Project Specific Technical Specification

Transport and Main Roads
PSTS003 HMI Equipment

August 2021

Queensland
Government

Document control sheet

Contact for enquiries and proposed changes

If you have any questions regarding this document or if you have a suggestion for improvements, please contact:

Contact officer   Miranda Blogg

Title   Director (CAVI)

Phone   07 3066 8251

Version history

Version no.	Owner	Date	Nature of amendment
1.0	Katharine Mosley	29/06/2018	Tender Issue
1.1	Katharine Mosley	20/03/2019	Minor Updates
1.2	David Alderson	06/07/2019	Updates to match learnings from implementation
1.3	Zinah Tam	27/07/2020	Updated Table 7.2 to match final incorporation of HUET recommendations
1.4	Zinah Tam	06/10/2020	Updated Table 7.2 to match release 25.2
1.5	Geoffrey McDonald	02/11/2020	Minor edits
1.6	Jian Qin	18/08/2021	Update Figure 5.1

Copyright

Contents

1   Introduction

This Technical Specification defines the supply and commissioning, performance, documentation, training and maintenance requirements for Human Machine Interface (HMI) and associated equipment.

The HMI consists of the HMI Hardware, communication interface, cabling and any software required to enable correct operation.

This Technical Specification shall be read in conjunction with *V-ITS-S Specifications PSTS002*.

The HMI is the primary interface between the V-ITS-S and the driver. The key functions of the HMI are:

- present C-ITS use case information/warnings as triggered by the V-ITS-S to provide an intervention on driver behaviour for the safety evaluation
- present other information/warnings (e.g. start-up, failures, out of pilot area) to all or a sub-set of participants – to keep participants informed of system operation and to support system performance monitoring, safety evaluation, and ethics/data privacy obligations.

2   Definition of Terms

Table 2-1 – Acronyms

Acronym	Term
ACMA	Australian Communications and Media Authority
ARLW	Advanced Red Light Warning
AS	Australian Standard
ASN.1	Abstract Syntax Notation One
BoQ	Back of Queue
C-ITS	Cooperative intelligent transport systems
C-ITS-F	Central ITS facility
CSEM	CAVI Safety Evaluation Message
DC	Direct Current
EEBL	Emergency Electronic Brake Light
ETSI	European Telecommunications Standards Institute
ETSI EN	European Telecommunications Standards Institute European Norm
ETSI TS	European Telecommunications Standards Institute Technical Standard
FOT	Field operational test
GNSS	Global Navigation Satellite System
HMI	Human machine interface
IEEE	Institute of Electrical and Electronic Engineers
IF	Interface
IP	Ingress Protection
ISO	International Organization for Standardization
ISO/TS	International Organization for Standardization Technical Standard
ITS	Intelligent transport systems
IVS	In Vehicle Signage
LxWxH	Length x Width x Height
MAPEM	Map Data extended Message
NZS	New Zealand Standard
PSTS	Project Specific Technical Specification
RHW	Road Hazard Warning

Acronym	Term
RWW	Road Work Warning
SPATEM	Signal Phase and Timing Extended Message
SSH	Secure SHell
SSV	Slow/Stopped Vehicle
TCP/IP	Transmission Control Protocol/Internet Protocol
TLS	Transport layer security
TMR	Queensland Department of Transport and Main Roads
TTL	Time to Live
TWVR	Turning Warning for Vulnerable Road User
UPER	Unaligned Packed Encoding Rules
USB	Universal Serial Bus
UTC	Coordinated Universal Time
V-ITS-S	Vehicle ITS station

Table 2-2 – Definitions

Acronym/Term	Term Description
Control Group	Control Group refers to participants that do not receive the C-ITS intervention (that is, the HMI does not display use case warnings and speed limits) but whose data will still be analysed for the safety evaluation. Participants will be in the Control Group for all or part of their duration in the FOT.
FOT	Field Operational Test – the period when the in-vehicle C-ITS systems are operational and logging data.
HMI Presentation Manager	The HMI Presentation Manager describes an application or process on the V-ITS-S that services all requests and responses to the HMI (single point of control).
Presentation Handler	The Presentation Handler controls the content displayed and audio alerts generated on the HMI. The Presentation Handler is the interface to the HMI Presentation Manager and the displays required when the HMI does not have a connection to the HMI Presentation Manager.
Participant	Driver who is a consenting participant in the C-ITS Pilot.
Presentation	A presentation is when the HMI Presentation Manager requests control of a HMI display region. Only one presentation per region should be active at a given time. Some presentation requests may also include an audio alert.
Region	Defined area of the HMI screen for presentation of an image.
Use case warning	A warning presented by the HMI when C-ITS use case applications are triggered.

3 Reference Documents

The requirements of the referenced documents listed in Table 3 below apply to this specification.

Table 3-1 – Referenced documents – External

Document ID	Document Name / Description
AS 1044 (1995)	Radio Disturbance characteristics
AS ISO/IEC 27001 (2015)	Information technology - Security techniques - Information security management systems - Requirements
AS/NZS 60950.1 (2015)	Information technology equipment - Safety General requirements
AS 2578 (2009)	Traffic Signal Controllers
SAE J2945/1_201603	On-Board System Requirements for V2V Safety Communications
ETSI TS 102 687 V1.2.1 (2018-04)	Intelligent Transport Systems (ITS); Decentralized Congestion Control Mechanisms for Intelligent Transport Systems operating in the 5 GHz range; Access layer part
ETSI TS 103 301 V1.1.1 (2016-11)	Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Facilities layer protocols and communication requirements for infrastructure services
ETSI EN 302 665 V1.1.1 (2010-09)	Intelligent Transport Systems (ITS); Communications Architecture
ETSI EN 302 637-2 V1.3.2 (2014-11)	Intelligent Transport Systems (ITS);Vehicular Communications; Basic Set of Applications; Part 2: Specification of Cooperative Awareness Basic Service
IEEE 802.11(2016)	Wireless LAN (WLAN) & Mesh Standard
MRTS01(2017)	Introduction to Technical Specifications
MRTS50 (2017)	Specific Quality System Requirements
ACMA Radio communications (Intelligent Transport Systems) Class Licence 2017	

Table 3-2 – Referenced documents – Internal

Document ID	Document Name / Description
PSTS002	V-ITS-S Equipment
PSTS007	C-ITS Station Protocol Specification
PSTS011	Emergency Electronic Brake Light
PSTS012	Slow Stopped Vehicle
PSTS013	Advanced Red Light Warning
PSTS014	Turning Warning - Vulnerable Road user
PSTS015	Road Works Warning
PSTS016	Road Hazard Warning
PSTS017	Back of Queue
PSTS018	In Vehicle Speed

4   Quality System Requirements

Quality system requirements shall be in accordance with this Technical Specification and the requirements of the Contract (including the requirements of MRTS01).

4.1   Testing and Commissioning

The HMI testing shall follow the same testing and commissioning phases as the V-ITS-S. Therefore the testing requirements for this specification shall be met in accordance with the Quality Requirements of *V-ITS-S Specification PSTS002*.

