Vehicle-to-Infrastructure (V2I) Safety Applications

Performance Requirements, Vol. 5, Spot Weather Information Warning – Reduced Speed (SWIW-RS)

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16. Abstract

This document is the fifth of a seven volume report that describe the Performance Requirements for the connected vehicle vehicle-to-infrastructure (V2I) safety applications developed for the U.S. Department of Transportation (U.S. DOT). This volume describes the Performance Requirements for the infrastructure and vehicle components of the Spot Weather Information Warning – Reduced Speed V2I Safety Application. This application is designed to advise drivers of current adverse weather conditions in an upcoming weather zone and provide an alert if the vehicle's speed may be too high to safely traverse the zone. The safety applications described here integrate roadside and in-vehicle advisories, alerts and warnings to make the driver aware of hazards in time to take action to prevent a potential crash. The performance requirements provide requirements for both infrastructure and vehicle application components to ensure the messages are consistent and coordinated, to best capture the attention of the driver and to avoid conflicting or confusing driver messaging.

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Chapter 1 Scope

1.1 Document Identification

This document is the fifth of a seven volume report that describes the performance requirements for six connected vehicle vehicle-to-infrastructure (V2I) safety applications developed for the U.S. Department of Transportation (U.S. DOT). This volume describes the Performance Requirements for the infrastructure and vehicle components of the Spot Weather Information Warning – Reduced Speed V2I Safety Application. This application is designed to advise drivers of current adverse weather conditions in an upcoming weather zone and provide an alert if the vehicle's speed may be too high to safely traverse the zone.

The seven volumes comprising this V2I Safety Applications Performance Requirements report are:

- Vol. 1, V2I Safety Application Overview and Common Requirements
- Vol. 2, Curve Speed Warning (CSW)
- Vol. 3, Red Light Violation Warning (RLVW)
- Vol. 4, Reduced Speed Zone Warning with Lane Closure (RSZW/LC)
- Vol. 5, Spot Weather Information Warning – Reduced Speed (SWIW-RS)
- Vol. 6, Spot Weather Information Warning – Diversion (SWIW-D)
- Vol. 7, Stop Sign Gap Assist (SSGA).

This volume transforms the Concept of Operations (ConOps) and System Requirements previously developed for the SWIW-RS application into a set of performance requirements which specify how the application integrates roadside and in-vehicle advisories, alerts and warnings to make the driver aware of hazards in time to take action to prevent a potential crash. Performance requirements are provided for both infrastructure and vehicle application components of the application to ensure that infrastructure and vehicle messages presented to drivers are consistent and coordinated, to best capture the attention of the driver, and avoid conflicts or confusion.

1.2 Document Overview

The objective of this V2I Safety Application Performance Requirements volume is to provide integrated requirements for the infrastructure and vehicle components of one of a series of V2I safety applications, their wireless messaging and their driver messaging that ensure coordinated and consistent delivery of safety hazard advisories, alerts and warnings to drivers. This volume describes the V2I System of Systems within which the application is expected to function.

The SWIW-RS safety application described here captures relevant data from roadside infrastructure sensors and in-vehicle sensors and processes them to determine if there is a potential crash hazard. If a hazard is detected, the application issues integrated roadside and in-vehicle advisories, alerts and warnings to make the driver aware of the hazards in time to take action to prevent the crash.

The application described here has both an infrastructure-based component and a vehicle-based component, which may be developed by different stakeholders. Infrastructure-based components are expected to be developed by state and local agencies responsible for building and maintaining the roadway infrastructure and their contractors. Vehicle-based components are expected to be developed by vehicle manufacturers, their tier one suppliers, and aftermarket system suppliers. The performance requirements provide requirements for both infrastructure and vehicle application components to ensure the data exchange between the two components is synchronized and consistent and that they deliver messages to the driver that are harmonized to best capture the attention of the driver and that avoid confusing the driver.

This document has been written with the assumption that the reader possesses a general knowledge associated with connected vehicles and the associated infrastructure surrounding connected vehicles.

The intended audience of this document includes infrastructure and vehicle application developers, wireless equipment systems manufacturers, intelligent transportation systems (ITS) developers, state and local departments of transportation, and U.S. DOT Connected Vehicle Program Managers.

The remainder of this volume consists of the following sections and content:

Section 2 (Applicable Documents) describes the external documentation utilized and referenced throughout this document.

Section 3 (Requirements) provides the background and requirements for the SWIW-RS application.

Appendices:

A. SWIW-RS Application Message Candidate Data Elements
B. Acronyms and Abbreviations
C. Terms and Definitions

Chapter 2 Referenced Documents

The following sections include documents that are either cited herein or were reviewed for the development of this document. Documents from U.S. DOT are presented first, followed by documents from other government and non-government organizations.

U.S. Department of Transportation

- Accelerated Vehicle-to-Infrastructure (V2I) Safety Applications Concept of Operations Document. FHWA Office of Safety Research and Development, Turner-Fairbank Highway Research Center. FHWA-JPO-13-058. (2012).
- Accelerated Vehicle-to-Infrastructure (V2I) Safety Applications System Requirements Document. FHWA Office of Safety Research and Development, Turner-Fairbank Highway Research Center. FHWA-JPO-13-059. (2012).
- Driver Vehicle Interface (DVI) Design Assistance for Advanced Technology Applications, Campbell, J. L., Brown, J. L., et al, National Highway Traffic Safety Administration, (in press). (Battelle Final Report to Virginia Tech Transportation Institute and National Highway Traffic Safety Administration).
- Highway Functional Classification: Concepts, Criteria and Procedures, Federal Highway Administration, FHWA-PL-13-026, 2013 Edition.
- Manual on Uniform Traffic Control Devices for Streets and Highways, 2009 edition, Federal Highway Administration. http://mutcd.fhwa.dot.gov/.
- Vehicle-to-Infrastructure (V2I) Safety Applications Concept of Operations Document. FHWA Office of Safety Research and Development, Turner-Fairbank Highway Research Center. FHWA-JPO-13-060. (2013).
- Vehicle-to-Infrastructure (V2I) Safety Applications System Requirements Document. FHWA Office of Safety Research and Development, Turner-Fairbank Highway Research Center. FHWA-JPO-13-061. (2013).

American Association of State Highway and Transportation Officials (AASHTO)

- The Green Book. A Policy on Geometric Design of Highways and Streets, 6th edition. 2011.

International Organization for Standardization (ISO)

- ISO 9141-2. Road vehicles – Diagnostic systems – Part 2: CARB requirements for interchange of digital information (1994).
- ISO 11898, Road vehicles – Controller area network (CAN) – Part 6: High-speed medium access unit with selective wake-up functionality.
- ISO 14230-4, Road vehicles – Diagnostic systems – Keyword Protocol 2000 – Part 4 Requirements for emission-related systems.
- ISO 15765, Road vehicles – Diagnostic communication over Controller Area Network (DoCAN) – Part 4: Requirements for emissions-related systems.

Institute of Transportation Engineers (ITE) Standards

- ITE ATC Transportation Controller (ATC) v5.2b.
- ITE Traffic Management Data Dictionary (TMDD) Standard v3.03 for the Center-to-Center Communications.

