

PROJECT DOCUMENT  
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**Project Specific Technical Specification**

**Transport and Main Roads  
PSTS001 System Overview**

**October 2021**

## Document control sheet

### Contact for enquiries and proposed changes

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### Version history

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1.1	David Alderson	06/07/2019	Updates to match learnings from implementation
2.1	Peter Chalmers	21/08/2020	Updated with the latest architecture diagram and modified related text.
2.2	Jian Qin	29/09/2021	Updated Hybrid Communications Example figure, High-Level C-ITS Architecture figure, Roles table, C-ITS Pilot system architecture components table and C-ITS Pilot system interfaces table.

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## 1 Introduction

This document provides a system overview and context for Contractors' of the roadside stations, vehicle stations and the vehicle's human machine interface. These devices form part of the Principal's Cooperative Intelligent Transport System (C-ITS).

### 1.1 Standards

The European C-ITS standards are adopted by the Principal's C-ITS including European Telecommunications Standards Institute (ETSI), Institute of Electrical and Electronics Engineers (IEEE), International Standards Organisation (ISO), and Society of Automotive Engineers (SAE) documents. These standards are intended to support new and existing safety, mobility, emissions and comfort ITS use cases. Compliant vehicle, roadside, personal and central stations' 'talk' to each other in real-time, and this information is used to generate user information and warnings.

The standards define the stations architecture, which is comprised of the OSI protocol stack, management and security. Per the architecture, the station is communication's agnostic, however, the standards are currently heavily focused on short range communications – specifically ITS-G5 (5.9GHz/IEEE 802.11p).

The standardised C-ITS messages are summarised in Table 1-1. The Principal's C-ITS is intended to align with the standards, however, a number of the standards are still emerging or are untested, and therefore departures to the standards are noted.

**Table 1-1 – Standard Message Formats**

Message	Standard	Description
Cooperative Awareness Message (CAM)	ETSI EN 302 637-2 V1.3.2 (2014-11)	Provides updates to other stations about the sending station's current position, dynamics and attributes.
Decentralised Environmental Notification Message (DENM)	ETSI EN 302 637-3 V1.2.2 (2014-11)	Provides alerts to stations about identified events both planned and unplanned
In vehicle information Messages (IVIM)	CEN ISO/TS 19321:2015 (2015-04)	Provides information to stations about regulatory and traffic situations such road speed limits
Signal Phasing and Timing Extended Message (SPATEM)	ETSI TS 103 301 V1.1.1 (2016-11)	Provides updates to stations about the state of signals at an intersection
Map Extended Message (MAPEM)	ETSI TS 103 301 V1.1.1	Provides information to stations about intersection layout and geometry

The Principal's C-ITS adopts Australian Standards (AS), Australian Communications and Media Authority (ACMA) documents and Main Roads Technical Specifications (MRTS) for the design and deployment of electrical equipment on Queensland roads.

## 1.2 Transport Use Cases

A number of early or day-one use cases have emerged, including, but not limited to the following:

- **Advanced red light warning (ARLW)** - This warning alerts drivers there is a risk of driving through a red light ahead.
- **Turning warning for bicycle riders and pedestrians – (TWVR)** - This warning alerts drivers to pedestrians or bicycle riders potentially crossing at an upcoming signalised intersection
- **Road Hazard Warning (RHW)** - This warning alerts drivers that there is a risk they are travelling at an unsafe speed for a hazard up ahead, such as water on the road, road closures or a crash.
- **Back-Of-Queue (BoQ)** - This warning alerts drivers that there is a risk they are travelling at an unsafe speed for upcoming traffic queue.
- **In-Vehicle Speed (IVS)** - This display provides drivers with information about the current speed limit.
- **Road Works Warning (RWW)** - This warning alerts drivers that there is a risk they are travelling at an unsafe speed for upcoming road works, giving them time to slow down or change lanes. It also alerts drivers if they exceed the speed limit within the road works.

Safety advice is provided to the driver through the following value chain:

- Observe the situation – C-ITS messages are generated and shared by the station. These stations are located in vehicles (V-ITS-S), on the roadside (R-ITS-S) and at the central facility (C-ITS-F).
- Assess the situation – the C-ITS messages are assessed by the V-ITS-S stations. Vehicle to infrastructure (V2I) use data collected by TMR (such as speed limits, incidents, and signal phase and timing data) that are broadcast from the R-ITS-S or C-ITS-F. The cooperative vehicles use their own movement data to assess the hazard risk, and if relevant, will provide a warning to the driver.
- Deliver the advice – the V-ITS-S has preconfigured advice based on the use case and condition. The advice is delivered to the driver via the human machine interface (HMI) as visual, audible, haptic and so on.
- Driver reads and reacts – the driver receives the advice and takes evasive or alternative action.

The use cases use data based on European Telecommunications Standards Institute (ETSI) standard message types and delivered via short-range (ITS-G5) or cellular communications (3G/4G). ETSI define a number of C-ITS message protocols to support the use cases. These include:

- Continuous Awareness Message (CAM) – the vehicle's position, speed, etc. broadcast up to 10 times per second
- Decentralised Environmental Notification Message (DENM) – generated by a vehicle, infrastructure or the central system to warn other users of a hazard such as hard-braking or roadworks
- In Vehicle Information (IVI) – typically regulatory information such as a posted speed sign
- Signal Phase and Timing (SPaTEM) – for a signalised intersection
- MAPEM – digital representation of the geometry of roadway intersections.

Indicative descriptions and diagrams for V2I use cases are provided in Table C.4-6.

All cooperative vehicles generate and share CAM. A DENM message can be generated and shared by the roadside or central station, or another cooperative vehicle (the vehicle creating and hence sending the hazard message). The roadside or central station can also generate and share an IVI or SPaTEM and MAPEM message.

