Intelligente Verkeers Regel Installatie

(iVRI) – Fase 1

Deliverable G4: IRSIDD Interface VLOG

Koppelvlakken beschrijving conform de Interface Requirements Specification (IRS) & Interface Design Description (IDD) methodiek









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**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 G4 van de afgesproken leverdelen in de opdrachtverstrekking, omschreven als “Koppelvlakken beschrijving conform de Interface Requirements Specification (IRS) & Interface Design Description (IDD) methodiek”.

Deze deliverable geeft een overzicht van de V-Log interface uitbreiding, waarmee “connected” use cases kunnen worden voorzien van de benodigde informatie.

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

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*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.**

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Content

1 Introduction 5

1.1 System overview 5

1.2 Document overview 7

1.2.1 Purpose 7

1.2.2 Document structure 7

1.2.3 Advice for the reader 7

2 References 8

3 Requirements 9

4 Interface design 12

4.1 V-Log format 12

4.1.1 Time reference message 12

4.1.2 Status message 12

4.1.3 Change message 13

4.2 V-Log messages 14

4.2.1 Phase timing 14

4.2.2 Reason for wait time 16

4.2.3 Environmental factors 16

Appendix A. ABBREVIATIONS & CONCEPTS 18

# Introduction

For the project “Beter Benutten Vervolg” concepts are defined to support the road user. The road authorities define use cases for devices connected with current networks such as 3G and 4G (connected use cases) and for future devices requiring local communication through cooperative technology (cooperative use cases). This document handles the connected use cases only and only the part in which the Traffic Light Controller (TLC) can provide the road users with information about the state / status of the traffic situation around the TLC. Road users already have connected devices so a roll out can be done with software deployment only. For most use cases additional data need to be defined. The use cases are analyzed in [UCVLOG] resulting in definition of data for which new messages need to be defined.

## System overview

This document specifies the new messages that shall be added to V-Log 2.1.0 to create a new version of V-Log. V-Log 3.0.0 will be compatible with previous versions. With this new version connected use cases can be fed with the needed information.

The data flow of V-Log is no part of the message definition, so this document has no intention to change the dataflow. To identify (dis)abilities a brief overview of the data flow is shown below.

In the overview V-Log is used in the below picture between the TLC and the Traffic Central System (TCS).

 

Figure 1 System overview

 If we zoom into the V-Log details, we get the following overview:

|  |  |
| --- | --- |
|  | Traffic application generates V-Log data and puts this on CVN interface. The following methods exists: 1. Streaming V-Log data2. File based V-Log data3. Command interface / user interactive V-Log data |
| CVN-C interface is a shared data area specified by CVN-C committee [CVN-C]. With respect to V-Log, this interface is transparent. |
| TLC middleware is the application driving the TLC.For V-Log purposes, it makes the data from the CVN-C interface available over TCP/IP and in files.  |
| Network is used for data transport and protection. |
| The Traffic Central System can receive, store and forward V-Log data to applications to implement the use cases. |

The V-Log data transport scheme will not change. The data is accessible once on a TCP port for a single TCS only. In case more applications needs the V-Log data the TCS shall multiply the data to make it available to all applications. It also should be noticed that the data flow is unidirectional so with V-Log no road user data can be fed to the TLC.

This document describes the new messages and their format. This description shall be provided to the V-Log committee to be added to the specification. Note that the V-Log specification is written in Dutch and therefore some content of this document may be written in Dutch.

## Document overview

### Purpose

This document provides specifications of the requirements as well as the proposed changes to the interface.

### Document structure

Chapter 1 contains system overview and background information.

Chapter 2 contains references to external and internal documents

Chapter 3 contains formal requirements resulting from the use case and functional specification discussions.

Chapter 4 contains the resulting specification of the additions to the V-Log protocol. For clarity, this chapter has been written in the same style as the original V-Log document [PVLOG2].

Appendix A contains acronyms, definition of concepts and Dutch to English translations of central terminology.