National Marine Electronics Association

- NMEA 0183 Interface Standard.

National Transportation Communications for Intelligent Transportation System Protocol (NTCIP) Standards

- NTCIP 1103 Transportation Management Protocols.
- NTCIP 1204 v03 Object Definitions for Environmental Sensor Stations (ESS) Standard.
- NTCIP 1203 v02 Object Definitions for Dynamic Message Signs (DMS) Standard.
- NTCIP 1209 v02 Object Definitions for Transportation Sensor Systems (TSS).

Radio Technical Commission for Maritime Services

- RTCM 10403.2, Differential GNSS (Global Navigation Satellite Systems) Services – Version 3.

Society of Automotive Engineers (SAE) Standards

- SAE J1211. Handbook for Robustness Validation of Automotive Electrical/Electronic Modules.
- SAE J1850 VPW, J1850 PWM. Class B Data Communications Network Interface (June 2006).
- SAE J2735:2009-11 Dedicated Short Range Communications (DSRC) Message Set Dictionary.
- SAE J2178 Class B Data Communication Network Messages-Detailed Header Formats and Physical Address Assignments.

Transportation Research Board (TRB)

- National Cooperative Highway Research Program (NCHRP) Report 600. Human Factors Guidelines for Road Systems, 2nd edition. (2012).

Chapter 3 Performance Requirements

3.1 Introduction and Overview

This section of the document enumerates the Performance Requirements for the Spot Weather Information Warning – Reduced Speed V2I Safety Application. The performance requirements provide requirements for both infrastructure and vehicle application components to ensure the advisories are consistent and coordinated.

3.1.1 Organization of this Chapter

The chapter begins by describing the V2I System, including its functional architecture, components and interfaces. This is followed application performance requirements first for the infrastructure application component, followed by the vehicle application component. This chapter is organized under the following headings.

- 3.1 Introduction and Overview
  - 3.1.1 Organization of this Chapter
  - 3.1.2 Structure and Format of the Performance Requirements
    - 3.1.2.1 Performance Requirements Identifier Structure
    - 3.1.2.2 Verification Methods
- 3.2 V2I System Functional Architecture
  - 3.2.1 System Components and Interfaces
    - 3.2.1.1 Driver
    - 3.2.1.2 Infrastructure Systems Components
    - 3.2.1.3 Vehicle System Components
    - 3.2.1.4 V2I/I2V Wireless Data Interface
    - 3.2.1.5 Infrastructure System Interfaces
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- 3.3 Spot Weather Information Warning – Reduced Speed (SWIW-RS) Application Performance Requirements
  - 3.3.1 SWIW-RS Application Introduction and Overview
    - 3.3.1.1 Application Purpose
    - 3.3.1.2 Safety Impacts of the Application
    - 3.3.1.3 Summary of Improvements
    - 3.3.1.4 How the Application Works
    - 3.3.1.5 Application Assumptions
    - 3.3.1.6 Application Swim Lane & Sequence Diagrams
    - 3.3.1.7 Messages Exchanged and Used by the Application

- 3.3.2 SWIW-RS Infrastructure Application Component Requirements
- 3.3.3 SWIW-RS Vehicle Application Component Requirements

In developing the performance requirements contained here, the authors developed a framework for coordinating the delivery of roadside and in-vehicle messages to drivers. The framework that sets the stage for subsequent requirements is described in the application introduction and overview and in its assumptions. This is followed by Application Swim Lane and Sequence Diagrams that illustrate the flow of data, data processing and decision trees for hazard assessment and for decisions in whether to issue advisories, alerts and/or warnings to drivers.

As illustrated in the V2I System of Systems description below, the V2I application is implemented in a framework of multiple existing and legacy systems that capture data, process it and issue messages to drivers and other systems. The application description includes a description of the messages that are exchanged between systems that make up the V2I System of Systems.

Following explanation of the rationale and underlying frameworks, requirements are presented, first for the infrastructure application components and then for the vehicle application components. Appendix A provides Application Message Data Tables which suggest data elements that may be needed by the application to perform its required functions.

The authors of these requirements expect that questions will arise during the design and implementation of this application. The rationales, frameworks, and requirements presented here are expected to evolve. Understanding that different components will be developed by different agencies, the purpose here is to provide an underlying structure for discussion between these agencies to support coordination and refinement of the requirements that are necessary to successfully develop and implement the application to achieve its safety objectives.

3.1.2 Structure and Format of the Performance Requirements

Each requirement in the following tables includes the following elements:

- **Unique Identifier** of the form **[A.B.CC.DD]**, described in more detail below.
- **Requirement Title** describes the topic of the requirement. **Requirement Titles** are presented in bold face type for readability.
- **Requirement Statement** provides the specific requirement which is subject to verification and validation, and represents the description of design, development, behavior, operation, performance, etc. of the application. **Requirement Statements** are presented in bold type face to distinguish them from supporting text including the *Requirements Elaboration.*
- *Requirements Elaboration* provides supporting text for the **Requirement Statement** that aids in understanding, interpretation and application of the **Requirement Statement** where needed. *Requirements Elaboration* text is presented in italics type face to distinguish it from the **Requirements Statement**. *Requirements Elaboration* is not necessarily subject to verification and validation, but may be useful in establishing methods and acceptance criteria for verification and validation.
- Verification Method describes how the performance requirements will be verified, whether by Inspection (I), Demonstration (D), Test (T) or Analysis (A). Each of these is described in more detail below.

3.1.2.1 Performance Requirements Identifier Structure

Performance requirements for this V2I application is organized and numbered by the application, the component, and requirement category. For consistency and accessibility the requirements are uniquely identified by a four element number of the format [A.B.CC.DD] where A designates the application, B designates the application component, CC designates the application category, and DD is the unique requirement number within the category. The [A] designators for each application are

- [1.B.CC.DD] Common Application Requirements
- [2.B.CC.DD] CSW Application Requirements
- [3.B.CC.DD] RLVW Application Requirements
- [4.B.CC.DD] RSZW/LC Application Requirements
- [5.B.CC.DD] SWIW-RS Application Requirements
- [6.B.CC.DD] SWIW-D Application Requirements
- [7.B.CC.DD] SSGA Application Requirements

The [B] designators for the application components are

- [A.1.CC.DD] Infrastructure Application Component Requirements
- [A.2.CC.DD] Vehicle Application Component Requirements
- [A.3.CC.DD] Infrastructure Application Platform Requirements[1]

The [CC] designator for the application categories are

- [A.B.01.DD] Interfaces and Interface Specifications
- [A.B.02.DD] Functional Requirements
- [A.B.03.DD] Data Input Requirements
- [A.B.04.DD] Data Output Requirements

Common Application requirements include the following additional categories:

- [A.B.05.DD] Computation and Communication Performance Requirements
- [A.B.06.DD] Operational Performance Requirements
- [A.B.07.DD] Supportability Requirements
- [A.B.08.DD] Security Requirements
- [A.B.09.DD] Human Factors, Health and Safety Requirements
- [A.B.10.DD] Installation and Setup Requirements
- [A.B.12.DD] Operation, Maintenance and Diagnostic Requirements
- [A.B.12.DD] Documentation Requirements
- [A.B.13.DD] Staffing and Training Requirements
- [A.B.14.DD] Physical and Environmental Performance Requirements

[1] While outside the system of interest, candidate performance requirements are provided in Volume 1 for the Infrastructure Application Platform for reference.