5   System Requirements

5.1   C-ITS System Architecture

The HMI is a component of the broader C-ITS system architecture as shown in Figure 5-1 below. The internal device architecture of the HMI is designed to meet the operational and technical requirements of this specification. This architecture is determined by the Contractor.
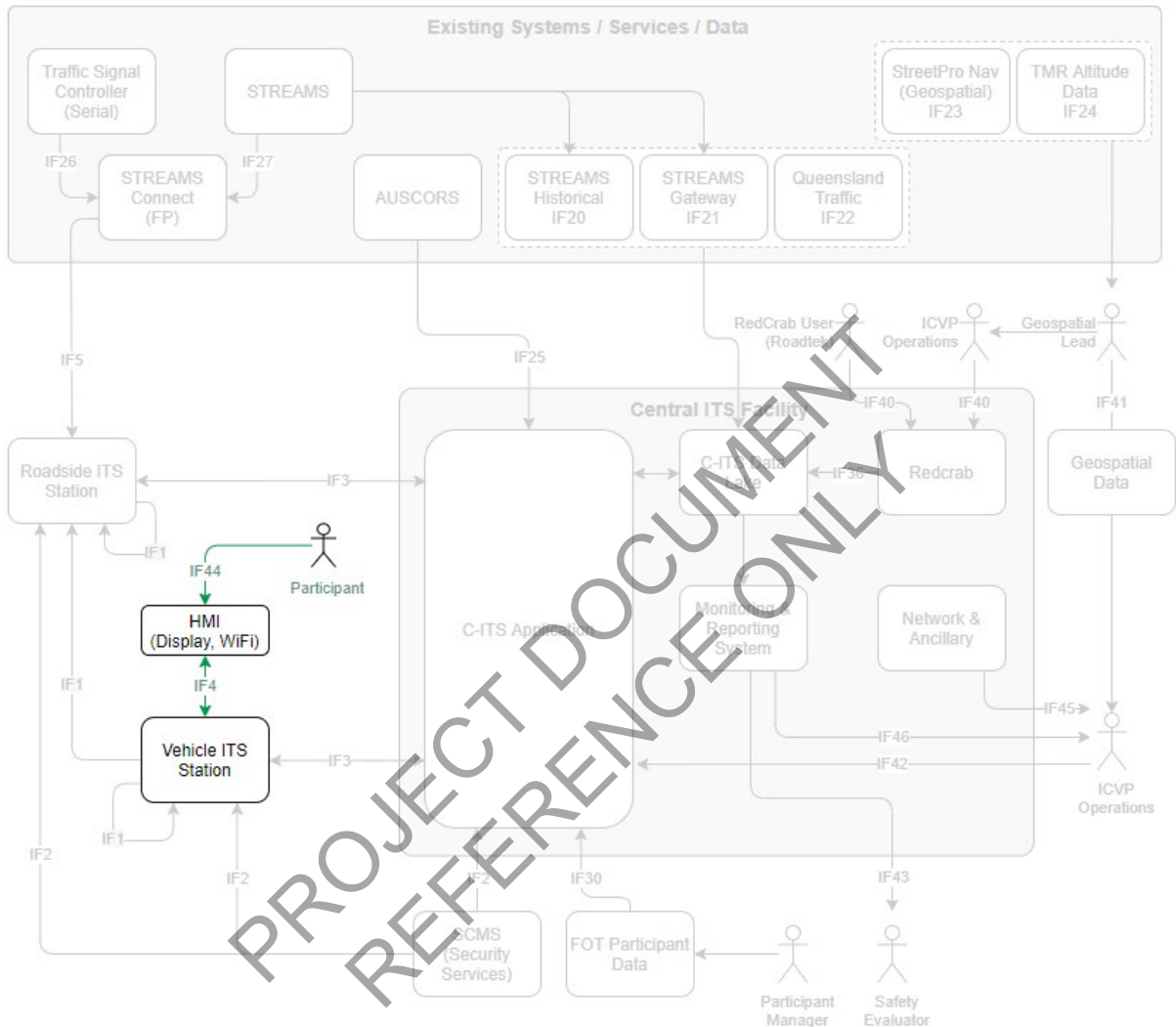

Figure 5-1 – HMI component in C-ITS system architecture

Table 5-1 presents the main HIM interfaces in the C-ITS Pilot.

Table 5-1- HMI component in C-ITS Pilot system interfaces

Interface	Description	Interface Type
C-ITS communications		
IF4	V-ITS-S ↔ HMI	UDP (802.11b/g/n)
Actors		
IF44	Participant → HMI	Human

Requirement: The HMI shall communicate through the V-ITS-S interface (IF4 in accordance with the system architecture (Figure 5-1). This interface shall be one of the following communications methods:

- Wireless connection (WIFI (IEEE 802.11:2016) or equivalent)

- Cabled connection (Ethernet, USB or equivalent)

Requirement: The HMI to V-ITS-S shall be 99% reliable when power is available to all equipment.

Requirement: The HMI shall provide support for the connection of V-ITS-S and accept presentation requests in accordance with the *V-ITS-S Specification PSTS002*.

Requirement: The HMI shall support the HMI Presentation Manager in the V-ITS-S by:

- Conforming with the data elements specified in *C-ITS Message Event and Station Platform Data* (refer to *V-ITS-S Specification PSTS002*)

- Providing a mechanism for updating software and configuration through the V-ITS-S.

6 Operational Requirements

6.1 HMI Visual Display

Requirement: The HMI shall have three regions for displaying visual content, as illustrated in Figure 6-1.

Figure 6-1 – HMI display regions

Requirement: The size and location of each display region shall be specified by the Principal.

Requirement: The HMI shall never have a blank screen while operational (ignition on), there shall always be an active display in one region.

Requirement: The HMI shall have four visual display layouts as follows:

- Login 1 Layout

- Login 2 Layout

- Use Case Layout

- General Layout

6.1.1   Login 1 Layout

There may be multiple participants per vehicle, as well as other drivers of the vehicle that are not participants. The HMI login will provide a selection process that enable differentiation between multiple participants and non-participants for the purpose of data logging, driver behavioural analysis and to meet ethical and privacy obligations.

Each participant will be assigned a Participant Code by QUT that will be unique to the participant. There may be changes to which participants are using a vehicle during the FOT, for example if a participant withdraws.

6.1.1.1   Regions 1 and 2

Requirement: In the Login 1 Layout, Regions 1 and 2 shall display text information. The region content shall be provided by the Principal as pre-defined images to avoid text rendering. Note that the pre-defined images provided for Region 1 are blank as per recommendations of the HMI Usability and Ergonomic Tests (HUET).

6.1.1.2   Region 3

Requirement: In the Login 1 Layout, Region 3 shall enable display of up to four Participant Codes as well as a Non-participant option. The codes must be selectable via touchscreen interaction.

Requirement: The touchscreen options in the Login 1 Layout shall be rendered in accordance with the requirements in Section 6.1.1 .

Requirement: The HMI Presentation Handler shall receive instruction on which Participant Codes to display in Region 3 of the Login 1 Layout via *participants* in the *Station Configuration Message*.