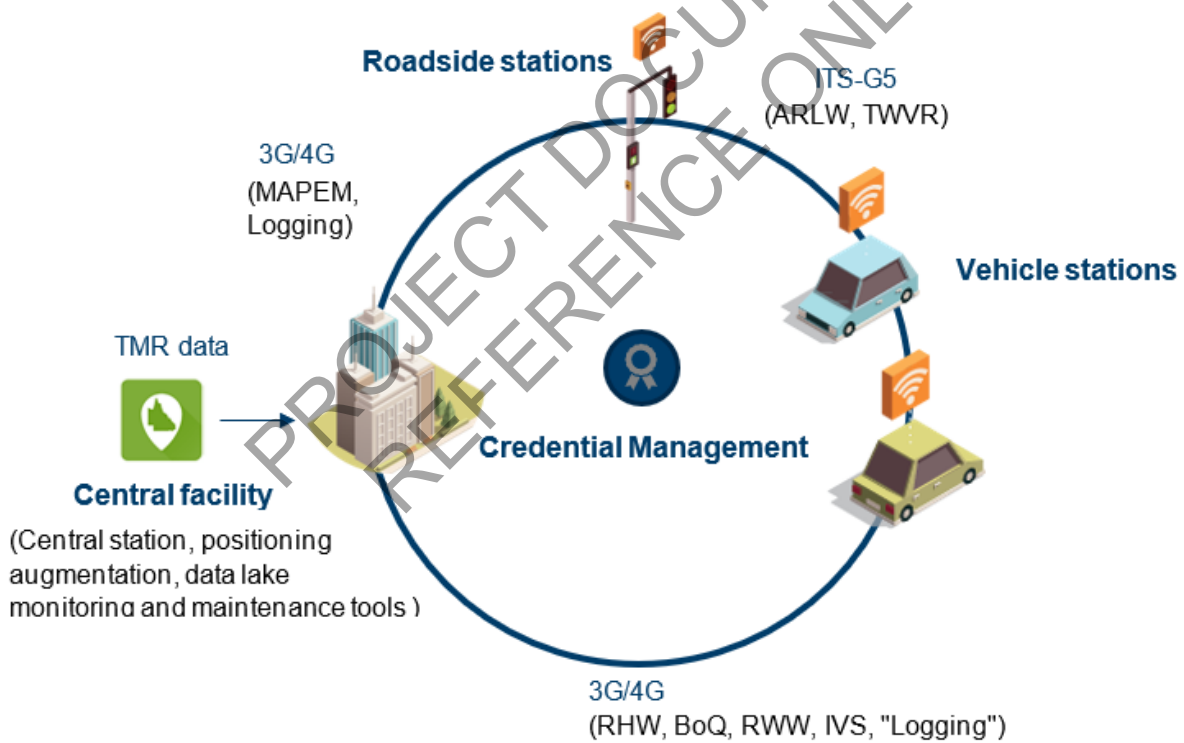
The C-ITS message (for example, RHW DENM) that is used to create an event for a use case warning is not currently harmonised. The Principal will generate C-ITS messages in support of emerging use case as indicated in Appendix C.

## 2 Communication Architecture

The Principal has adopted a hybrid communications model. An overview of the Principal's C-ITS communication architecture is shown in Figure 2.1.

Communication between vehicle-to-vehicle and vehicle-to-roadside is supported via ITS-G5. Short-range communications using the 5.9 GHz spectrum of ITS-G5 has short latency characteristics which enable fast changing, safety-critical C-ITS messages for use cases such as ARLW, and TWVR.

Communication between the central station and field stations is supported by 3G/4G. Long-range communication using 3G/4G extends the reach of C-ITS messages beyond the locations equipped with roadside stations. Long range communication is a viable option when the message is not time-critical and will enable the delivery of C-ITS messages for non-safety critical use cases such as RHW, RWW, IVS, and BoQ. All data generated or observed by the field devices are also shared with the central station.



**Figure 2.1 – Hybrid Communications Example**

The central station currently shares limited information with the roadside stations – specifically the signalised intersection's spatial data (MAPEM). The roadside station does not currently support the ITS-G5 distribution of C-ITS messages related to the RHW, RWW, IVS, and BoQ use cases.

The Principal's C-ITS has adopted ETSI EN 302 665:2010 for transfer of C-ITS messages. This standard does not describe a specific protocol for the data transfer over 3G/4G and therefore the Internet of Things (IoT) protocol – Message Queuing Telemetry Transport (MQTT) as defined in ISO/IEC 20922:2016 has been adopted. The transport network is divided into a number of tiles that include the IVS, RWW, RHW and BoQ use case information, and the vehicle contacts the central station using MQTT to subscribe and unsubscribe to relevant tiles. An example of the tile is provided in Figure 2.2.

The Security Credential Management System (SCMS) and positioning augmentation services are also available via 3G/4G as a centralised service.

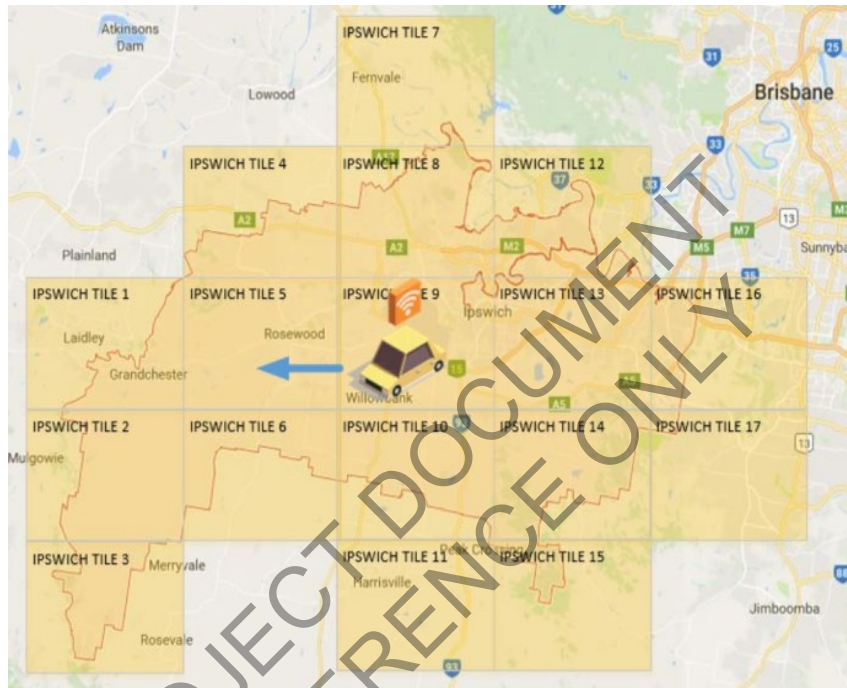
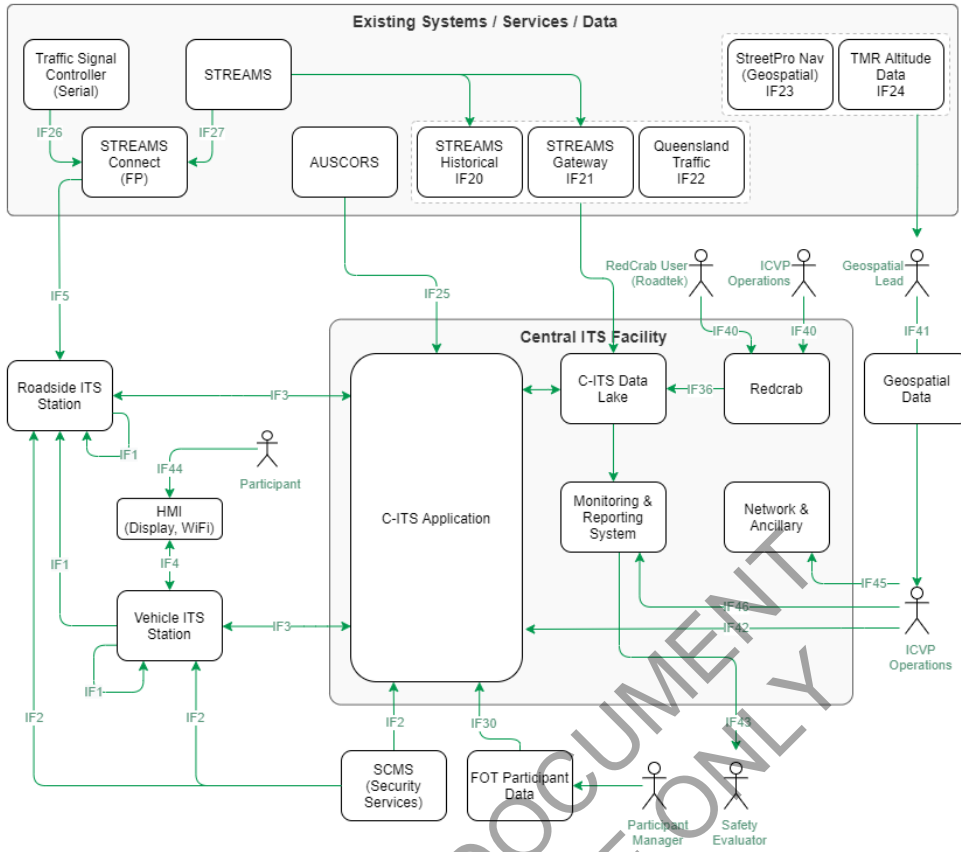


Figure 2.2 – Example tile layout for 3G/4G communication

### 3 System Architecture

The Principal's high-level C-ITS architecture is illustrated in Figure 3.1. Components of the system are described in the subsequent sections.