3.1.2.2 Verification Methods

The verification method describes how the performance requirements will be verified in order to ascertain that the system of interest conforms to the requirements in this specification. The four potential methods of verification include the following.

Analysis is a verification method that utilizes established technical or mathematical models or simulations, algorithms, charts, graphs, circuit diagrams, or other scientific principles and procedures to provide evidence that stated requirements are met.

Demonstration is a verification method that generally denotes the actual operation, adjustment, or re-configuration of items to provide evidence that the designed functions were accomplished under specific scenarios.

Inspection is a verification method that consists of investigation, without the use of special laboratory appliances or procedures, of items to determine conformance to those specified requirements. Examination is generally nondestructive and typically includes the use of sight, hearing, smell, touch; and/or simple physical manipulation of the system when it is safe to do so. Inspection can also be applied to the project work products. For instance, verifying that software is developed using a certain programming language would be verified by inspection.

Testing is a verification method that generally denotes the determination of properties by instrumentation and measurement. This method includes functional operation, and involves the application of established scientific principles and procedures.

3.2 V2I System Functional Architecture

Figure 3-1 illustrates the V2I System of Systems Functional Architecture upon which the Performance Requirements are based. The figure illustrates a number of key elements concerning the architecture of the V2I safety application described in this volume. First, the V2I safety application has two core components, an Infrastructure Application Component residing and operating on an Infrastructure Application (Computing) Platform and a Vehicle Application Component residing on a Vehicle Application (Computing) Platform. Both components are necessary to achieve the safety application objectives of integrating and processing infrastructure and vehicle data and delivering coordinated messages to the driver. These two application components share data and information by exchanging messages through wireless data interface(s).

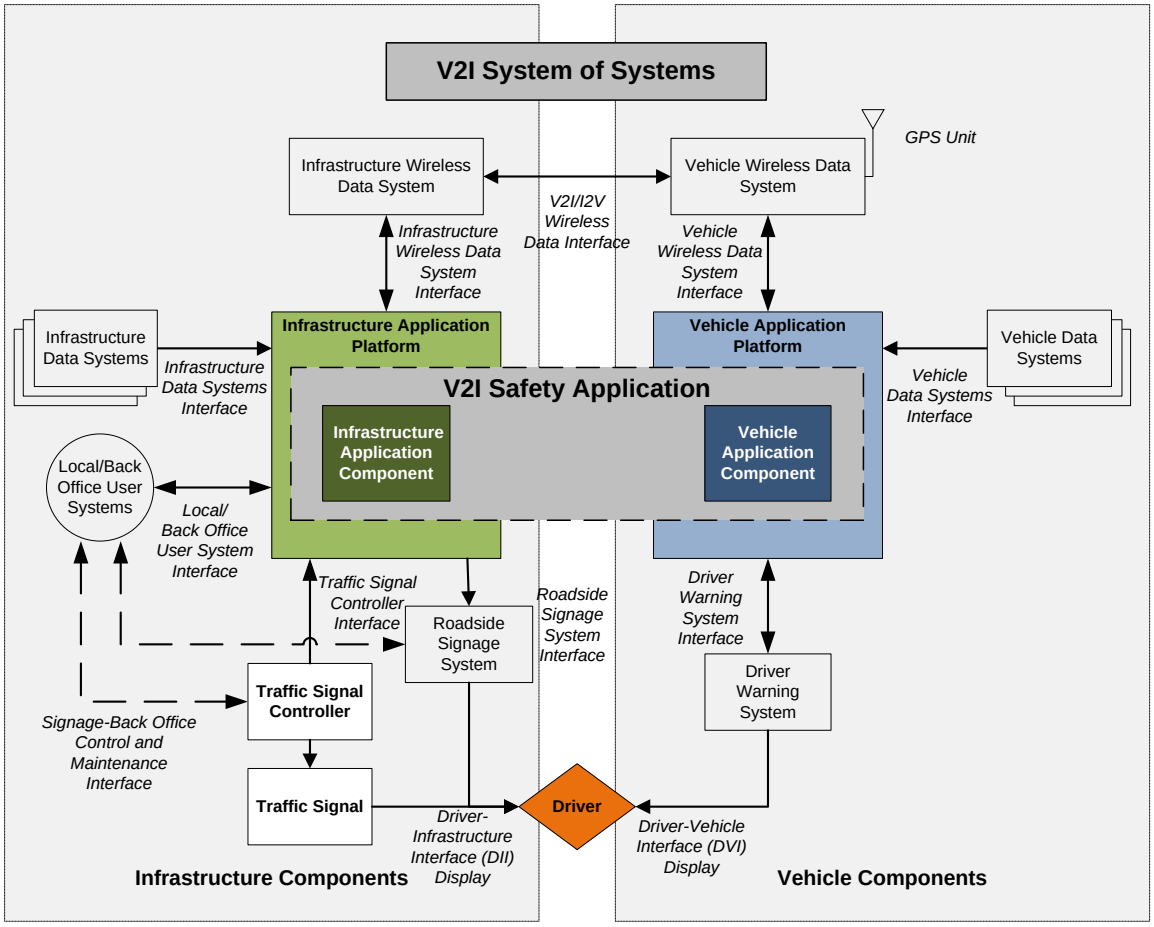
Each of the application components resides and operates on a computing platform that provides the necessary hardware and software data interfaces needed to exchange data with other systems. Each computing platform has an interface for wireless data systems that support with wireless exchange of data between the Infrastructure and Vehicle Application Components. From a requirements standpoint, the Application Components are independent from the form of wireless communication, it is expected that the primary form of communication between the two will be Dedicated Short Range Communication (DSRC).

The Infrastructure Application Platform also provides interfaces for data exchange with Infrastructure Data Systems, Local or Back Office User Systems and user interfaces, Traffic Signal Controllers and Roadside Signage Systems. The Vehicle Application Platform also provides interfaces for capture of data from vehicle systems and a driver warning system with a Driver-Vehicle Interface display.

The infrastructure application component issues messages through dynamic message signs that are visible to and applicable to all approaching vehicles and drivers. The vehicle application component issues messages through a driver warning interface that may be vehicle specific or may be the same as that displayed by dynamic message and static roadside signs. This V2I Safety Application is expected to coordinate and synchronize the display of roadside and in-vehicle messages to the driver.

Vehicle-specific messages for drivers may be equally or more cautious than roadside signs, but must never be less cautious. Vehicle-specific message must never conflict with roadside messages. For example, the vehicle application component in a truck carrying an unusual load with a high center of gravity and high rollover potential may recommend a lower vehicle-specific safe speed in a curve than the infrastructure application component recommends for all vehicles. However, the vehicle application component in a sports car under good road surface conditions must not recommend a higher safe speed in a curve than does the infrastructure signage.