Requirement: The arrangement of touchscreen options in Region 3 of the Login 1 Layout shall vary depending on how many Participant Codes are assigned to the vehicle, as illustrated in Figure 6-2. It shall be possible to change which Participant Codes are displayed in Region 3 at each HMI start-up, based on updates from the Station Configuration Message.
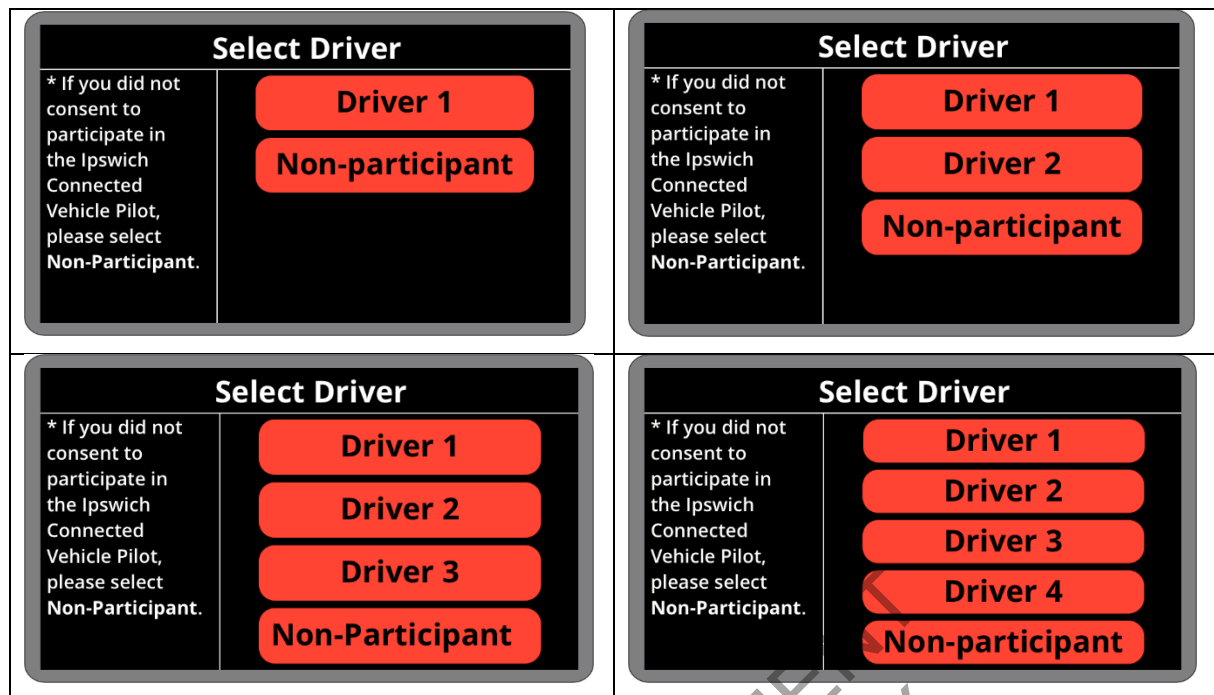
Figure 6-2: Indicative Login 1 Layout options

6.1.2 Login 2 Layout

If a driver has made an incorrect selection in the Login 1 Layout (that is, selected the wrong Participant Code), then they will be able to undo and re-select an option through the Login 2 Layout. If the correct selection was made in the Login 1 Layout, then no further action is required (that is, they are not required to re-confirm their selection).

Further, through the Login 2 Layout participants shall be able to adjust the display screen brightness based on their individual need/ preference, see Section 6.1.2.3.

6.1.2.1 Region 1

Requirement: In the Login 2 Layout, Region 1 shall display text information. The region content shall be provided by the Principal as pre-defined images to avoid text rendering.

6.1.2.2 Region 2

Requirement: As illustrated in Figure 6-4, in the Login 2 Layout, Region 2 shall display the selected participant code from the Login 1 Layout, as well as a touchscreen option that allows participants to undo their selection.

Requirement: The display in Region 2 of the Login 2 Layout shall be rendered in accordance with the requirements in Section 6.1.1.

6.1.2.3 Region 3

Requirement: As illustrated in Figure 6-4, in the Login 2 Layout, Region 3 shall display five touchscreen options for display screen brightness. The selected option shall be highlighted with a white border. This is illustrated in Figure 6-3. Note that these options appear removed as illustrated in Figure 6-4 (although the options are still available) as per recommendations of the HMI Usability and Ergonomic Tests (HUET).

Requirement: The display in Region 3 of the Login 2 Layout shall be rendered in accordance with the requirements in Section 6.1.1.
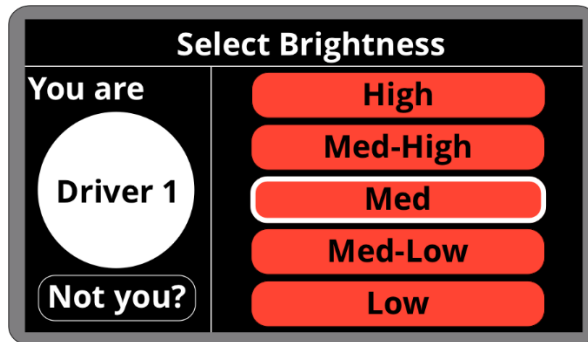

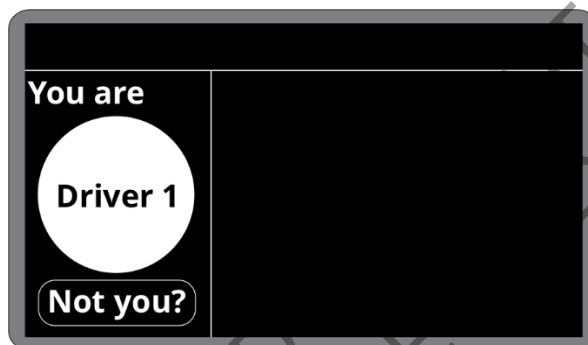**Figure 6-3 – Indicative Login 2 Layout**

Figure 6-4 – Indicative Login 2 Layout

6.1.3 Use Case Layout

Requirement: In the Use Case Layout, Region 1 shall display the system status (the Status Bar). Note that the pre-defined system status images provided for Region 1 are blank as per recommendations of the HMI Usability and Ergonomic Tests (HUET).

Requirement: In the Use Case Layout, Region 2 shall display speed limit information.

Requirement: In the Use Case Layout, Region 3 shall display use case warnings/ information.

An example of the Use Case Layout is provided in Figure 6-5.

Figure 6-5 – Example of Use Case Layout

6.1.3.1 Region 1

From the participant's perspective, the Status Bar represents confidence in the C-ITS use case information/warnings presented by the HMI. Note that as per recommendations of the HMI Usability and Ergonomic Tests (HUET), Region 1 appears blank at all times. However, the HUET also recommends that future iterations display system messages, albeit different system messages to represent confidence to the participant.

Requirement: There shall always be an active display of Status Bar in Region 1 in the Use Case Layout. Note that whilst there is always an active display in Region 1, these images are blank, so the participant does not perceive anything in Region 1.

Requirement: The HMI visual display and functionality for the Status Bar shall be co-designed between the Principal and Contractor.

Requirement: The Status Bar shall represent the "health" of the in-vehicle system (relating to operational/failed state of V-ITS-S GNSS (time synchronisation), 3G/4G and augmentation) as presented by the HMI Presentation Manager in the *V-ITS-S Specification PSTS002*.

Requirement: The Status Bar shall not be used to present system failure displays.

Requirement: The Status Bar shall be white (that is, colour shall not be used as an indicator of system health). Note that in the current iteration these appear black/blank, and recommendations of future iterations of the Status Bar remains white.