**Figure 3.1 – High-Level C-ITS Architecture**

The newly created primary roles in the normal operation of the Principal’s C-ITS are listed in Table 3-1. There are a number of existing ITS roles and new roles for configuration, installation, maintenance and decommissioning that are not listed below but are integrated into the deployment solution.

**Table 3-1 - Roles**

Role Name	Role Description
Participant	The driver of the vehicle where C-ITS equipment is installed. Interacts as the end user of the C-ITS.
Participant Manager	Primary point of contact for Participants.
ICVP Operations	Monitors the C-ITS (all components and interfaces) through the monitoring tool within the Central ITS Facility.
Safety Evaluator	Performs the safety evaluation of the use-cases to measure safety benefits for drivers.
Redcrab User (RoadTek)	Creates and updates roadworks information into the C-ITS based on upcoming and live roadworks.
Geospatial Lead	A role that is held by members of the TMR Geospatial Team. Members of this team are tasked with the production of spatial data used by the ICVP system.



**Table 3-2 - C-ITS Pilot system architecture components**

Category	Element	Details
Existing Systems / Service / Data	AUSCORS	Positioning augmentation information by providing Radio Technical Commission for Maritime Services (RTCM) version 3 data. The central facility shares these data with the vehicle station, which can be processed by the vehicle station using Real-Time Kinematic (RTK) positioning augmentation methods to support improved positioning accuracy.
	Traffic Signal Controller (TSC)	Provides signalised intersection data to the R-ITS-S.
	STREAMS® Connect (FP software)	Converts the TSC data to a C-ITS SPATEM message, which is sent to the R-ITS-S. There is no connection from the C-ITS environment to either TMR's existing ITS network or STREAMS® control system.
	STREAMS®	TMR's ITS network control system
	STREAMS Historical	This data is used by the MRS to validate the operation of the C-ITS against a known system – STREAMS®. This includes intersection movement, phase and state data used to verify ARLW and TWVR use cases, queue data to verify the BOQ use case and variable speed data used to verify the IVS use-case.
	STREAMS® Gateway	Back-of-queue and variable speed limit data that are extracted in near real-time. These data are used by the C-ITS-S to generate a BoQ DENM message and an IVS IVIM message.
	Queensland Traffic	Queensland Traffic Road hazard data that are extracted in near real-time. These data are used by the C-ITS-S to generate a RHW DENM message.
	Altitude Data	Altitude data that is required by the Spatial Service to enhance the C-ITS message.
	StreetPro Navigator	Geospatial data that are used to generate the Road Network Model, which are used by the Spatial Service to enhance the C-ITS message.
Central ITS Facility (C-ITS-F)	C-ITS Data Lake	<p>The C-ITS-S Data Lake is used to ingest, stage and curate store data sets which are of wide-spread interest to the TMR organisation and include QLDTraffic, Red Crab and STREAMS® data. The data stored in the C-ITS Data Lake are ingested by individual data adapters on schedule or pushed on change.</p> <p>The C-ITS Data Lake is also used to store ICVP data sets which are project specific and include system configuration data such as the Road Network Model and C-ITS application parameters and also operational data logs such as CME and CSEM safety evaluation data.</p> <p>Data from the C-ITS-S Data Lake is consumed by the C-ITS Application by modules such as the C-ITS-S which used the data to produce C-ITS message and by the Monitoring and Reporting Service to create dashboard visualisations.</p>

Category	Element	Details
	C-ITS Application	<p>Position Augmentation forwards RTK data using the RTCM version 3 protocol delivered over MQTT to V-ITS-S consumers. Position Augmentation provides automatic fallback to a variable number of, typically three, AUSCORS mountpoints.</p> <p>The Central ITS Station (C-ITS-S) is an implementation of the ETSI 302 665 V1.1.1 concept. The C-ITS-S ingests data such as QLDTraffic from the data lake and uses an implementation of the ETSI DEN, IVI and RLT basic services to generate DENM, IVIM and MAPEM respectively. The spatial content in the ingested data is modified to conform to the system’s road network model. C-ITS messages are signed to meet ETSI 103 097 V1.3.1 requirements using the C-ITS Message Signing Service.</p> <p>The C-ITS Message Signing Service (C-ITS-S security layer) requests and protects the C-ITS-S certificates issued by the SCMS. A physical Hardware Security Module is provided by the cloud vendor. The certificates are used by the C-ITS-S to sign the messages.</p> <p>The Safety Evaluator Data Logging service provides decoded pilot data and system performance metrics to the C-ITS Data Lake.</p> <p>The SSH Service is a secure shell for emergency remote maintenance on V-ITS-S or R-ITS-S stations.</p> <p>The Participant Management API enables the participant management team to provide updates to the V-ITS-S stations as needed to conduct the safety evaluation.</p> <p>The Software Update Service allows V-ITS-S and R-ITS-S vendors to update the software on the stations while within the private ICVP mobile network.</p> <p>The STREAM Gateway BoQ ingestor is running on the AWS Elastic Container Service to meet latency requirements.</p> <p>The STREAM Gateway VSL ingestor is running on the AWS Elastic Container Service to meet latency requirements.</p> <p>The Configuration Manager is a web interface to manage the ICVP deployment by the C-ITS-F Administrator and Change Managers.</p>
	Monitoring and Reporting System	<p>The Monitoring &amp; Reporting Service (MRS) uses Tableau to provide dashboard visualisations of the logged data. The visualisations are not real time – yesterday’s data is processed overnight. Process data is also made available to the third-party Safety Evaluator via the Data Lake.</p> <p>The Extract, Transform, Load Calculations and Storage retrieves data from the C-ITS Data Lake daily to monitor system performance and report on system metrics.</p> <p>Visualisation of the system performance is provided by the TMR Shared Services Tableau instance that is managed by TMR Information Technology Branch.</p>