An important concern and rationale for developing these Performance Requirements is that the vehicle and infrastructure components of the applications are likely to be developed and implemented by different entities. Infrastructure components may be developed by public state and local agency infrastructure owners and contractors and vehicle components may be developed by private vehicle manufacturers and suppliers.



Source: Battelle

Figure 3-1. Functional Architecture for Connected Vehicle V2I Safety Applications

3.2.1 System Components and Interfaces

As illustrated in Figure 3-1 there many components which make up the System-of-Interest (SOI) and supporting components. These components include:

- System-Of-Interest Components
  - Infrastructure Application Component
  - Vehicle Application Component
- Supporting Components
  - Infrastructure Application Platform
  - Infrastructure Wireless Data Systems (with GPS)
  - Infrastructure Data Systems
  - Roadside Signage System
  - Traffic Signal Controller
  - Traffic Signal
  - Local/Back Office User Systems

- Vehicle Application Platform
- Vehicle Wireless Data Systems (with GPS)
- Vehicle Data Systems
- Driver Warning System
- Driver

- Interfaces
  - V2I/I2V Wireless Data Interface
  - Infrastructure Wireless Data Systems Interface
  - Vehicle Wireless Data Systems Interface
  - Infrastructure Data Systems Interface
  - Vehicle Data Systems Interface
  - Roadside Signage System Interface
  - Driver Warning System Interface
  - Local/Back Office User Systems Interface
  - Traffic Signal Controller Interface

The function of each of these components and interfaces is described below.

3.2.1.1 Driver

The Driver is the consumer of information delivered by the safety application. Static roadside signage and dynamic Roadside Signage Systems and in-vehicle Driver Warning Systems convey information to drivers such as advisories, alerts, and warnings to make the driver aware of hazards in time to take action to prevent a potential crash.

3.2.1.2 Infrastructure Systems Components

Infrastructure Application Component is the infrastructure component of the V2I safety application. It obtains data from the Vehicle Application Component through the Infrastructure Wireless Data Systems, Infrastructure Data Systems, Traffic Signal Controller and Local/Back Office User Systems, processes the data and issues appropriate message to drivers through Infrastructure Wireless Data Systems and Roadside Signage Systems. The application also issues messages containing relevant data to the Vehicle Application Component through the Infrastructure Wireless Data Systems.

Infrastructure Application Platform is the computational platform which hosts the Infrastructure Application Component and provides the necessary hardware and software interfaces enabling communication with Infrastructure Wireless Data Systems, Infrastructure Data Systems, Roadside Signage System, Traffic Signal Controller, and Local/Back Office User Systems.

Roadside Signage System receives messages from the Infrastructure Application Component and delivers dynamic advisories and alerts to all approaching vehicles from the roadside.

Infrastructure Wireless Data System receives messages from the Infrastructure Application Component through the Infrastructure Application Platform, formats and processes the messages and issues the message via wireless communications to vehicles within wireless communication range. The System also performs the inverse, receiving wireless messages from nearby vehicles, formatting and processing the message and issuing the message to the Infrastructure Application Component through the Infrastructure Application Platform. The system also obtains universal time, coordinated (UTC) time.

Local/Back Office User System provides a technical user interface for the installation, configuration, maintenance, diagnostics, and management of the Infrastructure Application Component. The system may be a computer that is attached locally and temporarily to perform these functions or the system may connect remotely via dedicated lines or the Internet to perform these functions. The system may provide a function for upload or download of configuration and data files to the Infrastructure Application Platform. The system may also provide a connection to obtain GPS differential correction data.

Infrastructure Data Systems provide infrastructure data and information to the Infrastructure Application Component through the Infrastructure Application Platform. Examples of relevant data include weather information, road surface condition data, visibility data, and infrastructure-based vehicle detection and speed data.

Traffic Signal Controller is the external component that provide traffic signal phase and timing data required by some V2I Safety Applications through the Infrastructure Application Platform.

Traffic Signal is the traditional "driver display" component of the Traffic Signal Controller.

3.2.1.3 Vehicle System Components

Vehicle Application Component is the vehicle component of the V2I safety application. It obtains data from the Infrastructure Application Component through Vehicle Wireless Data Systems, Vehicle Data Systems, processes the data and issues appropriate messages to drivers through the Driver Warning System and Driver Vehicle Interface.

Vehicle Application Platform is the computational platform which hosts the Vehicle Application Component and provides the necessary hardware and software interfaces enabling communication with Vehicle Wireless Data Systems, Vehicle Data Systems, and the Driver Warning System.

Driver Warning System is the component which collects and arbitrates messages, advisories, alerts and warnings and delivers them to the driver. These alerts may be visual, aural, haptic, or some other means that captures the driver's attention and conveys the relevant information. When multiple safety applications are hosted on the Vehicle Applications Platform, the Driver Warning System will prioritize and arbitrate alerts and warnings from the multiple safety applications. Note: The placement of the Driver Warning System shown in Figure 3-1 is intended to show representative functionality and is not meant to restrict implementation.

Vehicle Wireless Data System receives messages from the Vehicle Application Component through the Vehicle Application Platform, formats and processes the messages and issues the message via wireless communications to Infrastructure Wireless Data Systems within wireless communication range. This system also performs the inverse, receiving wireless messages from nearby infrastructure, formatting and processing the message and issuing the message to the Vehicle Application Component through the Vehicle Application Platform. This system also obtains GPS location and time. It may include a processor for GPS differential correction.

Vehicle Data Systems represent systems contained within the vehicle that provide vehicle-related information to the Vehicle Application Component. Information provided may come from a positioning system, vehicle data bus, sensors, actuators on the vehicle, or stability systems. Specific interfaces to the original equipment manufacturers' (OEM) vehicle systems are dependent on specific information required to support the safety application.

3.2.1.4 V2I/I2V Wireless Data Interface

V2I/I2V Wireless Data Interface is the wireless communications interface that communicates relevant data between the Infrastructure and Vehicle Application Components through their respective Wireless Data Systems and Application Platforms.

3.2.1.5 Infrastructure System Interfaces

Infrastructure Wireless Data System Interface is the interface between the Infrastructure Application Platform and the Infrastructure Wireless Data Systems Component. This interface is used by the Infrastructure Applications Platform and the Infrastructure Applications Components to send and receive data to nearby vehicles via the V2I/I2V Wireless Data Interface.

Infrastructure Data Systems Interface is the interface between the Infrastructure Application Platform and Infrastructure Data Systems. The interface is used by Infrastructure Applications Platform to and Infrastructure Applications Components to capture data from infrastructure sensor systems such as weather information, road surface condition data, visibility data, and infrastructure-based vehicle detection and speed data.

Roadside Signage System Interface is the interface between the Infrastructure Applications Platform and the Roadside Signage System. The interface is used by Infrastructure Applications Platform to and Infrastructure Applications Components to send advisory and alert messages to local dynamic message signs at the roadside for display to all approaching vehicles.