6.1.3.2 Region 2

The HMI Presentation Manager will determine the priority speed limit for display based on notifications from the In-Vehicle Speed use case and Road Works Warning use case applications.

Requirement: In the Use Case Layout, Region 2 shall display speed limits as presented by the HMI Presentation Manager in accordance with the V-ITS-S Specification PSTS002, In-Vehicle Speed Use Case Specification PSTS018 and Road Works Warning Use Case Specification PSTS015.

Requirement: There shall always be an active display of speed information in Region 2 in the Use Case Layout. If the current speed limit is not known by the V-ITS-S, the IVS_UNKNOWN speed image (see Appendix A for all image identifiers) will be presented by the HMI Presentation Manager.

6.1.3.3 Region 3

Requirement: In the Use Case Layout, Region 3 shall display C-ITS use case warnings/ information as presented by the HMI Presentation Manager in accordance with the *V-ITS-S Specification PSTS002* and *Use Case Specifications PSTS011 to PSTS017*. The Use Case Warning Region shall support the following use cases:

- PSTS011 – Emergency Electronic Brake Light (EEBL)

- PSTS012 – Slow Stopped Vehicle (SSV)

- PSTS013 – Advanced Red Light Warning (ARLW)

- PSTS014 – Turning Warning – Vulnerable Road user (TWVR)

- PSTS015 – Road Works Warning (RWW)

- PSTS016 – Road Hazard Warning (RHW)

- PSTS017 – Back of Queue (BOQ)

Requirement: When the Use Case Layout is operational, if none of the use case warning presentations are requested by the HMI Presentation Manager then Region 3 shall remain blank.

Requirement: In the Use Case Layout, Region 3 shall allow for the addition and removal of other use cases as requested by the Principal.

6.1.4 General Content Layout

The General Content Layout shall be used to present all other displays. An example of a General Content Layout is provided in Figure 6-6.

Figure 6-6 – Example of General Content Layout

6.1.4.1 Region 1

Requirement: In the General Content Layout, Region 1 shall be blank.

6.1.4.2 Region 2 and 3

Requirement: In the General Content Layout, Region 3 shall display general content images (e.g. relating to start-up and failures, as illustrated in Appendix A) and Region 2 is blank. This is except for out-of-pilot, which is displayed in Region 2 and Region 3 is blank (see Figure 6-7). These displays may be presented by the HMI Presentation Manager in the *V-ITS-S Specification PSTS002* or generated independently by the HMI.
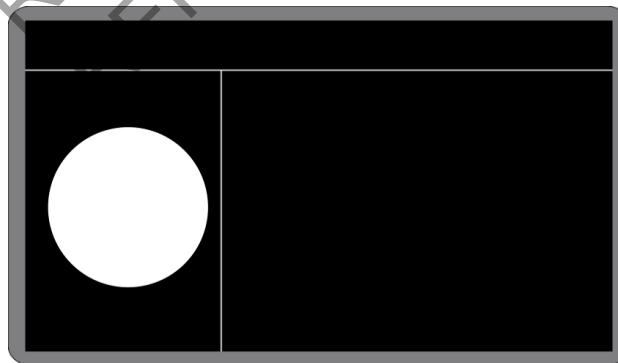
Figure 6-7 – Example of Out of Pilot

6.1.5 Image Files

Unless otherwise indicated, all images to be displayed on the HMI, as described in this Specification, will be provided by the Principal as pre-defined images to avoid text rendering. Each image is

assigned a unique identifier that will be included in the request from the HMI Presentation Manager in the V-ITS-S. Refer to Appendix A for a list of identifiers and indicative images.

Requirement: On request from the HMI Presentation Manager, the HMI shall display the image file with the corresponding unique identifier. Each image file shall be associated to a single display layout/region as defined in Appendix A and shall completely fill the region.

Requirement: The HMI shall display all aspects of the images including the colours and text.

6.2 HMI Audio

6.2.1 Audio Sounds

Audio sounds are only relevant to High-Level use case warnings, and occur concurrently with the visual display of High-Level use case warnings in Region 3 of the Use Case Layout. The HMI audio supports the following use cases:

● PSTS011 – Emergency Electronic Brake Light (EEBL)

● PSTS012 – Slow Stopped Vehicle (SSV)

● PSTS013 – Advanced Red Light Warning (ARLW)

● PSTS014 – Turning Warning – Vulnerable Road user (TWVR)

● PSTS015 – Road Works Warning (RWW)

Requirement: The HMI shall play audio as requested by the HMI Presentation Manager in the V-ITS-S, in accordance with *V-ITS-S Specification PSTS002* and *Use Case Specifications PSTS011 to PSTS015*.

Requirement: Audio for Use Case High-level Warnings shall not be repeated unless a new Use Case High-level Warning is requested by the HMI Presentation Manager in the V-ITS-S, in accordance with *V-ITS-S Specification PSTS002*.

Requirement: The HMI shall be capable of adding or removing audio to all warning identifiers.

6.2.2 Audio Files

All audio to be issued via the HMI, as described in this Specification, will be provided by the Principal. Each audio file will have a unique identifier that will be included in the request from the HMI Presentation Manager in the V-ITS-S. Refer to Appendix A for a list of identifiers.

Requirement: The HMI shall manage and activate audio in a format agreed between the Contractor and the Principal.

6.3 Presentation Handler

The Presentation Handler controls the content displayed and audio alerts issued by the HMI. The Presentation Handler is the interface to the HMI Presentation Manager as defined in *V-ITS-S Specification PSTS002* and manages the displays required when the HMI does not have a connection to the HMI Presentation Manager.

Requirement: The HMI shall:

- Handle and implement presentation requests (visual display and audio) from the HMI Presentation Manager as defined in *V-ITS-S Specification PSTS002* (for example, use case warnings, speed limits, status, Control Group and general content)

- Process and implement visual displays independently generated by HMI (for example start-up, participant selection, failures, shut-down)

- Acknowledge presentation (visual display and audio), and report presentations (independent and HMI Presentation Manager requested) for each region to the V-ITS-S

- Monitor HMI state and report status information (for example, volume and brightness/contrast settings) to the V-ITS-S.

Each request sent to the HMI from the HMI Presentation Manager in the V-ITS-S will have a duration. The V-ITS-S HMI Presentation Manager will refresh presentation requests for them to persist for longer than the duration.

Requirement: The HMI shall monitor presentation updates and duration of the presentation requests from the V-ITS-S. The HMI shall display a communication timeout failure in accordance with section 6.3.4.2 if the duration fails to be updated.

Requirement: The HMI shall provide acknowledgement of presentation requests by the V-ITS-S and shall include:

- Present Event identifier (an identifier for the presentation request by the V-ITS-S)

- Displayed HMI message identifier (an identifier for the image/ audio that was presented by the HMI, refer to Appendix A)

- Participant Code

- HMI display state – including volume and brightness settings.

Requirement: This data shall provide sufficient information to allow the V-ITS-S to log system and event data as part of the *C-ITS Message Event* and *Station Platform* messages, as defined in *V-ITS-S Specification PSTS002*.

Requirement: When independently implementing visual displays (that is, the visual display is not requested by the HMI Presentation Manager), the HMI shall ensure that if the vehicle is no longer stationary the current display has been presented for at least 2 seconds before replaced with a new display.