Category	Element	Details
		<p>The Tableau Hyper Extract queues and pushed hyper files to the Tableau instance.</p> <p>Data Packaging and Delivery is a service that provides safety evaluation data to the Field Operational Test safety evaluation team on a daily schedule.</p>
	Network and Ancillary	<p>The AWS Direct Connect provides a physical, dedicated and secure connection from AWS infrastructure to the Firewall.</p> <p>The Firewall is a virtual Palo Alto firewall that provides access to the private CAVI APN mobile network that the V-ITS-S and R-ITS-S operate within.</p> <p>Internet access is provided via the Firewall for access by the V-ITS-S and R-ITS-S to DNS resolution and the SCMS endpoint.</p> <p>The Virtual Private Network provides a backup for secure private communications that would usually occur over the AWS Direct Connect should the AWS Direct Connect fail.</p> <p>The Pipeline Deployment Management service provides deployment governance over the C-ITS application by enabling "hands off" deployment of the software from the AWS Pipeline account.</p> <p>Jasper is commercial of the shelf software for managing the cellular sim cards and associated data plans and is provided as a managed service by Telstra.</p> <p>Jira is commercial of the shelf software used for managing and tracking issues throughout the development, testing and production stages.</p> <p>AWS Cloudwatch is a managed service provided by AWS to review system logs within each AWS account.</p> <p>AWS CodeCommit is a software repository that is used to store source code and trigger builds on commit.</p> <p>AWS CloudFormation is used to define and deploy software and is stored within AWS CodeCommit software repositories.</p>
	Red Crab	<p>Red Crab is a bespoke tool that is used to manage roadwork permits and provide the location of active roadworks signs. These data are used by the C-ITS-S to generate RWW DENM and IVIM messages.</p>
Geospatial Data	MAPEM	<p>ETSI Road Lane Topology basic service information for the signalised intersection use cases.</p>
	Road Network Model	<p>Provides the full static speed limit set including school zones.</p>
	Detector Location	<p>Spatial data for STREAMS® detector sites.</p>
	Tiles	<p>Predetermined geofenced tiles for which messages are published on the Message Broker for use by the vehicle stations.</p>

Category	Element	Details
	Variable Speed Sign Zones	Spatial data for the segments of the road network model controlled by STREAMS® variable speed signs.
Roadside ITS station		<p>The Roadside ITS Station (R-ITS-S) role is to provide the status of signalised intersection data to be broadcast locally for V-ITS-S to interpret the state of the signalised intersection ahead in the context of the road network it is traversing.</p> <p>The R-ITS-S interfaces to:</p> <ul style="list-style-type: none"> <li>The C-ITS-S to obtain configuration and MAPEM and for operational and logging requirements</li> <li>The SCMS for security information</li> <li>Their local STREAMS Connect (Field Processor) for signal status updates</li> <li>V-ITS-S for informing of infrastructure status</li> </ul>
Vehicle ITS Station		<p>Provides the main communication and processing needs for a cooperative vehicle. The V-ITS-S consists of the hardware, firmware, software, applications, communication interfaces, antennae, cabling and any other items required to enable operation to the technical specifications defined.</p> <p>The V-ITS-S interfaces to:</p> <ul style="list-style-type: none"> <li>The C-ITS-F for operational and logging requirements</li> <li>The SCMS for security information</li> <li>R-ITS-S for intersection information</li> <li>Other V-ITS-S for surrounding vehicle information</li> <li>Global navigation satellite service (GNSS)</li> <li>Configured HMI for driver awareness and interaction</li> </ul>
HMI		<p>Provides the driver with content situational awareness/alerts, system status and participant selection. The HMI consists of the hardware, firmware, software, applications, communication interfaces, cabling and any other items required to enable operation to the technical specifications defined.</p> <p>The HMI connects to the V-ITS-S as the interface between the C-ITS system and the driver.</p>
SCMS (Security Services)		<p>The Security Credential Management System (SCMS) is a V2X identity management system mandated by European, US and International standards. It uses Public Key Infrastructure concepts to allow devices that have had no prior contact to anonymously distinguish between a trusted and an untrusted device.</p> <p>The SCMS is one of the security systems that enables C-ITS to meet its safety objectives and defend against cyber-attacks.</p>

Category	Element	Details
FOT Participant Data		Participant Manager (Package F) provides the C-ITS-F with participant information (anonymised) for V-ITS-S configuration relating to the HMI display and logging.
Actors	Participant	The Participant role in the ICVP is held by a person that operates a vehicle with C-ITS equipment installed and connected to the ICVP system. More than one person can operate the same vehicle
	Geospatial Data Lead	A role that is held by members of the TMR Geospatial Team. Members of this team are tasked with the production of spatial data used by the ICVP system
	ICVP Operation	A role that is tasked with the day-to-day operation of the ICVP system
	Safety Evaluator	A role that is tasked with the FOT analysis to evaluate the safety impacts of the C-ITS use-cases implemented by the ICVP
	Participant Manager	The Participant Manager is part of the FOT team that provides anonymous V-ITS-S station configurations to the C-ITS-F. The C-ITS-F publishes the station configuration to the V-ITS-S as required.
	Red Crab User (RoadTek)	A role that is tasked with the day to day duties of updating Red Crab with relevant road works warnings within the pilot area.

Table 3-2 presents the main interfaces in the C-ITS Pilot.

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Table 3-3 - C-ITS Pilot system interfaces

Interface	Description	Interface Type
<b>C-ITS communications</b>		
IF1	V-ITS-S ↔ R-ITS-S ↔ V-ITS-S	ITS-G5 (DSRC)
IF2	SCMS → C/R/V-ITS-S	HTTPS (Internet)
IF3	C-ITS-F ↔ R/V-ITS-S	MQTT, HTTPS
IF4	V-ITS-S ↔ HMI	UDP (802.11b/g/n)
IF5	FP → R-ITS-S	UDP (Ethernet)
<b>Existing Systems / Services /Data</b>		
IF20	STREAMS® Historical → Enterprise data set (STREAMS® historical)	SFTP
IF21	STREAMS® Gateway (BoQ/VSL) → Enterprise data set (STREAMS® Gateway)	API (Internet)
IF22	Queensland Traffic → Enterprise data set (QLDTraffic)	API (Internet)
IF23	StreetPro Nav → Geospatial Data Lead	TMR tooling
IF24	Geoscience Australia Altitude → Geospatial Data Lead	TMR tooling
IF25	AUSCORS → Position Augmentation	RTCM (Internet)
IF26	TSC ↔ FP	Serial
IF27	STREAMS® → STREAMS® Connect	HTTPS (ITS network)
<b>Others</b>		
IF30	FOT Participant Data → C-ITS-S	API Gateway (Internet)
IF36	Red Crab Application → Enterprise data set (Red Crab)	HTTPS (Internet)
<b>Actors</b>		
IF40	ICVP Operations → Red Crab	HTTPS (Internet)
IF41	StreetPro Nav and Altitude Data → Geospatial Lead	TMR tooling
IF42	ICVP Operations → C-ITS-S (Configuration Manager)	API Gateway (Internet)
IF43	FOT Data Export Service → Safety Evaluator	HTTPS (Internet)
IF44	Participant → HMI	Human
IF45	ICVP Operations → Network & Ancillary	HTTPS (Internet)
IF46	ICVP Operations → MRS	HTTPS (Internet)

### **3.1 Central ITS Facility (C-ITS-F)**

The Principal's C-ITS-F is made up of the following components:

- The C-ITS Application that contains the Central ITS Station (C-ITS-S) that sends C-ITS compliant, signed messages. It also provides remote management for field stations, a software update service, a position augmentation service and manages device configuration for the central and field stations. The C-ITS Application also receives device data logs which it stores in the C-ITS Data Lake.
- The C-ITS Data Lake is used to ingest, stage and curate store data sets which are of wide-spread interest to the TMR organisation and include QLDTraffic, Red Crab and STREAMS® data.
- The Monitoring & Reporting Service (MRS) that uses Tableau to provide dashboard visualisations of the logged data.
- The Network and Ancillary services provides a physical, dedicated and secure connection from AWS services to the firewall.
- Red Crab is a bespoke tool that is used to manage roadwork permits and provide the location of active roadworks signs. These data are used by the C-ITS-S to generate RWW DENM and IVIM.