Local/Back Office User System Interface supports IP communication with a computer that is attached locally or remotely via dedicated lines or the Internet to perform upload and download of data files as well as installation, configuration, maintenance, diagnostics, and management of the Infrastructure Application Component.

Traffic Signal Controller Interface is the interface between the Infrastructure Applications Platform and the local Traffic Signal Controller. The interface is used by Infrastructure Applications Platform to and Infrastructure Applications Components to capture traffic signal phase and timing data required by some V2I Safety Applications.

3.2.1.6 Vehicle System Interfaces

Vehicle Wireless Data System Interface is the interface between the Vehicle Application Platform and the Vehicle Wireless Data Systems component. This interface is used by the Vehicle Applications Platform and the Vehicle Applications Components to send and receive data to nearby infrastructure via the V2I/I2V Wireless Data Interface.

Vehicle Data Systems Interface is the interface between the Vehicle Application Platform and Vehicle Data Systems. The interface is used by Vehicle Applications Platform and Vehicle Applications Components to capture data from vehicle systems such as a positioning system, vehicle data bus, sensors, actuators on the vehicle, or stability systems.

Driver Warning System Interface is the interface between the Vehicle Application Platform and Driver Warning System. The interface is used by Vehicle Applications Platform and Vehicle Applications Components to send messages, advisories, alerts and warnings to the Warning System for arbitration and delivery to the driver.

3.3 Spot Weather Information Warning – Reduced Speed (SWIW-RS) Application Performance Requirements

3.3.1 SWIW-RS Application Introduction and Overview

Spot Weather Information Warning – Reduced Speed – Application designed to advise drivers of current adverse weather conditions in an upcoming weather zone and provide an alert if the vehicle's speed may be too high to safely traverse the zone. The application integrates data from infrastructure- and vehicle-based sensors, receives back office verification of adverse weather and/or roadway conditions, and determines recommended safe speeds and coordinates roadside and in-vehicle messages to alert the driver in time to slow to the recommended safe speed. The application is intended for multiple types of weather, including high winds, flood conditions, adverse road surface conditions due to ice, snow, or rain, or reduced visibility due to smoke or fog. This application is intended to advise of current or near-term adverse conditions detected by infrastructure- and vehicle-based sensors. The application does not address forecast weather conditions.

3.3.1.1 Application Purpose

The goal of the SWIW-RS application is to improve roadway safety by assisting drivers in avoiding weather-related crashes by informing the vehicle driver of potential weather-induced crash hazards and appropriate precautions, such as reduced speed. The application uses both infrastructure- and vehicle-based sensor data, to recommend safe speeds given current weather conditions. Recommendations are based upon available real-time weather and roadway conditions data and vehicle dynamics and stability telematics data. The application coordinates roadside messages for all vehicles with in-vehicle, vehicle-specific advisories and alerts to notify drivers in time for them to slow to the recommended safe speed before entering the weather zone.

The objective of SWIW-RS V2I Application is to deliver coordinated infrastructure- and vehicle-based advisories and alerts when adverse weather and/or roadway conditions are present that notify the driver of potentially unsafe vehicle speeds in sufficient time to slow the vehicle to recommended safe speeds.

3.3.1.2 Safety Impacts of Application

There will be several impacts on drivers in the deployment of V2I safety applications:

- ***Real-Time Messaging:*** The greatest impact is that drivers will receive real-time advisories and alerts while driving based on their current driving conditions and current weather and roadway conditions.
- ***Reduction in Weather Related Incidents:*** The SWIW-RS application should result in safer trips with fewer weather-related incidents on roadways.
- ***Effective Messaging (Format and Timing):*** The safety application is designed to provide drivers with a combination of haptic, visual, and/or audio messages in an effective format that does not distract or overwhelm them. These messages are designed to be presented to drivers in a timeframe that provides adequate reaction time to reduce speed and safely traverse an adverse weather zone.

- ***Modified Driving Behavior:*** It is expected that drivers will modify their driving behaviors in response to the applications' intended purposes, thus creating a safer driving environment. However, as drivers become more accustomed to the safety application, behavior may change as drivers rely more on the application and potentially assume a less active role in driving defensively. Becoming desensitized to and ignoring provided alerts is an example of a modified behavior that would compromise the safety benefits expected from this application.

3.3.1.3 Summary of Improvements

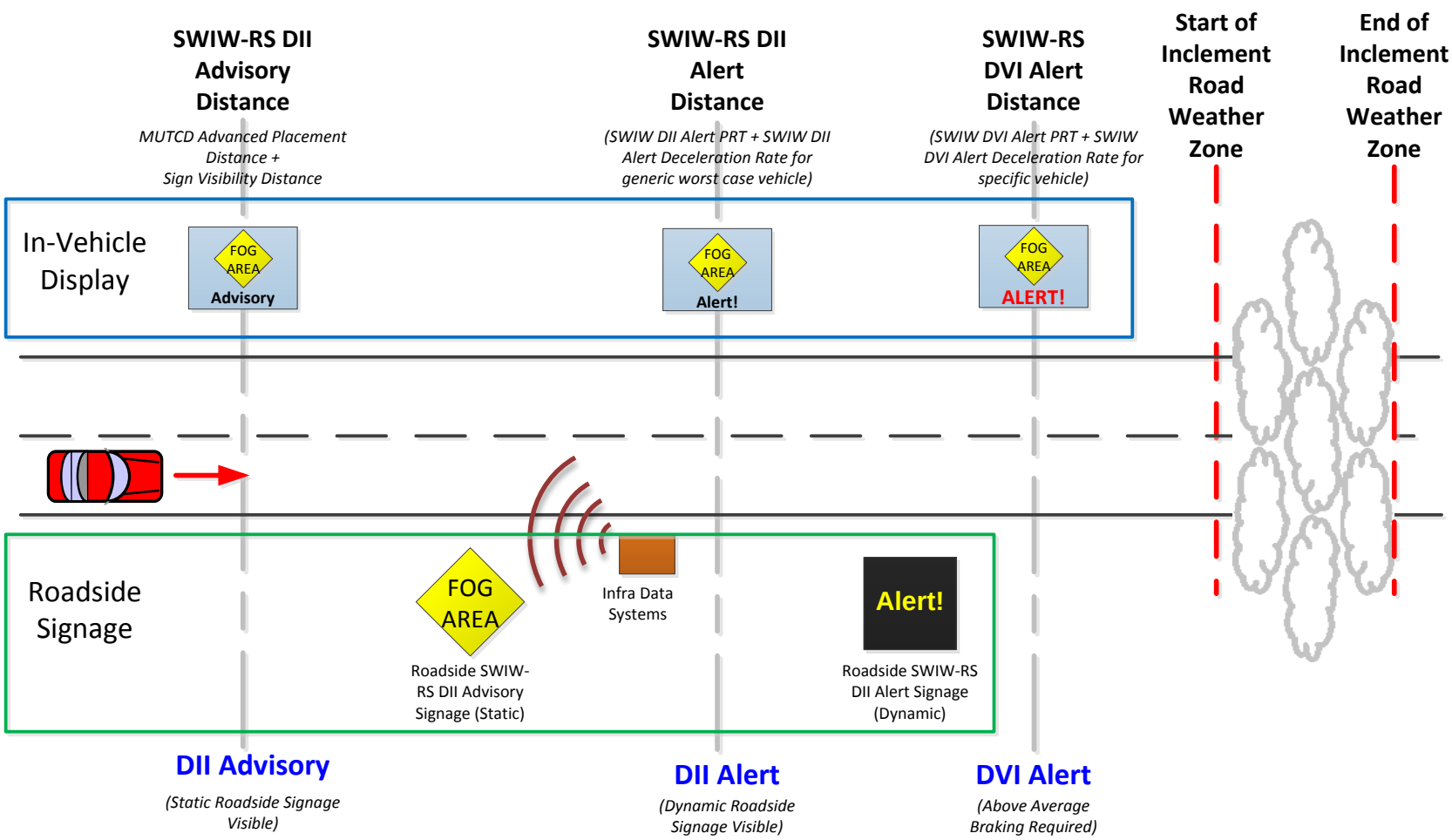
- ***Reduces number of run-off-road and multi-vehicle incidents due to excessive speed:*** SWIW-RS aids drivers by encouraging slower speeds, which could reduce run-off-road incidents in slippery conditions, and contribute to speed harmonization by providing reduced speed advisories thereby reducing multi-vehicle incidents during poor visibility from fog or smoke, for example. The application will provide messages to the driver regarding safe speeds based on current weather and roadway conditions.
- ***Increases driver awareness of current weather and roadway conditions:*** Unlike current applications, which largely provide a generic message about weather conditions, the connected vehicle application provides a real-time alert based on the driver's current driving conditions, unique to the driver and his or her vehicle. The application includes the capability of recommending reduced speeds based on weather and road conditions in real time via roadside equipment. The SWIW-RS application is functional for multiple types of weather, including high winds, flood conditions, adverse road surface conditions due to ice, snow, or rain, or reduced visibility due to smoke or fog.
- ***Provides real-time calculation of safe speed based on current conditions:*** SWIW-RS allows for the real-time calculation of a safe speed, based upon current road and weather conditions along with other vehicle telematics data to calculate a more accurate safe speed (as compared to current weather safety applications). The application is also capable of providing an alert within sufficient time for the driver to receive and react to it. The application is designed to provide an advisory message of the upcoming adverse weather zone, followed by an alert if applicable to assure driver awareness of the adverse weather and/or roadway conditions.