6.3.1 HMI Display Priority

While use case warning, speed limit and some general content notification prioritisations are managed by the HMI Presentation Manager, the Presentation Handler needs to handle prioritisation between HMI generated content and V-ITS-S generated content.

Requirement: The HMI shall prioritise display in the following order:

1. HMI start-up (section 6.3.2)

2. HMI shutdown (section 6.3.6)

3. Login 1 and 2 displays (section 6.3.3)

4. Non-participant display (section 6.3.3)

5. HMI failures (section 6.3.4)

6. HMI Presentation Manager requests (section 6.3.5)

6.3.2 Start-Up

Requirement: The HMI shall become active when the vehicle's ignition is turned on regardless of last power state (for example sleep, powered off).

Requirement: The HMI shall automatically connect with the V-ITS-S without user intervention.

Requirement: The HMI shall present the HMI_WAITING image in Region 3 of the General Content Layout while the HMI is waking-up.

Requirement: The HMI shall present the HMI_SYS_UPDATE image in Region 3 of the General Content Layout if the HMI is updating during start-up (section 7.3).

Requirement: If the vehicle is no longer stationary whilst a HMI software update is still in progress, then the HMI will skip the participant login process and operate as if for a Non-participant (refer to Section Participant Login6.3.3).

6.3.3 Participant Login

Requirement: The HMI shall present the Login 1 Layout typically within 2 seconds of vehicle ignition and a maximum of 10 seconds. This shall occur after HMI start-up and independently of the V-ITS-S start-up. Note that this requirement has degraded to presentation of Login 1 Layout typically within 4 seconds due to results in extensive testing.

Requirement: The Login 1 Layout shall only be displayed when the vehicle is stationary (within a geofence of the vehicle starting location or movement (speed) detected with an accelerometer or equivalent). The detection of stationary shall not be dependent on the V-ITS-S as the vehicle may move prior to the HMI and V-ITS-S connecting. There should be a redundancy measure (for example, fixed time period of 60 seconds) whereby vehicle movement is assumed, to reduce driver interaction with the HMI.

Requirement: The HMI shall apply the configuration settings that were uploaded in the *Station Configuration* on the previous HMI start-up.

Requirement: Once a participant selection has been made, and provided the vehicle is still stationary, the HMI shall present the Login 2 Layout.

Requirement: The Login 2 Layout shall remain on the display screen until the vehicle is no longer stationary.

Requirement: If the participant selects the touchscreen option in Region 2 of the Login 2 Layout, ("Not you" as shown in Figure 6-4), then the Login 1 Layout shall be re-presented. Once the participant has re-selected, and if the vehicle is still stationary, Login 2 Layout shall also be re-presented.

Requirement: Once the vehicle is no longer stationary, the Login 1 Layout and Login 2 Layout shall not be displayed again until the next time the ignition is turned on.

Requirement: If the vehicle is no longer stationary and the V-ITS-S has not completed start-up (that is, waiting for connection between HMI and V-ITS-S), then the HMI shall present the HMI_WAITING image in Region 3 of the General Content Layout (section 6.1.4).

Requirement: The HMI shall present the NOT_IN_OPERATION image in Region 3 of the General Content Layout (section 6.1.4) if a Non-participant is selected (noting Regions 1 and 2 shall remain blank in this layout). The HMI shall inform the HMI Presentation Manager that the NOT_IN_OPERATION image is displayed.

Requirement: The HMI shall retain the NOT_IN_OPERATION image for Non-participants until the next time the ignition is turned on.

Requirement: If no participant selection is made (at all or prior to the vehicle moving), then the HMI shall operate in the same hmi*Enabled* mode as for a participant based and select participant *unknown*. The HMI shall report back to the V-ITS-S the participant selection (that is, the selected Participant Code, Non-participant, or Unknown if no selection is made).

6.3.4   HMI Failures

6.3.4.1   System Start

Requirement: The HMI shall present the HMI_SYS_ERROR_CONNECT image in Region 3 of the General Content Layout if the HMI does not connect to the V-ITS-S within a specified period (for example, 3 minutes).

6.3.4.2   Presentation Duration Timeout

Requirement: The HMI shall present the HMI_SYS_ERROR_TTL image in Region 3 of the General Content Layout if the HMI Presentation Manager does not refresh a message before the presentation duration (Time-To-Live (TTL)) expires.

6.3.5   HMI Presentation Manager Requests

Requirement: The HMI shall use the information presented by the HMI Presentation Manager to display in the relevant regions and generate audio in accordance with Table 6-1.

Table 6-1 – HMI Presentation Manager to HMI Presentation Handler regions

HMI Presentation Manager (PSTS002)	HMI Visual Display Layout/ Region
Use Case Warnings	Use Case Layout, Region 3 (section 6.1.3.3)
Speed Limits	Use Case Layout, Region 2 (section 6.1.2)
Station Status	Use Case Layout and General Content Layout, Region 1 (section 6.1.2)
Control Group	General Content Layout, Region 3 (section 6.1.4)
General Content	General Content Layout, Region 3 (section 6.1.4)

Requirement: For Control Group and de-activated participants, the HMI shall not act on requests to present Use Case Warning and Speed Limit images or audio, and instead will display the CONTROL image in the General Content Region. The HMI shall inform the HMI Presentation Manager that the CONTROL image is displayed.

6.3.6   Shutdown

Requirement: The HMI shall turn off safely with vehicle ignition switch off. HMIs may enter a sleep mode or equivalent shortly after ignition switch off instead of turn off, however, the HMI display screen must be blank.

6.3.7 Restart

Requirement: If a restart/reset occurs, the HMI shall follow the shutdown and start-up procedures.

6.3.8 Other Applications

Requirement: All other HMI applications and system functions (for example, notification bar, menu, home screen access, and so on) not defined in this Specification shall be permanently disabled.

7 Management

7.1 Display Screen

7.1.1 Type

Requirement: The HMI shall support participant selection input from the driver via touchscreen capability.

Requirement: The display screen shall provide a visual interface for clearly displaying all content described in section 6.1 and Appendix A for safety awareness purposes (for example, a minimum pixel resolution of 800 x 480 is considered appropriate).

7.1.2 Size

Requirement: The HMI display screen shall be 3.5 inches minimum (measured on the diagonal).

Requirement: The HMI enclosure shall be 6 inches maximum (measured on the diagonal).

7.1.3 Display On-Set and Flashing

Requirement: C-ITS use case Medium-Level and High-Level warning images (Appendix A) shall appear abruptly with an onset of less than 50 milliseconds.

Requirement: C-ITS use case Low-Level information images (Appendix A) and all other image displays shall occur with an onset of no more than 1000 milliseconds.

Requirement: All HMI image displays shall be static (not flashing).

7.1.4 Contractor-designed Presentation

For all other displays that are not defined in Appendix A but may be presented on the HMI, the guidelines in sections 7.1.4.1 and 7.1.4.2 apply. These guidelines do not apply to HMI displays used for diagnostics/maintenance.

Requirement: Audio shall not be used for Contractor-designed presentations.

Requirement: All Contractor-designed visual displays shall be presented in the General Content Layout.

Requirement: The HMI shall not display Contractor logos or other corporate branding (including during start-up and shut-down).

Requirement: Contractor-designed displays shall be approved by the Principal.