### Advice for the reader

The following format is used to define a requirement:

|  |  |
| --- | --- |
| Req-ID | IRS-xx-yyyy |
| Title | Protocol compliancy |
| Description | The V-Log protocol shall be an extension of the current V-Log 2.1 protocol (see [PVLOG2]) |
| Source | VLOG / 5.1 |
| Comment |  |

* Req-ID: unique identification of the requirement according to the following format: ’IRS-xx-yyyy”, where xx is an identifier for the interface, yyyy 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.

# References

|  |  |
| --- | --- |
| ID | Reference |
| [BIJ2] | Bijlage 1 Plan van Aanpak.pdf, 18 mei 2015, definitief t.b.v. DO BBV 26/5/2015 |
| [UCVLOG] | VRI Tafel WG1 V-Log Use Case mapping 20150807.pptx |
| [PVLOG2] | V-Log protocol en definities (V-Log vs 2.1.0 document vs 1.4) |
| [FSVLOG] | VRI Tafel WG1 V-Log Functionele Specificatie 20150731.pptx |
| [SAE-J2735] | Dedicated Short Range Communications (DSRC) Message Set Dictionary, SAE International - Proposed draft 2014-09-XX, J2735 |
| [CVN-C] | De CVN C-interface, 5.0 Specification of the CVN-C interface. |
| [IVERA] | IVERA Functionele specificatie (versie 3.01)IVERA Objectdefinitie Verkeersregelinstallaties (versie 3.01)IVERA Technische specificatie (versie 3.01)Specification of the IVERA protocol. |

# Requirements

This chapter contains requirements identified during analysis of the use-cases of [BIJ2]. For the resulting analysis, refer to [UCVLOG] and [FSVLOG].

|  |  |
| --- | --- |
| Req-ID | IRS-VLOG3-001 |
| Title | Standards compliance |
| Description | When defining functional additions to the protocol, conformance with international standards shall be sought.  |
| Source | [BIJ2] |
| Comment | For instance, standards such as specified for cooperative systems in ETSI shall be followed. |

|  |  |
| --- | --- |
| Req-ID | IRS-VLOG3-002 |
| Title | Protocol compliancy |
| Description | The V-Log protocol shall be an extension of the current V-Log 2.1 protocol (see [PVLOG2]) |
| Source |  |
| Comment |  |

|  |  |
| --- | --- |
| Req-ID | IRS-VLOG3-003 |
| Title | Time-to-green (TTG) information |
| Description | The V-Log data shall contain information about the expected time remaining until green realization. The following information is required: 1. *Minimum* time (unit [s], resolution 0.1s).
2. *Maximum* time (unit [s], resolution 0.1s)
3. *Likely* time (unit [s], resolution 0.1s)
* A specific value shall be used in case any of the above mentioned times are unknown.
1. *Confidence* (OPTIONAL) value of the *likely* time following [SAE-J2735]
 |
| Source | FSVLOG |
| Comment | All times identifies an explicit time in the future. This time is a combination of the time-reference message, delta-time field of the status and/or change messages in combination with the expected times. When the *minimum* time is known, it may not be changed to an earlier point in time with a new message. Similarly, a *maximum* time may not be changed to a later point in time. However, *minimum* and *maximum* times can be changed to “unknown”. When the minimum and maximum times are equal, the actual time is guaranteed. (Not conform SAE) Maximum is always larger than or equal to the minimum time. The *likely* time provides the most likely remaining time. This time may be based on historical values, detection data or any other means to give accurate predictions. It is always between the *minimum* and *maximum* times. The *confidence* value indicates the level of confidence of the *likely* time. **Note:** The *confidence* value is defined to be compliant with the [SAE-J2735] Signal Phase and Timing (SPAT) messages.  |