The C-ITS-F includes a number of Principal's data source interfaces, including STREAMS® and QLDTraffic which are external to the C-ITS-F, and databases for the signalised intersection MAPEM and static speeds, which are hosted by the C-ITS-F.

### **3.2 Vehicle ITS Station (V-ITS-S) and Human Machine Interface (HMI)**

The V-ITS-S provides the main communication and processing needs for a cooperative vehicle. The V-ITS-S consists of the hardware, firmware, software, applications, communication interfaces, antennae, cabling and any other items required to enable operation to technical specification PSTS002.

The V-ITS-S connects to:

- The C-ITS-F for operational and logging requirements
- The SCMS for security information
- R-ITS-S for intersection information
- Other V-ITS-S for surrounding vehicle information
- Their HMI for driver awareness and interaction

The HMI provides the driver with content situational awareness/alerts, system status and participant selection. The HMI consists of the hardware, firmware, software, applications, communication interfaces, cabling and any other items required to enable operation to technical specification PSTS003. The HMI connects to the V-ITS-S as the main link between the C-ITS system and the driver.

### **3.3 Roadside ITS Station (R-ITS-S)**

The R-ITS-S provides an interface for the status of signalised intersection data to be broadcast locally for vehicles stations to understand the upcoming environment. The signalised intersection data is sourced from the Traffic Signal Controller (TSC). STREAMS® Connect converts this data to a C-ITS message, which is sent to the R-ITS-S. There is no connection to the Principal's existing ITS network or STREAMS® control system.

The R-ITS-S consists of the hardware, firmware, software, applications, communication interfaces, antennae, cabling and any other items required to enable operation to technical specification PSTS005.

The R-ITS-S connects to:

- The C-ITS-F for operational and logging requirements
- The SCMS for security information
- Their local STREAMS® Connect for signal status updates
- V-ITS-S for informing of infrastructure status

The standards do not dictate how the messages between the signal system (STREAMS® Connect) and the roadside station are encoded. The Principal's C-ITS use UPER to transfer SPATEM.

### **3.4 Security Credential Management System (SCMS)**

Fundamental to the Principal's C-ITS is the delivery of trusted and accurate C-ITS messages. Security controls to ensure that the system produces trusted and accurate information on which safety decisions can be made. The system's security controls directly support the system's safety objectives. By extension, a failure or lack of these controls results in a failure or lack of or reduced level of safety.

The standards require a Security Credential Management System (SCMS), which is based on public key infrastructure. C-ITS messages shared between stations are 'signed' (certified) so that the message content is trustworthy and that – where it matters – the confidentiality of participating entities is maintained. The SCMS manages the stations lifecycle including:

- Enrolment (compliance/validation certificate),
- Authorisation (certificates that indicates the type of station and their associated privileges)
- Operation (short-term validity pseudonym certificates that sign C-ITS messages).

All stations in the Principal's C-ITS interface with the external SCMS. Vehicle stations operating outside of the Principal's C-ITS and hence SCMS will be able to receive messages from other stations, however the data that is sent will not be used because it is not signed.

### **3.5 Field Operational Test (FOT)**

The FOT is a data portal used by third parties for the transfer of the C-ITS data from the stations. This data is used for the evaluation of the system.

### **3.6 Existing Systems, Services, and Data**

#### **3.6.1 AUSCORS Positioning Augmentation**

To support lane-level use cases implemented for the pilot, the vehicle must have a position accuracy of 1 metre +/- 95 percentile confidence. AUSCORS provides Radio Technical Commission for Maritime Services (RTCM) version 3 data. The central station shares this data with the vehicle station in the tile, which can be processed by the vehicle station using Real-Time Kinematic (RTK) positioning augmentation methods to support improved positioning accuracy.



### 4 Technical Documentation

The technical specification set is defined in a suite of documents in order to provide the Contractor with the requirements to develop and deliver appropriate stations. In meeting the requirements of the technical specifications listed below the Contractor must ensure the stations operate in accordance with a deployed C-ITS system as described in the system overview of this specification. The documentation structure is illustrated in Figure 4.1 and summarised in Table 4.1.