7.1.4.1 Icons

Requirement: Contractor-designed images shall not use icon shapes (or close similarities) used for C-ITS use case information/warnings as displayed in Regions 2 and 3 of the Use Case Layout (refer to Appendix A).

Requirement: All Contractor-designed icons shall be white on a black background.

Requirement: No icon shall be smaller than the optimum visual angle. Based on an assumed maximum distance of 80 cm between driver eye and HMI, no icon on the HMI shall be smaller than 80cm x Tangent (1.42 degrees) = 2cm.

7.1.4.2 Text

Requirement: If any other text information is to be presented on the HMI, it shall comply with the following specifications:

- Google Open Sans font

- Mixed case (initial capital letters for multiword labels)

- Character width-to-height ratio range of 0.6 to 0.85

- Negative display (white text on a dark/black background)

- Brief labels (two to three words)

- Spacing between lines at least 1/30 the line length

- No boldface, italics, underlining, or differences of colour.

7.1.5 Brightness and Contrast

Requirement: The HMI shall automatically adjust the display according to night and day conditions following ISO 15008:2017.

Requirement: The HMI shall have controls to allow the user to adjust the screen brightness from minimum to maximum settings in accordance with ISO 15008:2017. Note that these options appear removed as illustrated in Figure 6-4 (although the options are still available) as per recommendations of the HMI Usability and Ergonomic Tests (HUET). This is illustrated in Figure 6-4.

Requirement:

7.2 Control and Configuration

During the C-ITS Pilot, control and configuration of key system parameters will be required.

Requirement: The HMI shall retrieve/update HMI relevant configuration (such as image content) from the V-ITS-S based on the configuration updates defined in *V-ITS-S Specification PSTS002*.

7.3 Software Updates

Requirement: The HMI shall support the download, update, activation and maintenance of application software through the V-ITS. HMI application software updates shall be received via the V-ITS-S either as a HMI software update relay or tunnel through V-ITS-S to the C-ITS-F HMI software update service.

Requirement: The HMI shall download available software updates without impact to current trip operation and not require any participant interaction.

Requirement: The HMI shall apply downloaded software updates at the next start of a trip. (For example a software update shall be downloaded on a previous trip but not applied until the next HMI start-up).

7.4 Remote Maintenance

Requirement: It is desirable for any remote maintenance functions of the HMI to be undertaken via the SSH connection to the V-ITS-S as specified in *V-ITS-S Specification PSTS002*. Other connection methods will be considered at the discretion of the Principal. Contractor-specific diagnostic tools shall be used to access the HMI device remotely to undertake remote maintenance activities as required.

Contractors may choose to display detailed diagnostic information on the HMI display screen.

Requirement: Contractor-specific diagnostic information shall not be displayed to pilot participants.

8 Technical Requirements

8.1 On/ Off/ Reset Controls

It is intended that vehicle users will not be able to power on/off the device themselves. If a participant withdraws, or are being removed from the FOT, they will be instructed by the FOT Participant Manager to select 'non-participant' during the participant selection process until the in-vehicle system can be de-installed.

Requirement: On/off/reset controls on the HMI shall be disabled or not be accessible for user control.

Requirement: All power and data connections to the HMI shall be fixed/secure to minimise tampering by vehicle users.

8.2 Audio and Volume

Requirement: The HMI shall play audio through an integrated speaker.

Requirement: The HMI shall not have controls to allow the user to adjust the audio volume.

Requirement: The HMI shall allow audio volume within a range of 50 to 84 dBA (at 80cm in open space).

Requirement: The HMI shall monitor ambient background noise (masked threshold) and adjust the output volume to 15 dBA (at 80cm in open space) above the masked threshold up to the maximum range.

8.3 Storage

Requirement: The HMI shall locally store (non-volatile memory) of all image and audio files to be presented. These shall be prepared and uploaded prior to installation and be updatable through the V-ITS-S.

Requirement: The list of Participant Codes and HMI software updates received via the V-ITS-S shall be downloaded to non-volatile storage.

Requirement: The HMI shall make allowance for any other Contractor-specific storage requirements for applications internal to the HMI.

8.4 Communications Access

Requirement: The HMI shall provide secure login for any remote or local access communications (for example SSH, FTP, SFTP, SCP).

Requirement: The HMI privacy-related data shall be developed in accordance with, and with due regard to, AS/NZS 17799, and AS/NZS 7799.2.

9 Electrical Requirements

9.1 Connection to Vehicle Battery System

Requirement: All equipment shall operate on a nominal 12V DC with battery output Voltage range from 11.5V to 14V.

Requirement: Maximum power load of the HMI shall be no greater than 50% of the rated current of the vehicle accessory circuits or 30W whichever is lesser.

Requirement: The HMI will be powered by a relay activated circuit driven by the ignition circuit of the vehicle. This will energise on start-up of the vehicle and de-energise on switch off of the vehicle. The HMI shall safely start-up and shut-down. Additional electrical equipment required to manage start-up or shut-down beyond a standard automotive relay shall be provided by the Contractor. The HMI and all associated equipment (including V-ITS-S) shall draw less than 300mW for low power "standby" needs if a direct connection to the vehicle battery is used as the main power source.

Requirement: If the Contractor provides a HMI with internal battery backup, sleep and wake mechanisms may be used. If the HMI is powered off, the HMI shall power on, initialise and operate when the power connection is energised.

9.2 Electrical Safety

Requirement: Telecommunication and radio equipment shall comply with the relevant regulatory requirements and standards of Australian Communications and Media Authority (ACMA).

Requirement: All electrical equipment shall be in accordance with the Electrical Legislation. The equipment shall not suffer damage if any of the terminations are open circuited, short circuited or disconnected while energised.

Requirement: All HMI equipment shall comply with the requirements of AS/NZS 60950.1.

Requirement: Electromagnetic interference produced by the equipment shall not exceed the limits prescribed in AS 1044 and by the ACMA. Equipment shall be immune to electromagnetic interference from other sources

10 Mechanical and Physical Requirements

10.1 Environmental Conditions

Requirement: The equipment shall be capable of continuous, normal operation in the conditions described below:

   a) installed in a vehicle dash mount environment
   b) installed directly in sunlight
   c) operating ambient air temperature range between –5°C and 70°C
   d) a humidity of up to 95% non-condensing
   e) vibrations reasonably expected in the installed location
   f) a minimum IP Rating of IP20.

Requirement: Equipment operation shall cause no adverse effect on the vehicle environment in which it is installed. Likewise, equipment shall not be affected by adverse environmental conditions expected during typical vehicle operations, such as vibrations and high in-vehicle temperatures.

10.2   HMI Size and Mounting

The positioning of the HMI will be in accordance with TMR's *Vehicle Standards Instruction (General 3.2) – Fitting of visual display units in vehicles* (2014). The HMI positioning must not breach the Australian Design Rules or obscure the driver's forward field of view or any pre-installed displays within the vehicle dash.

The HMI is intended to be located within areas A, B1 and D in Figure 10-1 (noting that this figure is indicative only and it is expected that the majority of participant vehicles will be right hand drive). Area A is within ± 15 degrees of the drivers' central line of sight, and is the preferred location with the HMI being located as close to the central line of sight as practicable. Area B1 and D1 is also desirable to minimise glare.

Requirement: The HMI physical characteristics shall allow the installation of the HMI to be performed in accordance with the Australian Design Rules.