|  |  |
| --- | --- |
| Req-ID | IRS-VLOG3-004 |
| Title | Remaining green time (RGT) information |
| Description | The V-Log data shall contain information about the expected remaining green time. The following information is required: 1. *Minimum* time (unit [s], resolution 0.1s).
2. *Maximum* time (unit [s], resolution 0.1s)
3. *Likely* time (unit [s], resolution 0.1s)
* A specific value shall be used in case any of the above mentioned times are unknown.
1. *Confidence* (OPTIONAL) value of the *likely* time following [SAE-J2735]
 |
| Source | FSVLOG |
| Comment | All times identifies an explicit time in the future. This time is a combination of the time-reference message, delta-time field of the status and/or change messages in combination with the expected times. When the *minimum* time is known, it may not be changed to an earlier point in time with a new message. Similarly, a *maximum* time may not be changed to a later point in time. However, *minimum* and *maximum* times can be changed to “unknown”. When the minimum and maximum times are equal, the actual time is guaranteed. (Not conform SAE) Maximum is always larger than or equal to the minimum time. The *likely* time provides the most likely remaining time. This time may be based on historical values, detection data or any other means to give accurate predictions. It is always between the *minimum* and *maximum* times. The *confidence* value indicates the level of confidence of the *likely* time. **Note:** The *confidence* value is defined to be compliant with the [SAE-J2735] Signal Phase and Timing (SPAT) messages  |

|  |  |
| --- | --- |
| Req-ID | IRS-VLOG3-005 |
| Title | TTG and RGT update |
| Description | A TTG or RGT update shall be sent when the expected times have changed. The number of messages shall be limited by sending one message at most every 1 second. For changes less than one second no update shall be sent. Changes more than 10% of the current value will lead to an update. |
| Source |  |
| Comment | The intention is to avoid congestion of messages.It is allowed to limit the number of messages even further when the impact on the prediction is low. |

|  |  |
| --- | --- |
| Req-ID | IRS-VLOG3-006 |
| Title | Reason for Wait time |
| Description | It shall be possible to indicate a general reason for extra wait time. Each reason is either active or inactive. Examples of type of reasons: * Public transport priority
* Emergency vehicle priority
* Train crossing active
* Bridge intervention
* Height warning
* Weather intervention
* Traffic jam intervention
* Tunnel closed
* Dosing active

 (translations available in Appendix A) |
| Source | FSVLOG |
| Comment |  |

|  |  |
| --- | --- |
| Req-ID | IRS-VLOG3-007 |
| Title | Active environmental factors |
| Description | It shall be possible to indicate a change in active environmental factors. Each factor can be either active or inactive.Examples* Rain
* Mist
* Risk of slipperiness

(translations available in Appendix A) |
| Source | FSVLOG |
| Comment |  |

# Interface design

The interface design stated in this chapter is an extension of the [PVLOG2] document. Only V-Log messages needed to meet the requirements in chapter 3 are described in the next paragraphs.

## V-Log format

V-Log messages can be divided into three kind of messages. First, a time reference message. This Message marks the beginning of a V-Log cycle. Second, a status message, this message contains the actual state of a specific item, i.e. phase state or detection state. Third, a change message. These messages are sent on every state change relative to a status message or a previous change message. For data size optimization the status and change massages only contains a delta time relative to the time reference message.

### Time reference message

A time reference message only contains the date and time of the started V-Log cycle. For a detailed description see [PVLOG2].

### Status message

A status message has the following format:

<type> <delta-time / number> <data-1>..<data-number>

For a detailed description see [PVLOG2 section 2.3].

*<type> indication:*

|  |  |  |
| --- | --- | --- |
| **Message type** | **Data element length in bits** | **Data description** |
| 35 | n.a. | Reserved, see change message 36 see §4.1.3 |
| 37 | 16 | Reason for wait time per signal group |
| 39 | 8 | Environmental factors |

### Change message

A change message has the following format, depending on if the specific type has an index or not:

<type><delta time / number> <data-1>…<data-number>

Or

<type><delta time / number> <index/data-1>…<index/data-number>

For a detailed description see [PVLOG2 section 2.4].