3.3.1.4 How the Application Works

The objective of SWIW-RS V2I Application is to deliver coordinated infrastructure- and vehicle-based advisories and alerts when adverse weather and/or roadway conditions are present that notify the driver of potentially unsafe vehicle speeds in sufficient time to slow the vehicle to recommended safe speeds.

Figure 3-2 below illustrates the key concepts and integration of roadway and in-vehicle signage. The figure shows the vehicle approaching the weather zone when adverse conditions are present. The box below the roadway illustrates roadside signage displayed to the driver. The driver may first encounter static (or fixed) weather signage advising the driver of an impending weather zone such as that shown in Figure 3-3. Driver Infrastructure Interface (DII) signage may include a graphic representation of the adverse weather type, an alert message, and/or an advisory or regulatory speed limit, when applicable. The location of this sign in advance of the weather zone is defined by the MUTCD advanced placement distance in Table 2C-4. Subsequently, the driver encounters a roadside

speed detection device and a DII dynamic message sign (DMS). DMS messages are typically text based, as illustrated in Figure 3-4, but may contain graphics. If the speed of the subject or any nearby vehicle exceeds a "DII Alert Speed" (generic safe vehicle speed) threshold for all vehicles, the DMS displays a DII Alert, such as flashing or some other accepted means of capturing the driver's attention. The SWIW-RS Infrastructure Application component delivers these roadside advisory and alert messages to the driver, based upon infrastructure-based sensor systems. The DII Alert Speed for all vehicles, defined below, is conditional based upon available weather or road surface conditions data available from the local road-weather information system (RWIS) and other infrastructure. Infrastructure-based signage and messaging is generic, intended for display to all drivers. While intended for all drivers, DII messages may be targeted for specific vehicle classes, such as commercial trucks, and include appropriate language to identify target vehicles.



Not to Scale

Source: Battelle

Figure 3-2. Illustration of SWIW-RS Roadside and In-Vehicle Signage

Source: MUTCD 2009 Ed.

Figure 3-3. Examples of Weather Condition Signage

Source: FHWA

Figure 3-4. Example of Dynamic Message Sign Weather Message

The box above the vehicle and road in the Figure 3-2, illustrates the coordinated in-vehicle SWIW-RS signage. This illustration assumes the vehicle includes a graphical Driver Vehicle Interface (DVI) display. As the vehicle approaches the weather zone when adverse conditions are present, the SWIW-RS Vehicle Application Component receives a wireless message from the infrastructure containing infrastructure-based sensor data and collects applicable dynamics and stability data from the vehicle. The SWIW-RS Vehicle Application Component computes the SWIW-RS DVI Alert Speed (or vehicle-specific safe speed), using both infrastructure-based sensor data and vehicle-based sensor data. This speed may be above or below the infrastructure-based SWIW-RS DII Alert Speed. For example, a heavy vehicle may have a lower vehicle-specific safe speed than the generic safe speed computed by the infrastructure. In contrast, a sports car under good road surface conditions may have a safe speed above the posted infrastructure based speed. The lesser of the (generic) SWIW-RS DII Alert Speed or the (vehicle specific) SWIW-RS DVI Alert Speed is used as the basis for in-vehicle alerts.

At approximately the same time that a driver would observe the static roadside advisory sign, the DVI displays a SWIW-RS speed advisory, containing the lesser of the SWIW-RS DVI Alert Speed or the SWIW-RS DII Alert Speed. (The distance at which the SWIW-RS Advisory is displayed in the vehicle in advance of the weather zone is the MUTCD “Sign Visibility Distance” plus the MUTCD Advanced placement Distance in Table 2C-4). If no alerts are warranted subsequently, the DVI continues to display the SWIW-RS speed advisory continuously, until the vehicle exits the weather zone.