Requirement: The HMI shall be robust to minimise the risk of physical damage to the equipment.
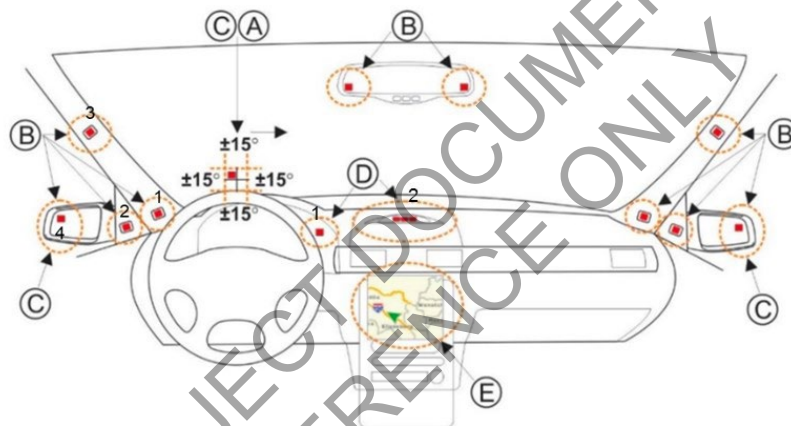
Figure 10-1 – HMI mounting locations (Campbell et al. 2016)[1]

10.3   Cabling Requirements

Requirement: Physical interconnections shall be captive, (in the following order of preference):

- manual "click" type (such as retention clips), and

- screw-type.

Requirement: All cables including power (minimum 5m length) and communications (minimum 5m length) shall be provided by the Contractor. The HMI cabling may combine communications and power.

---

[1] Image source: J. L. Campbell et al. (2016) Human factors design guidance for driver-vehicle interfaces (Report no. DOT HS 812 360). Washington, DC: National Highway Traffic Safety Administration.

11 Installation

Requirement: The HMI shall be configured at installation in accordance with *V-ITS-S Specification PSTS002*.
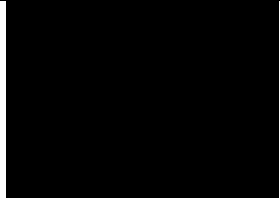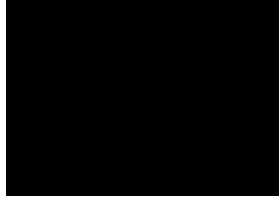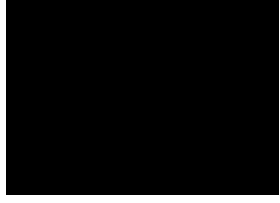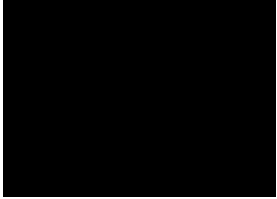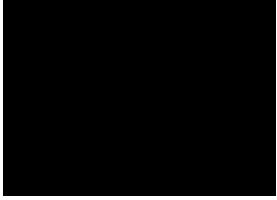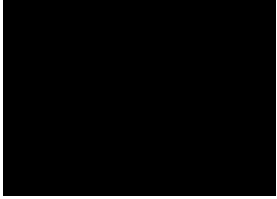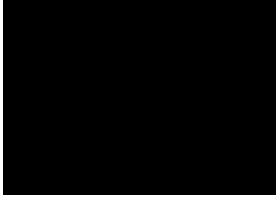
Appendix A   Warning Library

All image files will be provided by the Principal. An indicative list of images, file unique identifiers and audio associations are detailed in Table 11-1, noting that this list may not be all inclusive and images relating to the Status Bar (Region 1) are not yet defined. The images are subject to change and will be tested to validate driver comprehension/usability and contrast. The category refers to the origin of the image display request (HMI or V-ITS-S generated).
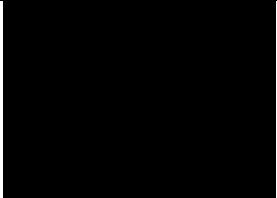
Table 11-1 – Warning library
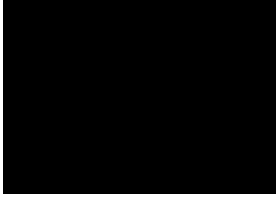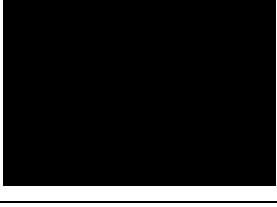
Unique identifier	Description	Category	Display layout/ region	Audio File associated (Y = yes)	Indicative image
LOGIN_1_REGION 1	Text instruction to participant	HMI	Login 1 Layout/ Region 1		Refer to Figure 6-2
LOGIN_1_REGION 2	Text instruction to participant	HMI	Login 1 Layout/ Region 2		Refer to Figure 6-2
LOGIN_2_REGION 2	Text instruction to participant	HMI	Login 2 Layout/ Region 2		Refer to Figure 6-4
HMI_WAITING	HMI waking-up or not yet connected to V-ITS-S	HMI / V-ITS-S	General Content Layout – Region 3		
HMI_SYS_UPDATE	HMI updating	HMI / V-ITS-S	General Content Layout – Region 3		
NOT_IN_OPERATION	Non-participant selected	HMI	General Content Layout – Region 3		
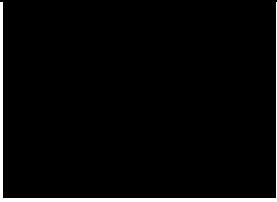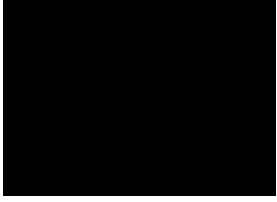
HMI_SYS_ERROR_CONNECT	HMI and V-ITS-S connection failure	HMI	General Content Layout – Region 3		
HMI_SYS_ERROR_UPDATE	HMI update failure	HMI	General Content Layout – Region 3		
HMI_SYS_ERROR_TTL	Message duration expiry	HMI	General Content Layout – Region 3		
CONTROL	Control Group	HMI	General Content Layout – Region 3		
OUT_OF_ AREA	Vehicle is out of pilot area	V-ITS-S	General Content Layout – Region 3		Refer to Figure 6-7
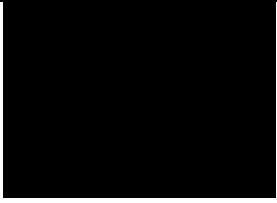
STATION_ERROR	V-ITS-S critical failure, such as continued communication failure	V-ITS-S	General Content Layout – Region 3		
EEBL_HIGH	EEBL High-Level (RED) warning	V-ITS-S	Use Case Layout – Region 3	Y	
EEBL_MEDIUM	EEBL Medium-Level (YELLOW) warning	V-ITS-S	Use Case Layout – Region 3		
EEBL_LOW	EEBL Low-Level (BLUE) warning	V-ITS-S	Use Case Layout – Region 3		
SSV_HIGH	SSV High-Level (RED) warning	V-ITS-S	Use Case Layout – Region 3	Y	