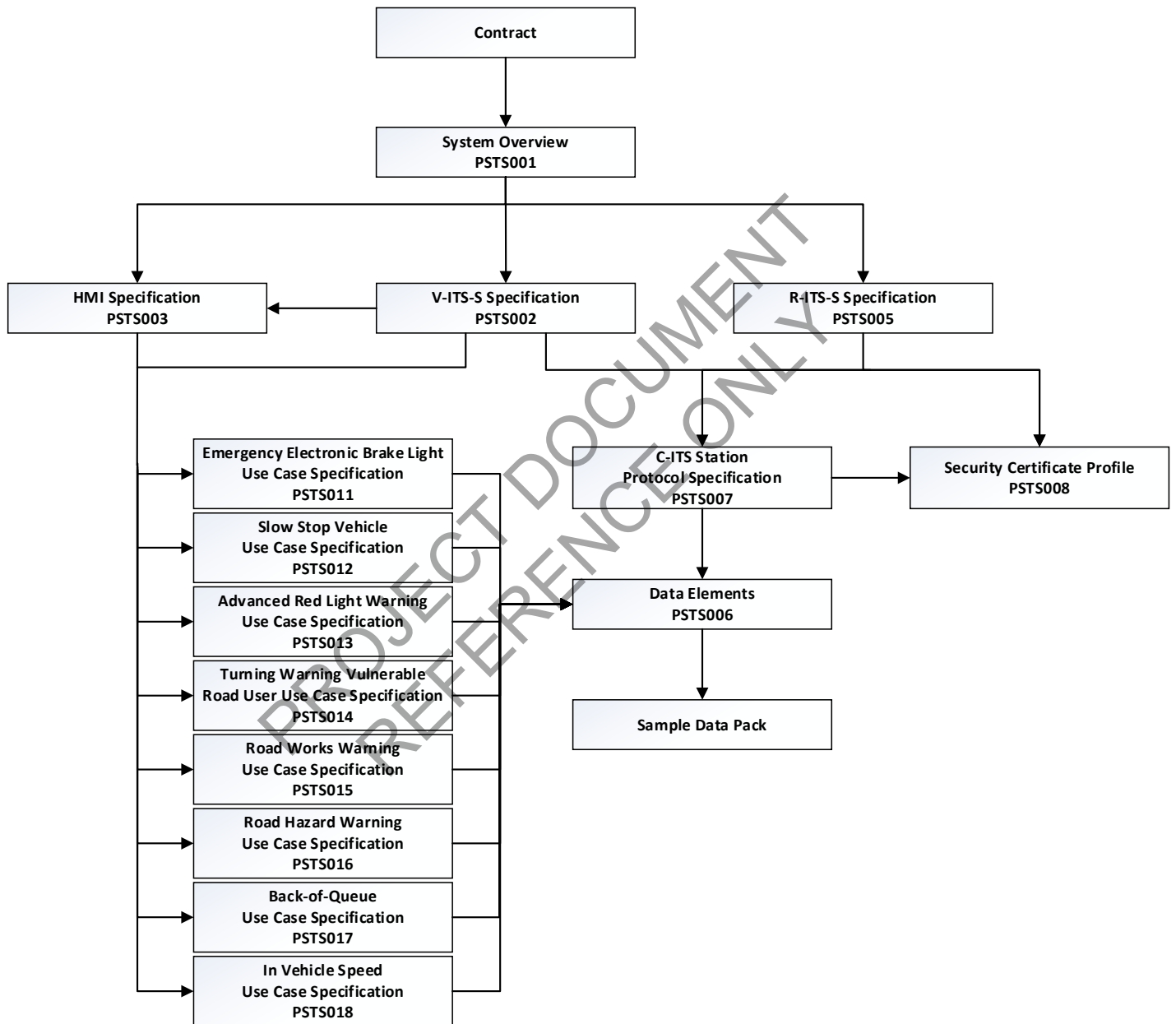


Figure 4.1 – Document Overview

**Table 4-1 – Document Descriptions**

<b>Document Name</b>	<b>Description</b>
PSTS001 System Overview	This document.
PSTS002 V-ITS-S Specification	The supply, commissioning, performance, documentation, training and maintenance requirements for V-ITS-S and associated equipment. The software components related to the operation and maintenance of the system for the C-ITS that are to be implemented in the V-ITS-S.
PSTS003 HMI Specification	The supply and commissioning, performance, documentation, training and maintenance requirements for HMI and associated equipment. The software components related to the operation and maintenance of the system for the C-ITS that are to be implemented in the HMI.
PSTS005 R-ITS-S Specification	The supply and commissioning, performance, documentation, training and maintenance requirements for R-ITS-S and associated equipment. The software components related to the operation and maintenance of the system for the C-ITS that are to be implemented in the R-ITS-S.
PSTS006 Data Elements	The data dictionary for the C-ITS implementation of DENM, CAM, IVI, SPATEM and MAPEM.
PSTS007 C-ITS-S Station Protocol Specification	The protocol for use between all stations and equipment in the C-ITS, (such as C-ITS-S, V-ITS-S, R-ITS-S, HMI and SCMS).
PSTS008 Security Certificate Profile	The security requirements for stations in the C-ITS.
PSTS011 to PSTS018 Use Cases	The use cases provide objectives, general operation and applicable scenarios relating to events to be displayed in the C-ITS.
Sample Data	A package of example messages based on information provided within the technical documentation.

## Appendix A Package Wide Acronyms and Definition of Terms

Acronyms used in this document and the C-ITS are shown in Table A.4-2.

**Table A.4-2 - Acronyms**

Term	Definition
AA	Authorisation Authority (an SCMS component)
ACMA	Australian Communications and Media Authority
ARLW	Advanced Red Light Warning
AS	Australian Standard
ASN.1	Abstract Syntax Notation One
AT	Authorisation tickets
BoQ	Back of Queue
BTP	Basic Transfer Protocol
C2CCC	Car to Car Communication Consortium
CA	Cooperative Awareness
CAM	Cooperative Awareness Message
CAN (bus)	Controller area network
CAVI	Cooperative and Automated Vehicle Initiative
CEN	European committee for standardization
CIT	Component Integration Test
C-ITS	Cooperative ITS
C-ITS-F	Central ITS Facility
C-ITS-S	Central ITS Station
CPOC	C-ITS Point of Contact
CPU	Central Processing Unit
CRL	Certificate Revocation List
CSEM	CAVI Safety Evaluation Message
CT	Commissioning Test
CTL	Certificate Trust List
DC	Direct Current
DEN	Decentralised environmental notification
DENM	Decentralised Environmental Notification Message
DSRC	Dedicated short range communications
EA	Enrolment Authority (an SCMS component)
EC	Enrolment Certificate
EEBL	Emergency Electronic Brake Light
ETSI	European Telecommunications Standards Institute
FAT	Factory Acceptance Test
FOT	Field Operational Test
FP	Field Processor
GNSS	Global Navigation Satellite System
HMI	Human Machine Interface
HSM	Hardware Security Module
IEEE	Institute of Electrical and Electronic Engineers
IF	Interface
IP	Ingress Protection
IPv4	Internet protocol version 4
IPv6	Internet protocol version 6
ISO	International Organization for Standardization
ITA	International Telegraph Alphabet
ITS	Intelligent Transport Systems
ITS-AID	ITS Application object Identifier
ITS-S	ITS station

Term	Definition
IVI	In-vehicle Information
IVIM	In vehicle information Messages
IVS	In Vehicle Speed
LSB	Least Significant Bit
LxWxH	Length x Width x Height
MAP	Cooperative ITS message, broadcasting geography/topology of intersection
MAPEM	Map Extended Message
MQTT	Message Queuing Telemetry Transport
MSB	Most Significant Bit
NTP	Network Time Protocol
NZS	New Zealand Standard
OSI	Open Systems Interconnection
PDU	Packet Data Unit
P-ITS-S	Personal ITS Station
PSID	Physical Security ID
PSTS	Project Specific Technical Specification
RCA	Root Certificate Authority (an SCMS component)
RHW	Road Hazard Warning
R-ITS-S	Roadside ITS Station
RLT	Road and Lane Topology
RTCM	Radio Technical Commission for Maritime Services
RTK	Real-Time Kinematic
RWW	Road Works Warning
SCMS	Security Credential Management System
SIAT	Site Integration Acceptance Test
SIT	System Integration Test
SPaT	Signal phase and timing (cooperative message)
SPATEM	Signal Phasing and Timing Extended Message
SSH	Secure SHell
SSP	Security Service Provider
SSV	Slow Stopped Vehicle
TCP/IP	Transmission Control Protocol/Internet Protocol
TLM	Trust List Manager
TLS	Transport Layer Security
TMR	Queensland Department of Transport and Main Roads
TSC	Traffic Signal Controller
TTL	Time to Live
TWVR	Turning Warning Vulnerable Road user
UPER	Unaligned Packed Encoding Rules
USB	Universal Serial Bus
UTC	Coordinated Universal Time
V2I	Vehicle-to-Infrastructure
V2V	Vehicle-to-Vehicle
V-ITS-S	Vehicle ITS station