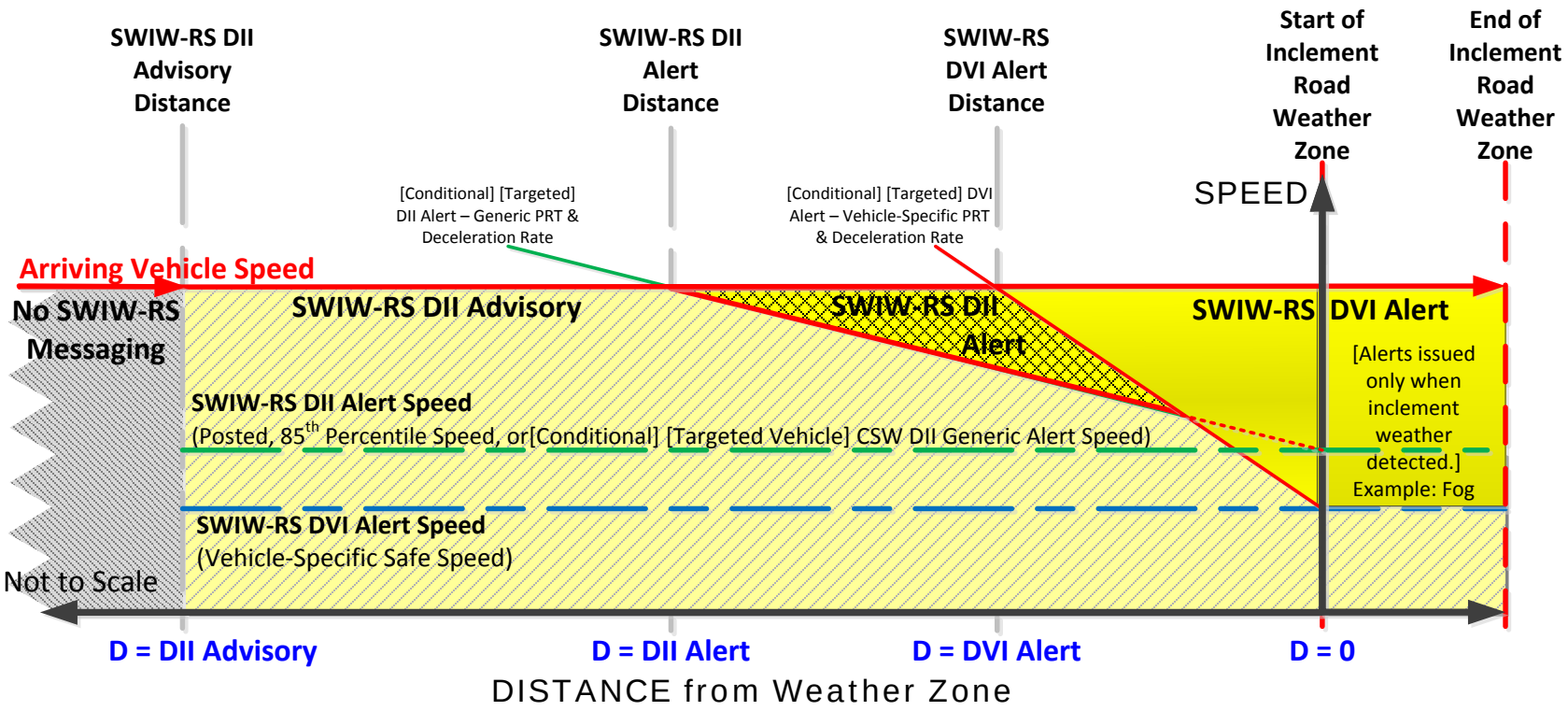
If the vehicle proceeds toward the weather zone above the advisory speed during adverse conditions, the SWIW-RS Vehicle Application Component computes and continuously updates the DVI Alert Distance for its current speed. The DVI Alert Distance is a distance at which *above average braking* is required to achieve the DVI Alert Speed at the weather zone. The Alert Distance is vehicle specific, dependent upon the DVI Alert Perception Reaction Time (PRT) and DVI Alert Deceleration Rate. They are conditional, based upon infrastructure weather or road surface conditions where data are available.

If the vehicle approaches the weather zone above the SWIW-RS DVI Alert Speed, a DVI Alert is issued when the distance to the weather zone is below the SWIW-RS DVI Alert Distance, for its given speed. If the vehicle decelerates to the SWIW-RS DII Alert Speed before the Alert Distance threshold is crossed, no DVI alerts are issued. As noted earlier, a SWIW-RS Advisory is displayed by default when adverse weather or roadway conditions are present.

Figure 3-5 illustrates advisories and alerts displayed within the vehicle as a function of vehicle speed and distance from the weather zone. It also illustrates how the DII Alert Distance and DVI Alert Distance are functions of perception reaction time and vehicle deceleration rates. (The SWIW-RS DII Alert Distance is the distance at which *above average braking* is required by a *generic worst case vehicle* to achieve the DII Alert Speed at the weather zone.)

The DII Alert Speed, DII Alert PRT and DII Alert Deceleration Rate (for generic worst case vehicles) are supplied to the vehicle application component by the infrastructure. The vehicle specific PRT and Deceleration rates are computed by the vehicle. They are conditional based upon infrastructure weather or road surface conditions where data are available.

Table 3-1 provides a definition of the terms used here for the SWIW-RS advisories and alerts. Table 3-2 provides a tabular summary of the DII and DVI display criteria, display signage and their distances from the weather zone.



Source: Battelle

Figure 3-5. Illustration of In-vehicle Signage as a Function of Vehicle Speed and Distance from Weather Zone Entrance

Table 3-1. Definition of SWIW-RS Terms

SWIW-RS DII Alert Speed	Generic, infrastructure-based recommendation for speed at which weather zone can be traversed safely. May be the posted speed, the current or typical 85th Percentile Speed[2], a conditional speed based upon weather or road surface conditions, or may be targeted speed for specific vehicles.
SWIW-RS DVI Alert Speed	Vehicle specific recommendation for speed at which the subject vehicle can traverse the weather zone safely. Based upon both infrastructure and vehicle data. Conditional, based upon weather or road surface conditions; defaults to DII Alert Speed for low visibility conditions.
SWIW-RS DII Advisory	Informative signage indicating a potentially adverse weather conditions ahead
SWIW-RS DII Alert	Dynamic signage indicating the speed of an approaching vehicle is above the SWIW-RS DII Alert Speed and a generic worst case vehicle must apply above average braking to achieve the DII Alert speed at the entrance to the adverse weather zone.
SWIW-RS DII Alert Distance	Generic, infrastructure-based recommendation for distance at which to display SWIW-RS DII Alert in the vehicle DVI. Distance at which above average braking is required by a generic worst case vehicle to achieve the DII Alert Speed at the weather zone. Dependent upon SWIW-RS DII Alert PRT, SWIW-RS DII Alert Deceleration Rate, and current environmental conditions.
SWIW-RS DII Alert PRT	Generic, infrastructure-based recommendation for Perception Reaction Time used in computing DII Alert Distance.
SWIW-RS DII Alert Deceleration Rate	Generic, infrastructure-based recommendation for vehicle deceleration rate used in computing DII Alert Distance.
SWIW-RS DVI Alert	In-vehicle display indicating the subject vehicle must apply above average braking to achieve the DVI Alert Speed at the entrance to the adverse weather zone.
SWIW-RS DVI Alert Distance	Vehicle specific recommendation for distance at which to display SWIW-RS DVI Alert. Distance at which above average braking is required by the subject vehicle to achieve the DVI Alert Speed at the entrance to the adverse weather zone. Dependent upon vehicle specific SWIW-RS DVI Alert PRT, SWIW-RS DVI Alert Deceleration Rate, and current environmental conditions.
SWIW-RS DVI Alert PRT	Vehicle specific recommendation for Perception Reaction Time used in computing DVI Alert Distance.
SWIW-RS DVI Alert Deceleration Rate	Vehicle specific recommendation for vehicle deceleration rate used in computing DVI Alert Distance.