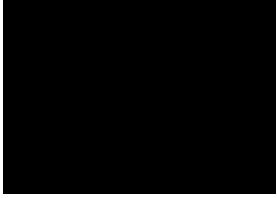|					
SSV_MEDIUM	SSV Medium-Level (YELLOW) warning	V-ITS-S	Use Case Layout – Region 3		
SSV_LOW	SSV Low-Level (BLUE) warning	V-ITS-S	Use Case Layout – Region 3		
ARLW_HIGH	ARLW High-Level (RED) warning	V-ITS-S	Use Case Layout – Region 3	Y	
ARLW _MEDIUM	ARLW Medium-Level (YELLOW) warning	V-ITS-S	Use Case Layout – Region 3		
ARLW_LOW	ARLW Low-Level (BLUE) warning	V-ITS-S	Use Case Layout – Region 3		

ARLW_HIGH_EVENT	ARLW High-Level (RED) warning [Event Zone]	V-ITS-S	Use Case Layout – Region 3	Y	
TWVR_HIGH_RIGHT	TVUL High-Level (RED) warning – Right	V-ITS-S	Use Case Layout – Region 3	Y	
TWVR_HIGH_LEFT	TVUL High-Level (RED) warning – Left	V-ITS-S	Use Case Layout – Region 3	Y	
TWVR_HIGH_BOTH	TVUL High-Level (RED) warning – Both	V-ITS-S	Use Case Layout – Region 3	Y	
TWVR_HIGH_RIGHT_EVENT	TVUL High-Level (RED) warning – Right [Event Zone]	V-ITS-S	Use Case Layout – Region 3	Y	

TWVR_HIGH_LEFT_EVENT	TVUL High-Level (RED) warning – Left [Event Zone]	V-ITS-S	Use Case Layout – Region 3	Y	
TWVR_HIGH_BOTH_EVENT	TVUL High-Level (RED) warning – Both [Event Zone]	V-ITS-S	Use Case Layout – Region 3	Y	
TWVR_MEDIUM_RIGHT	TVUL Medium -Level (YELLOW) warning – Right	V-ITS-S	Use Case Layout – Region 3		
TWVR_MEDIUM_LEFT	TVUL High-Level (YELLOW) warning – Left	V-ITS-S	Use Case Layout – Region 3		
TWVR_MEDIUM_BOTH	TVUL High-Level (YELLOW) warning – Both	V-ITS-S	Use Case Layout – Region 3		

TWVR_LOW_LEFT	TVUL Low-Level (BLUE) warning – Right	V-ITS-S	Use Case Layout – Region 3		
TWVR_LOW_RIGHT	TVUL Low-Level (BLUE) warning –Left	V-ITS-S	Use Case Layout – Region 3		
TWVR_LOW_BOTH	TVUL Low-Level (BLUE) warning – Both	V-ITS-S	Use Case Layout – Region 3		
RWW_HIGH	RWW High-Level (RED) warning	V-ITS-S	Use Case Layout – Region 3	Y	Road Work
RWW_MEDIUM	RWW Medium-Level (YELLOW) warning	V-ITS-S	Use Case Layout – Region 3		

RWW_LOW	RWW Low-Level (BLUE) warning	V-ITS-S	Use Case Layout – Region 3		
RWW_HIGH_EVENT	RWW High-Level (RED) warning [Event Zone]	V-ITS-S	Use Case Layout – Region 3	Y	Reduce Speed
RWW_MEDIUM_EVENT	RWW Medium-Level (YELLOW) warning [Event Zone]	V-ITS-S	Use Case Layout – Region 3		
RWW_LOW_EVENT	RWW Low-Level (BLUE) warning [Event Zone]	V-ITS-S	Use Case Layout – Region 3		
RWW_10	RWW 10 km/h	V-ITS-S	Use Case Layout –Region 2		10
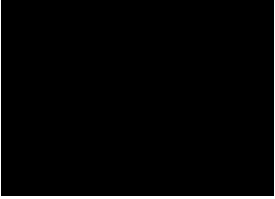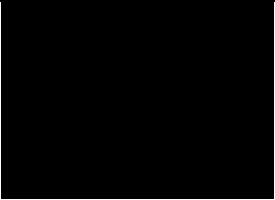
RWW_20	RWW 20 km/h	V-ITS-S	Use Case Layout – Region 2		**20**
RWW_30	RWW 30 km/h	V-ITS-S	Use Case Layout – Region 2		**30**
RWW_40	RWW 40 km/h	V-ITS-S	Use Case Layout – Region 2		**40**
RWW_50	RWW 50 km/h	V-ITS-S	Use Case Layout – Region 2		**50**

RWW_60	RWW 60 km/h	V-ITS-S	Use Case Layout – Region 2		**60**
RWW_70	RWW 70 km/h	V-ITS-S	Use Case Layout – Region 2		**70**
RWW_80	RWW 80 km/h	V-ITS-S	Use Case Layout –Region 2		**80**
RWW_90	RWW 90 km/h	V-ITS-S	Use Case Layout – Region 2		**90**

RWW_100	RWW 100 km/h	V-ITS-S	Use Case Layout – Region 2		
RWW_110	RWW 110 km/h	V-ITS-S	Use Case Layout – Region 2		
RHW_HIGH	RHW High-Level (RED) warning	V-ITS-S	Use Case Layout – Region 3		
RHW_MEDIUM	RHW Medium-Level (YELLOW) warning	V-ITS-S	Use Case Layout – Region 3		

RHW_LOW	RHW Low-Level (BLUE) warning	V-ITS-S	Use Case Layout – Region 3		Hazard
BOQ_HIGH	BoQ High-Level (RED) warning	V-ITS-S	Use Case Layout – Region 3		
BOQ_MEDIUM	BoQ Medium-Level (YELLOW) warning	V-ITS-S	Use Case Layout – Region 3		Congestion
BOQ_LOW	BoQ Low-Level (BLUE) warning	V-ITS-S	Use Case Layout – Region 3		

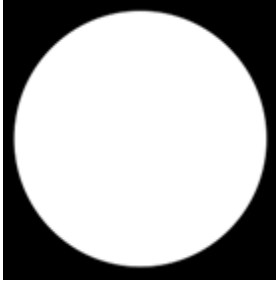| IVS_10 | IVS 10 km/h | V-ITS-S | Use Case Layout – Region 2 | | 10 |
| ICS_20 | IVS 20 km/h | V-ITS-S | Use Case Layout – Region 2 | | 20 |
| IVS_30 | IVS 30 km/h | V-ITS-S | Use Case Layout – Region 2 | | 30 |

IVS_40	IVS 40 km/h	V-ITS-S	Use Case Layout – Region 2		**40**
IVS_50	IVS 50 km/h	V-ITS-S	Use Case Layout – Region 2		**50**
IVS_60	IVS 60 km/h	V-ITS-S	Use Case Layout – Region 2		**60**
IVS_70	IVS 70 km/h	V-ITS-S	Use Case Layout – Region 2		**70**

IVS_80	IVS 80 km/h	V-ITS-S	Use Case Layout – Region 2		**80**
IVS_90	IVS 90 km/h	V-ITS-S	Use Case Layout – Region 2		**90**
IVS_100	IVS 100 km/h	V-ITS-S	Use Case Layout – Region 2		**100**

IVS_110	IVS 110 km/h	V-ITS-S	Use Case Layout – Region 2		
IVS_UNKNOWN	Speed Unknown	V-ITS-S	Use Case Layout – Region 2		

PROJECT DOCUMENT
REFERENCE ONLY