Table A.4-3 - Definitions

Term	Definition
C-ITS Team	Monitors the C-ITS (all components and interfaces) through the monitoring tool within the Central ITS Facility. C-ITS Team consists of experts from each Contractor and the Principal's C-ITS staff.
C-ITS event	FOT related term related to tracking C-ITS messages as they are processed by the systems. Events occur on C-ITS-F, C-ITS-S, R-ITS-S and V-ITS-S and include message creation, transmission and receipt, use case triggers, C-ITS message geometry triggers (e.g. start of trace) and HMI message presentations
C-ITS	The C-ITS back-end and field systems and stations, interconnections and supporting systems (e.g. SCMS). Stations include C-ITS-S, R-ITS-S and V-ITS-S
C-ITS-F	Back-end C-ITS including C-ITS-S, monitoring system, data capture system and FOT logging system
C-ITS-F data logging service	A service provided by the C-ITS-F that is used to log data mainly for the FOT evaluation
C-ITS-F manager	Manages the operations and maintenance of the C-ITS back-end system
FOT manager	Manages the execution of the FOT
FOT participant manager	Manages the FOT participant interactions
FOT safety evaluator	Uses logged data to evaluate the FOT safety hypotheses
HMI presentation manager	Function of the V-ITS-S that arbitrates the information presentation requests to the HMI device
HMI notification	Messages from the V-ITS-S platform (e.g. start-up, software update, error) and use case warnings sent to the HMI message manager
HMI message presentation	Messages sent to the HMI device from the V-ITS-S HMI message manager to present to the driver. Presentations includes a pictogram with text and/or graphic components and an optional sound
HMI Presentation	Message (image, audio and metadata) for presentation via the HMI
Message audio	The audio associated with the message to be presented via the HMI speaker
Message image	The image (including pictograms and text) associated with the message to be presented via the HMI screen
Monitoring system	Sub-system of the C-ITS-F that monitors the operation of the C-ITS Pilot system
MQTT	MQTT is a machine-to-machine (M2M)/"Internet of Things" connectivity protocol (mqtt.org)
Region	Defined area of the HMI screen for presentation of a message
Use case warning	A warning presented by the HMI when use case applications are triggered

## Appendix B Project Wide Reference Documents

**Table B.4-4 – Referenced documents – Internal**

Document ID	Document Name / Description
PSTS001	System Overview
PSTS002	V-ITS-S Equipment
PSTS003	HMI Equipment
PSTS005	R-ITS-S Equipment
PSTS006	Data Entity Catalogue
PSTS007	C-ITS Station Protocol Specification
PSTS008	SCMS Certificate Profile Specification
PSTS011	Electronic Emergency Brake Light (EEBL) Use Case Specification
PSTS012	Slow Stopped Vehicle (SSV) Use Case Specification
PSTS013	Advanced Red Light Warning (ARLW) Use Case Specification
PSTS014	Turning Warning Vulnerable Road user (TWVR) Use Case Specification
PSTS015	Road Works Warning (RWW) Use Case Specification
PSTS016	Road Hazard Warning (RWW) Use Case Specification
PSTS017	Back of Queue (BoQ) Use Case Specification
PSTS018	In-vehicle Speed (IVS) Use Case Specification

**Table B.4-5 – Referenced documents – External**

Document ID	Document Name / Description
ISO 14823 (2017-05)	Intelligent transport systems -- Graphic data dictionary
ISO 17419 (2018)	Intelligent transport systems -- Cooperative systems -- Globally unique identification
ISO/TS 19091 (2017)	Intelligent transport systems - Cooperative ITS - Using V2I and I2V communications for applications related to signalized intersections
ISO/TS 19321:2015 (2015-04)	Intelligent transport systems - Cooperative ITS - Dictionary of in-vehicle information (IVI) data structures
ISO TS 3166-1 (2013)	Codes for the representation of names of countries and their subdivisions -- Part 1: Country codes
ISO/IEC 20922:2016 (2016)	Information technology -- Message Queuing Telemetry Transport (MQTT) v3.1.1
SAE J2945/1 (2016)	On-Board System Requirements for V2V Safety Communications
SAE J2735 (2016)	Surface Vehicle Standard, Dedicated Short Range Communications (DSRC) Message Set Dictionary (SPAT,MAP)
ETSI EN 302 571 V2.1.1 (2017-02)	Radiocommunications equipment operating in the 5 855 MHz to 5 925 MHz frequency band; Harmonised Standard covering the essential requirements of article 3.2 of Directive 2014/53/EU
ETSI EN 302 636-1	Vehicular Communications; GeoNetworking; Part 1: Requirements
ETSI EN 302 636-2	Vehicular Communications; GeoNetworking; Part 2: Scenarios
ETSI EN 302 636-3	Vehicular Communications; GeoNetworking; Part 3: Network Architecture
ETSI EN 302 663 V1.2.1 (2013-07)	ITS-G5 Access layer specification for Intelligent Transport Systems operating in the 5 GHz frequency band
ETSI EN 302 665 V1.1.1 (2010-09)	Intelligent Transport Systems (ITS); Communications Architecture

Document ID	Document Name / Description
ETSI EN 302 890-2	Facilities Layer function; Part 2: Position and Time management (PoTi); Release 2
ETSI EN 302 931 V1.1.1 (2011-07)	Geographical Area Definition
ETSI TR 102 638 V1.1.1 (2009-06)	Vehicular Communications; Basic Set of Applications; Definitions
ETSI TS 101 539-1 V1.1.1 (2013-08)	Intelligent Transport Systems (ITS); V2X Applications; Part 1: Road Hazard Signalling (RHS) application requirements specification
ETSI TS 101 539-3 v1.1.1 (2013-11)	Intelligent Transport Systems (ITS); V2X Applications; Longitudinal Collision Warning (LCRW) application requirements specification
ETSI TS 102 894-1 V1.1.1	Intelligent Transport Systems (ITS); Users and applications requirements; Part 1: Facility layer structure, functional requirements and specifications
ETSI TS 102 894-2 V1.2.1 (2014-09)	Users and applications requirements; Part 2: Applications and facilities layer common data dictionary
ETSI TS102 941 V1.2.1(2018-05)	Intelligent Transport Systems (ITS) Security; Trust and Privacy Management
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 I2V messages
ETSI TR 103 415 V1.1.1 (2018-04)	Intelligent Transport Systems (ITS) ; Security; Pre-standardization study on pseudonym change management
ETSI EN 302 636-4-1 V1.3.1 (2017-08)	Vehicular Communications; GeoNetworking; Part 4: Geographical addressing and forwarding for point-to-point and point-to-multipoint communications; Sub-part 1: Media-Independent Functionality
ETSI TS 102 636-4-2 V1.1.1 (2013-10)	Vehicular Communications; GeoNetworking; Part 4: Geographical addressing and forwarding for point-to-point and point-to-multipoint communications; Sub-part 2: Media-dependent functionalities for ITS-G5
ETSI TS 102 637-1 V1.1.1 (2010-09)	Vehicular Communications; Basic Set of Applications; Part 1: Functional Requirements
ETSI EN 302 636-5-1 2.1.1 (2017-05)	Intelligent Transport Systems (ITS); Vehicular Communications; GeoNetworking; Part 5: Transport Protocols; Sub-part 1: Basic Transport Protocol

