iVRI Interface
V-log

IRS IDD V-log 3.0 version 2.5.2

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 V-log

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.

Document control sheet

Document versions:

Version	Date	Author	Comment
1.0	2016-01-22	WG1	Initial version
1.1	2016-01-29	WG1	Final draft
1.2	2016-11-23	WG1	Final

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Contents

1 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.

1.1 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).

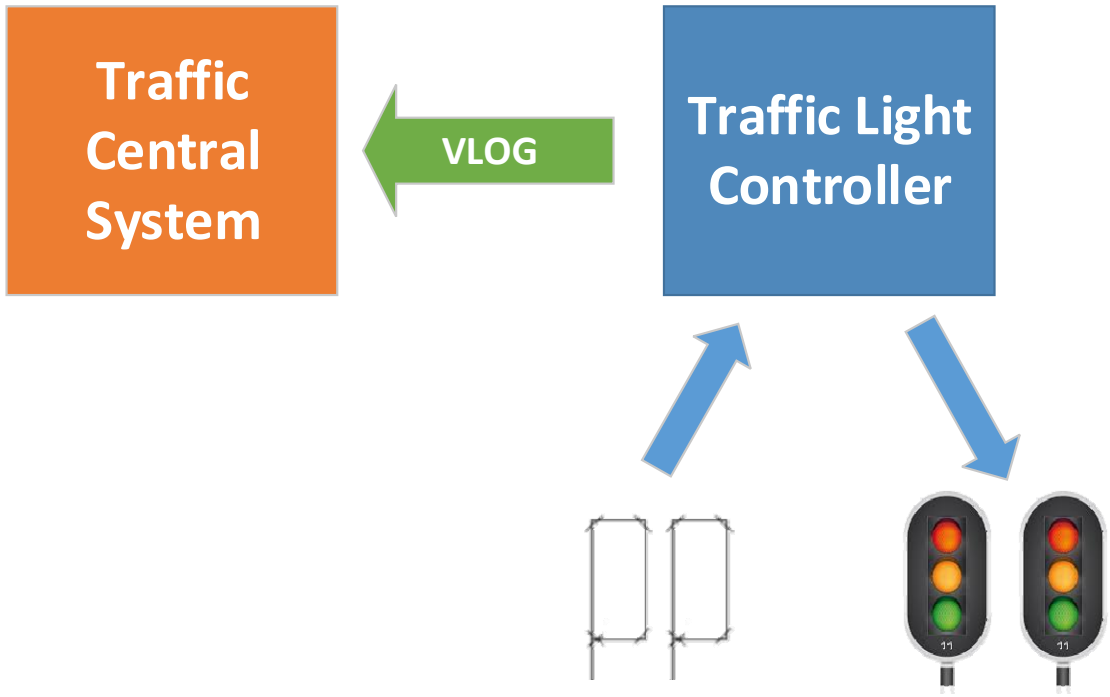
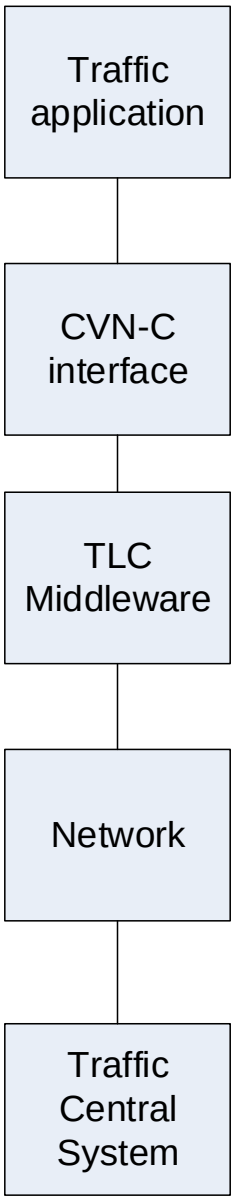


Figure 1 System overview

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 data
2. File based V-Log data
3. 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.

1.2 Document overview

1.2.1 Purpose

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

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 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].
0 contains acronyms, definition of concepts and Dutch to English translations of central terminology.

1.2.3 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.

2 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.

3 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. 4. *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. 4. *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 0)
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 0)
Source	FSVLOG
Comment	

4 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.

4.1 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.

4.1.1 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].

4.1.2 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

4.1.3 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

4.2 V-Log messages

V-Log 3 messages:

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

4.2.1 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] 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

4.2.2 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

4.2.3 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] 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.

Appendix 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

Colophon

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