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   + Manual intervention request   + 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   + Priority request   + Priority request status   + Peloton presence   + Green wave status   + Heavy goods vehicle presence   + Magic green[[1]](#footnote-2) status   + Reason for wait time * Meta information   + Type (vehicle, bicycle, pedestrian, tram)   + Timing (E.g. Minimum red, minimum green)   + Conflicts   + 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 |  |

|  |  |
| --- | --- |
| 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 APPENDIX 1) |

|  |  |
| --- | --- |
| 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   + Type   + 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   + Latency classes |
| Source | [Ref 1] |
| Comment |  |

## 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.

### 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 |  |

### 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 |  |

### 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 |  |

1. **Requirements overview**

As a reference, all requirements are listed below.

|  |  |
| --- | --- |
| [IRS-TLCFI-TIME-001](#_Toc441740027)  [IRS-TLCFI-PROT-001](#_Toc441740028)  [IRS-TLCFI-PROT-002](#_Toc441740029)  [IRS-TLCFI-PROT-003](#_Toc441740030)  [IRS-TLCFI-COM-001](#_Toc441740031)  [IRS-TLCFI-COM-002](#_Toc441740032)  [IRS-TLCFI-COM-003](#_Toc441740033)  [IRS-TLCFI-COM-004](#_Toc441740034)  [IRS-TLCFI-COM-005](#_Toc441740035)  [IRS-TLCFI-COM-006](#_Toc441740036)  [IRS-TLCFI-REG-001](#_Toc441740037)  [IRS-TLCFI-REG-002](#_Toc441740038)  [IRS-TLCFI-REG-003](#_Toc441740039)  [IRS-TLCFI-REG-004](#_Toc441740040)  [IRS-TLCFI-REG-005](#_Toc441740041)  [IRS-TLCFI-REG-006](#_Toc441740042)  [IRS-TLCFI-REG-007](#_Toc441740043)  [IRS-TLCFI-ICA-REG-001](#_Toc441740044)  [IRS-TLCFI-ICA-AD-001](#_Toc441740045)  [IRS-TLCFI-ICA-AD-002](#_Toc441740046)  [IRS-TLCFI-ICA-AD-003](#_Toc441740047)  [IRS-TLCFI-ICA-AD-004](#_Toc441740048)  [IRS-TLCFI-ICA-AD-005](#_Toc441740049)  [IRS-TLCFI-ICA-AD-006](#_Toc441740050)  [IRS-TLCFI-ICA-AD-007](#_Toc441740051)  [IRS-TLCFI-TIF-OD-001](#_Toc441740052)  [IRS-TLCFI-TIF-OD-002](#_Toc441740053)  [IRS-TLCFI-TIF-OD-003](#_Toc441740054)  [IRS-TLCFI-TIF-OD-004](#_Toc441740055)  [IRS-TLCFI-TIF-OD-005](#_Toc441740056)  [IRS-TLCFI-TIF-OD-006](#_Toc441740057)  [IRS-TLCFI-TIF-OM-001](#_Toc441740058)  [IRS-TLCFI-TIF-OM-002](#_Toc441740059)  [IRS-TLCFI-TIF-OM-003](#_Toc441740060)  [IRS-TLCFI-TIF-OM-004](#_Toc441740061)  [IRS-TLCFI-TIF-OT-001](#_Toc441740062)  [IRS-TLCFI-TIF-OT-002](#_Toc441740063)  [IRS-TLCFI-TIF-OT-003](#_Toc441740064)  [IRS-TLCFI-TIF-OT-004](#_Toc441740065)  [IRS-TLCFI-TIF-OT-005](#_Toc441740066)  [IRS-TLCFI-TIF-OT-006](#_Toc441740067)  [IRS-TLCFI-TIF-OT-007](#_Toc441740068)  [IRS-TLCFI-TIF-OT-008](#_Toc441740069)  [IRS-TLCFI-TIF-OT-009](#_Toc441740070)  [IRS-TLCFI-TIF-OT-010](#_Toc441740071)  [IRS-TLCFI-TIF-OT-011](#_Toc441740072)  [IRS-TLCFI-TIF-OT-012](#_Toc441740073)  [IRS-TLCFI-QA-PERF-001](#_Toc441740074)  [IRS-TLCFI-QA-PERF-002](#_Toc441740075)  [IRS-TLCFI-QA-PERF-003](#_Toc441740076)  [IRS-TLCFI-QA-PERF-004](#_Toc441740077)  [IRS-TLCFI-QA-PERF-005](#_Toc441740078)  [IRS-TLCFI-QA-PERF-006](#_Toc441740079)  [IRS-TLCFI-QA-PERF-007](#_Toc441740080)  [IRS-TLCFI-QA-AVAIL-001](#_Toc441740081)  [IRS-TLCFI-QA-AVAIL-002](#_Toc441740082)  [IRS-TLCFI-QA-AVAIL-003](#_Toc441740083)  [IRS-TLCFI-QA-AVAIL-004](#_Toc441740084)  [IRS-TLCFI-QA-EVO-001](#_Toc441740085) | [UTC time 9](#_Toc441740086)  [IP based 9](#_Toc441740087)  [Access channel – non secure 10](#_Toc441740088)  [Access channel - encrypted 10](#_Toc441740089)  [Messaging pattern - Request response 10](#_Toc441740090)  [Messaging pattern – Publish subscribe 10](#_Toc441740091)  [Subscriptions inactivity removal 11](#_Toc441740092)  [Subscription – update period 11](#_Toc441740093)  [Message filtering 11](#_Toc441740094)  [Message pre-defined filtering definitions 11](#_Toc441740095)  [ITS Application registration 12](#_Toc441740096)  [ITS Application registration – Application types 12](#_Toc441740097)  [ITS Application registration - priority levels 13](#_Toc441740098)  [ITS Application deregistration request 13](#_Toc441740099)  [ITS Application deregistration by TLC-FI 13](#_Toc441740100)  [Alive Checking 14](#_Toc441740101)  [Alive Checking – TLC-FI actions 14](#_Toc441740102)  [ITS Control application - specific registration 15](#_Toc441740103)  [ITS Control application - ready to control 15](#_Toc441740104)  [ITS Control application - activate control 16](#_Toc441740105)  [ITS Control application - deactivate 16](#_Toc441740106)  [ITS Control application - abandon control 16](#_Toc441740107)  [Exclusive intersection control 16](#_Toc441740108)  [Multiple intersection control 16](#_Toc441740109)  [Multiple ITS control applications 17](#_Toc441740110)  [TLC Object dictionary 17](#_Toc441740111)  [TLC Objects 18](#_Toc441740112)  [TLC Object dictionary version 18](#_Toc441740113)  [TLC Object requirements 18](#_Toc441740114)  [TLC Object access rights 18](#_Toc441740115)  [TLC Object identification 18](#_Toc441740116)  [Adding a TLC Object 19](#_Toc441740117)  [Updating a TLC Object 19](#_Toc441740118)  [Querying a TLC Object 19](#_Toc441740119)  [Deleting a TLC Object 19](#_Toc441740120)  [TLC Object types 20](#_Toc441740121)  [TLC Object – Intersection 20](#_Toc441740122)  [Intersection – requested state 20](#_Toc441740123)  [TLC Object – Signal group 21](#_Toc441740124)  [Signal group – requested external state 22](#_Toc441740125)  [Signal group – Estimated time to external state change 22](#_Toc441740126)  [TLC Object – Detector 22](#_Toc441740127)  [TLC Object – Public transport and Emergency Vehicle 23](#_Toc441740128)  [TLC Object – Multifunctional digital inputs 23](#_Toc441740129)  [TLC Object – Multifunctional digital outputs 23](#_Toc441740130)  [TLC Object – Multifunctional variable 24](#_Toc441740131)  [TLC Object – Meta information 24](#_Toc441740132)  [Latency classes 25](#_Toc441740133)  [Concurrent ITS Applications 25](#_Toc441740134)  [ITS Applications – number of subscriptions 25](#_Toc441740135)  [ITS Applications – number of requests / replies 25](#_Toc441740136)  [ITS Applications – number of notifications 25](#_Toc441740137)  [TLC-FI latency 26](#_Toc441740138)  [Publish – subscribe latency 26](#_Toc441740139)  [Resilience against temporal network disruption 26](#_Toc441740140)  [ITS control application self-assessment 26](#_Toc441740141)  [Traffic control with relative timing 27](#_Toc441740142)  [Estimated signal group states – UTC time 27](#_Toc441740143)  [TLC-FI protocol backwards compatibility 27](#_Toc441740144) |

1. Dutch: Tovergroen [↑](#footnote-ref-2)