Document ID	Document Name / Description
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 102 724 V1.1.1 (2012-10)	Harmonized Channel Specifications for Intelligent Transport Systems operating in the 5 GHz frequency band.
ETSI TS 102 731 V1.1.1 (2010-09)	Security; Security Services and Architecture
ETSI TS 102 792 V1.2.1 (2015-06)	Mitigation techniques to avoid interference between European CEN Dedicated Short Range Communication (CEN DSRC) equipment and Intelligent Transport Systems (ITS) operating in the 5 GHz frequency range
ETSI TS 102 860 V1.1.1 (2011-05)	Classification and management of ITS application objects
ETSI TS 102 940 V1.3.1 (2018-04)	Security; ITS communications security Architecture and security management
ETSI TS 102 942 V1.1.1 (2012-06)	Security; Access Control
ETSI TS 102 943 V1.1.1 (2012-06)	Security; Confidentiality services
ETSI TS 102 965 V1.3.1 (2016-11)	Application Object Identifier (ITS - AID); Registration list.
ETSI TS 103 097 V1.3.1 (2017-10)	Intelligent Transport Systems (ITS); Security; Security header and certificate formats
ETSI TS 103 175 V1.1.1 (2015-06)	Cross Layer DCC Management Entity for operation in the ITS G5A and ITS G5B medium
ETSI TS 103 248 V1.2.1 (2018-08)	GeoNetworking; Port Numbers for the Basic Transport Protocol (BTP)
ETSI TS 103 600 V1.1.1 (2019-05)	Interoperability test specifications for security
ETSI EN 302 637-3 V1.2.2 (2014-11)	Intelligent Transport Systems (ITS); Vehicular Communications; Basic Set of Applications; Part 3: Specifications of Decentralized Environmental Notification Basic Service
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 1609.2:2017 (2A)	Wireless Access in Vehicular Environments--Security Services for Applications and Management Messages
ISO/IEC 20922 v3.1.1 (2016)	Information technology -- Message Queuing Telemetry Transport (MQTT)

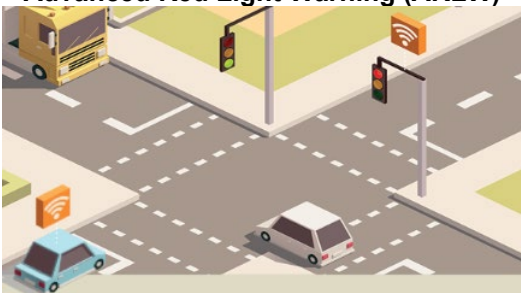





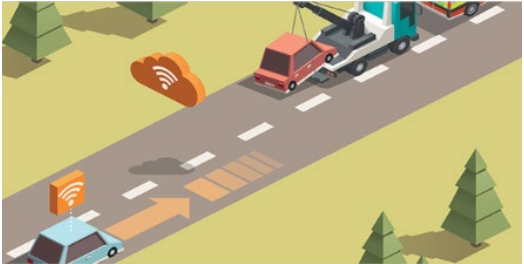
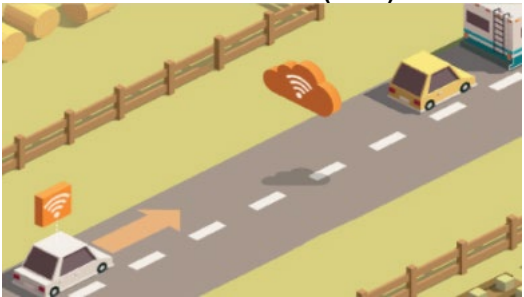
Document ID	Document Name / Description
AS 1044 (1995)	Radio Disturbance characteristics
AS/NZS 17799 (2006)	Security techniques — Code of practice for information security management
AS/NZS 7799.2 (2003-02)	Information security management Specification for information security management systems
AS/NZS 3100 (2017)	General requirements for electrical equipment
AS 2578 (2009)	Traffic Signal Controllers
MRTS01 (2017)	Introduction to Technical Specifications
MRTS50 (2017)	Specific Quality System Requirements
MRTS97 (2017-07)	Mounting Structures for Roadside Equipment
IEEE 802.11 (2016)	Telecommunications and information exchange between systems Local and metropolitan area networks—Specific requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications
IEEE 802.15	Bluetooth Special Interest Group Bluetooth standard
RTCM Standard 10403.3 (2016-10)	Differential GNSS (Global Navigation Satellite Systems) Services – version 3:2016
ACMA Radio communications (Intelligent Transport Systems) Class Licence 2017	

### Appendix C Use Case Summary

A summary of the use cases, interface, communication and message format is defined in Table C.4-6. The system design allows for the addition and removal of use cases both during the C-ITS Pilot and beyond the pilot.

**Table C.4-6 – Use Cases (graphics are indicative only)**

Use Case Name and Graphic	Use Case Description and Features
<p><b>Advanced Red Light Warning (ARLW)</b></p> 	<p><b>Description:</b> There is a risk of violating the red light at a signalised intersection unless the driver brakes.</p> <p><b>Vehicle Interface:</b> R-ITS-S→V-ITS-S</p> <p><b>Vehicle Communications:</b> ITS-G5</p> <p><b>Message Format:</b> MAPEM and SPATEM</p> <p><b>Data Source:</b> SPATEM – Traffic controller via the FP. MAPEM – TMR database via the C-ITS-S:</p>
<p><b>Turning Warning Vulnerable User (TWVR)</b></p> 	<p><b>Description:</b> There is a risk of a conflict with a pedestrian or cyclist that is crossing at a signalised intersection.</p> <p><b>Vehicle Interface:</b> R-ITS-S→V-ITS-S</p> <p><b>Vehicle Communications:</b> ITS-G5</p> <p><b>Message Format:</b> MAPEM and SPATEM</p> <p><b>Data Source:</b> SPATEM – Traffic controller via the FP. MAPEM – TMR database via the C-ITS-S.</p>
<p><b>In-Vehicle Speed (IVS)</b></p> 	<p><b>Description:</b> Provides current regulatory speed limit, i.e. the default static, variable, school zone or roadworks speed limit.</p> <p><b>Vehicle Interface:</b> C-ITS-F→V-ITS-S</p> <p><b>Vehicle Communications:</b> 3G/4G</p> <p><b>Message Format:</b> IVI</p> <p><b>Data Source:</b> STREAMS Gateway (variable speed limits), TMR database (static/school)</p>
<p><b>Road Work Warning (RWW)</b></p> 	<p><b>Description:</b> Driving speed is not appropriate for the roadworks speed condition. .</p> <p><b>Vehicle Interface:</b> C-ITS-F→V-ITS-S</p> <p><b>Vehicle Communications:</b> 3G/4G</p> <p><b>Message Format:</b> DENM and IVI</p> <p><b>Data Source:</b> TMR Red Crab (road works sign tool)</p>

Use Case Name and Graphic	Use Case Description and Features
<p><b>Road Hazard Warning (RHW)</b></p> 	<p><b>Description:</b> Driving speed is not appropriate for a downstream hazard such as a crash or debris.</p> <p><b>Vehicle Interface:</b> C-ITS-F→V-ITS-S</p> <p><b>Vehicle Communications:</b> 3G/4G</p> <p><b>Message Format:</b> DENM</p> <p><b>Data Source:</b> QLDTraffic</p>
<p><b>Back of Queue (BoQ)</b></p> 	<p><b>Description:</b> – alerts the driver if their current speed is not appropriate for a downstream back of queue.</p> <p><b>Vehicle Interface:</b> C-ITS-F→V-ITS-S</p> <p><b>Vehicle Communications:</b> 3G/4G</p> <p><b>Message Format:</b> DENM</p> <p><b>Data Source:</b> STREAMS Gateway</p>

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