*<type> indication:*

| **Change type** | **Index length in bits** | **Data length in bits** | **Output format and length in bits** | **Total length in bits** | **Description** |
| --- | --- | --- | --- | --- | --- |
| 36 | 8 | n | 8/variable | n | Phase timing per signal group. |
| 38 | 8 | 16 | 8/8/8 | 24 | Reason for wait time per signal group |
| 40 | n.a.(0) | 8 | 8 | 8 | Environmental factors |

## V-Log messages

V-Log 3 messages:

|  |  |  |
| --- | --- | --- |
| **Type** | **V-Log version** | **Related requirement** |
| Phase timing  | 3.0.0 | IRS-VLOG3-003IRS-VLOG3-004IRS-VLOG3-005 |
| Reason for wait time | 3.0.0 | IRS-VLOG3-006 |
| Environmental factors | 3.0.0 | IRS-VLOG3-007 |

### Phase timing

This information is available on the CVN-C interface CIF\_FC\_TIMING[FC][CIF\_MAX\_EVENT][8] where for every phase de current state, including corresponding timing, and possible one or more future state(s), including corresponding timing, is available. A phase state including the corresponding timing is called an event. The time to green and remaining green time can be derived from phase timing information.

V-Log phase timing is based on the SAE Signal Phase And Timing (SPAT) message definition [SAE-J2735]

Phase time is calculated by the application. Update frequency: minimal once a second when there is no significant change in the resulting absolute time. Significant changes in the resulting absolute time must be sent immediately.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **BIT** | **111-104(MSB)** | **103-96** | **95-88** | **87-0(LSB)** |
| **Meaning** | Number of events | Option mask | State | Timing |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **BIT** | **87-72** | **71-56** | **55-40** | **39-24** | **23-16** | **15-0** |
| **Meaning** | Start | Minimum | Maximum | Likely | Confidence | Next |

**Number of events:**

Contains the number of events per message. The number of events varies between 1 and CIF\_MAX\_EVENT, the current state including the corresponding timing and possible one or more future states, including corresponding timing.

**Option mask:**

Indicates for each event which of optional phase timing fields are available.

| **Bit** | **Meaning** |
| --- | --- |
| 0 | Reserved CVN-C interface, within V-Log always set to 1. |
| 1 | Start (1 = available, 0 = not available) |
| 2 | Minimum (1 = available, minimum is not optional; 0 means no timing information at all) |
| 3 | Maximum (1 = available, 0 = not available) |
| 4 | Likely (1 = available, 0 = not available) |
| 5 | Confidence (1 = available, 0 = not available) |
| 6 | Next (1 = available, 0 = not available) |

For example, when all of optional phase timing fields are available the option mask is set to 127 (binary: 01111111).

**State:**

Indicates the current or a future phase state. Range 0 – 9, where:

|  |  |
| --- | --- |
| **Value** | **Meaning** |
| 0 | Unavailable |
| 1 | Dark |
| 2 | Stop then proceed |
| 3 | Stop and remain |
| 4 | Pre-movement |
| 5 | Permissive movement allowed |
| 6 | Protected movement allowed |
| 7 | Permissive clearance |
| 8 | Protected clearance |
| 9 | Caution conflicting traffic |
| 10 | Permissive movement pre-clearance |
| 11 | Protected movement pre-clearance |

**Timing (Optional):**

All timing fields are relative to the generated V-Log message. The resulting absolute timestamp can be retrieved by calculating the sum of the <date/time> from the time reference message, the <delta-time> from the change message and the timing value itself.

**Start (Optional)**

Relative timestamp in 0.1 sec indicating the moment that a phase starts or has started. Range -32768 – 32767 where:

* -32766 – 32766: time in 0.1 sec
* -32767: time <= -32767
* 32767: time >= 32767
* -32768: time unknown

**Minimum:**

Relative timestamp indicating the minimum time a phase remains in the indicated state. Range -1 – 32767 where:

* 0 – 32767: time in 0.1 sec
* -1: time unknown

**Maximum (Optional):**

Relative timestamp indicating the maximum time a phase remains in the indicated state. Range -1 – 32767 where:

* 0 – 32767: time in 0.1 sec
* -1: time unknown

**Likely (Optional):**

Relative timestamp indicating the predicted time a phase state remains in the indicated state. Range -1 – 32767 where:

* 0 – 32767: time in 0.1 sec
* -1: time unknown

**Confidence (Optional):**

The confidence[[1]](#footnote-1) is a number that represents the percentage of probability that the predicted likely time falls within the bandwidth of 20% of the likely time. Range: -1 – 100% where -1 means unknown.

**Next (Optional):**

Relative timestamp indicating the moment a phase remains re-enters the indicated state. Range -1 – 32767 where:

* 0 – 32767: time in 0.1 sec
* -1: time unknown

### Reason for wait time

This information is available on the CVN-C interface CIF\_FC\_RWT[].

The reason for wait time is signal group specific.

|  |  |
| --- | --- |
| **Bit** | **15 – 0**  |
| **Meaning** | Bitmask reason for wait time |

**Bitmask reason for wait time:**

|  |  |
| --- | --- |
| **Bit** | **Reason** |
| 0 | Public transport priority |
| 1 | Emergency vehicle priority |
| 2 | Train crossing active |
| 3 | Bridge intervention |
| 4 | Height warning |
| 5 | Weather intervention |
| 6 | Traffic jam intervention |
| 7 | Tunnel closed |
| 8 | Dosing active |
| 9-15 | Reserved |

### Environmental factors

This information is available on the CVN-C interface CIF\_OMGEVING[].

Environmental factors are intersection specific and only applicable when the traffic controller is prepared with appropriate sensors.

|  |  |
| --- | --- |
| **Bit** | **7 - 0** |
| **Meaning** | Bitmask for Environmental factors |

**Bitmask Environmental factor:**

|  |  |
| --- | --- |
| **Bit** | **Environmental factor** |
| 0 | Rain |
| 1 | Mist |
| 2 | Risk of slipperiness |
| 3-7 | Reserved |

1. ABBREVIATIONS & CONCEPTS

**Abbreviations**

|  |  |
| --- | --- |
| Abbreviation | Description |
| IRS | Interface Requirements Specification |
| IDD | Interface Design Description |
| V-Log | Traffic data log |
| TLC | Traffic Light Controller |
| TCS | Traffic Central System |
| TTG | Time to green |
| RGT | Remaining green time  |

All other abbreviations are assumed as known.

**Concepts**

|  |  |
| --- | --- |
| Concept | Description |
| TLC middleware | The internal software of a TLC delivered by the manufacturer. Amongst others responsible for translating requested signal group states to actual hardware output. |
| Traffic application | The software inside a TLC that implements the traffic flow regulation. Based on traffic detection information it sends to the TLC middleware the desired signal group states. |
| Signal group | Traffic signaling for one driving direction. |

**Translations**

|  |  |
| --- | --- |
| English | Dutch |
| Bridge intervention | Brug ingreep |
| Dosing active | Doseren actief |
| Emergency vehicle priority | Hulpdienst ingreep |
| Height warning | Hoogtemelding |
| Mist | Mist |
| Public transport priority | OV ingreep |
| Rain | Regen |
| Risk of slipperiness | Kans op gladheid |
| TLC Middleware | Procesbesturing |
| Traffic application | Regelapplicatie |
| Traffic Central System | Verkeerscentrale  |
| Traffic jam intervention | File ingreep |
| Traffic Light Controller | Verkeersregelautomaat |
| Traffic signal installation  | Verkeersregelinstallatie |
| Train crossing active | Trein ingreep |
| Tunnel closed | Tunnel afsluiting |
| Weather intervention | Weersingreep |

1. Example 1: The prediction is 100 seconds, which means the prediction is assumed correct if start green is realized between 80 and 120 seconds. The probability indicates this with a value in percent. So if in this case the probability is 11 (91%) in 91 of the 100 cases the start green will be in 95 to 105 seconds.

Example 2: The prediction is 10 seconds, which means the prediction is assumed correct if start green is realized between 8 and 12 seconds. The probability indicates this with a value in percent. So if in this case the probability is 11 (91%) in 91 of the 100 cases the start green will be in 9.5 to 10.5 seconds. [↑](#footnote-ref-1)