Source: Battelle

[2] Manual on Uniform Traffic Control Devices (MUTCD) for Streets and Highways, 2009 edition, Federal Highway Administration, http://mutcd.fhwa.dot.gov/.

Table 3-2. Summary of SWIW-RS Infrastructure and Vehicle Displays

	Driver Infrastructure Interface			Driver Vehicle Interface		
	Display Criterion	**Display Signage**	**Distance from Entrance**	**Display Criterion**	**Display Signage***	**Distance from Entrance**
Stage 1 Advisory	Approaching weather zone, for which adverse weather and/or roadway conditions have been detected by the infrastructure and verified by the local/back office or traffic management center (TMC)	All vehicle Advisory to reduce speed to SWIW-RS DII Alert Speed	MUTCD Advanced Placement Distance	Received SWIW-RS I2V Wireless Message	If SWIW-RS DVI Alert Speed is less than SWIW-RS DII Alert Speed then display Vehicle-specific Advisory to reduce speed to SWIW-RS DVI Alert Speed; otherwise display all vehicle Advisory to reduce speed to the SWIW-RS DII Alert Speed prior to entering the adverse weather zone.	MUTCD Advanced Placement Distance + Sign Visibility Distance
Stage 2a Infrastructure Alert	Infrastructure detected speed of an approaching vehicle is above the SWIW-RS DII Alert Speed and a worst case vehicle must apply above average braking to achieve SWIW-RS DII Alert speed prior to entering the adverse weather zone.	All vehicle Alert to reduce speed to the SWIW-RS DII Alert Speed prior to entering the adverse weather zone.	MUTCD Advanced Placement Distance B	Received SWIW-RS I2V Wireless Message indicating infrastructure detected speed of approaching vehicle is above the SWIW-RS DII Alert Speed and a worst case vehicle must apply above average braking to achieve SWIW-RS DII Alert speed prior to the adverse weather zone.	All vehicle Alert to reduce speed to the SWIW-RS DII Alert Speed prior to entering the adverse weather zone.	Distance at which above average braking is required by a worst case vehicle to achieve the SWIW-RS DII Alert Speed prior to entering the adverse weather zone.
Stage 2b Vehicle Specific Alert	N/A	N/A	N/A	Speed of the subject vehicle is above the SWIW-RS DVI Alert Speed and the vehicle must apply above average braking to achieve the SWIW-RS DVI Alert speed prior to the adverse weather zone; or the vehicle is exceeding the SWIW-RS speed within the adverse weather zone.	Vehicle-specific Alert to reduce speed to SWIW-RS DVI Alert Speed prior to or within the adverse weather zone.	Distance at which above average braking is required by subject vehicle to achieve the SWIW-RS DVI Alert Speed prior to entering the adverse weather zone; continues to the end of adverse weather zone.

* If applicable, DVI displays Stage 2b Vehicle-specific Alert; otherwise if applicable DVI displays Stage 2a Infrastructure Alert; otherwise if applicable, DVI displays Vehicle-specific Advisory (DVI Alert Speed); otherwise, DVI displays all vehicle Advisory (DII Alert Speed).

Source: Battelle

3.3.1.5 Application Assumptions and Considerations

Assumptions

- The vehicle is driving along a route equipped with a SWIW-RS application.
- The vehicle is en route to a destination requiring it to traverse a stretch of roadway with adverse weather conditions that disproportionately impact safety.
- The SWIW-RS application is intended for a variety of weather conditions, which could require minor modifications during deployment for adaptation to local conditions.
- Issuance of speed recommendations will vary by local policy and weather type. During a low visibility condition, e.g., fog, smoke, etc., DII Alert Speed will equal DVI Alert Speed to achieve speed harmonization and reduce the likelihood of a vehicle overtaking another vehicle. Other weather events, e.g., high winds, could utilize a recommended slower speed for only specific vehicle types including trucks.
- Recommended speeds may be advisory only or enforceable. The application will likely issue recommended speeds that are less than the static posted speed limit for the roadway.
- The SWIW-RS application might be used in conjunction with other connected vehicle applications.
- In the case of an equipped vehicle, if any data element is unavailable for calculating an appropriate speed, a previously determined default value will be used by the application to compute a safe speed.
- Weather data from local RWIS and sensors are first validated by the local/back office or TMC before being used to compute SWIW-RS advisories or alerts.
- The SWIW-RS DII Roadside Sign is connected to the back office and can be used for non-SWIW-RS messages.

Considerations

The SWIW-RS system is intended to advise and alert the equipped vehicle only about possible weather-related conditions and the need to slow down. The system does not account for other drivers on the roadway or their driving behavior.

3.3.1.6 Application Swim Lane & Sequence Diagrams

As the next step in the description of the SWIW-RS Application, Figure 3-6 provides a swim-lane process diagram for the SWIW-RS application illustrating the sequence of data flows and processing by the SWIW-RS Infrastructure Application Component and the SWIW-RS Vehicle Application Component. The figure includes the V2I Systems architecture diagram presented earlier for reference.

At a high level, the SWIW-RS Infrastructure Application Component monitors current weather data and if adverse conditions are present receives back office validation before obtaining remaining infrastructure, local/back office, and vehicle data inputs, determines if an advisory or alert is warranted, and, if so, issues a SWIW-RS Roadside Signage Message to the Roadside Signage System for display and a SWIW-RS I2V Wireless Data Message to the Infrastructure Wireless Data System for broadcast to nearby vehicles. Upon receipt of a SWIW-RS I2V Wireless Data Message, the Vehicle Application Platform initiates the SWIW-RS Vehicle Application Component. The SWIW-RS Vehicle

Application Component obtains I2V, position and map data inputs, determines if a driver alert is warranted and, if so, issues a SWIW-RS Driver Alert Message to the Driver Warning System. These processes are performed at a rate of 10 Hz to update SWIW-RS Roadside Signage Message and the SWIW-RS Driver Alert Message to drivers whose vehicles are rapidly approaching the spot weather zone and may need to reduce speed. This diagram illustrates the concepts that are the basis for SWIW-RS application requirements enumerated in section 3.6.2 and 3.6.3.

Source: Battelle

Figure 3-6. Swim Lane Process Diagram for the SWIW-RS Application

3.3.1.7 Messages Exchanged and Used by the Application

For the purposes of these requirements, the data exchanged between system components, across system interfaces are encapsulated in ten messages summarized in Table 3-3 below. The table summarizes the message name, the source and recipient of the message, general description of the message content, location for description of data elements, and purpose of the message. In some cases such as the Basic Safety Message, the message is defined in an existing standard, such as SAE J2735. For further reference and background information, Appendix A suggests candidate data elements which may be included in these messages to support the SWIW-RS safety application algorithms. Table A-1 provides an explanation of the headers in candidate data tables. As noted in Table 3-3, Table A-2 through Table A-7 describe the candidate data elements for each of the messages. This information is provided for guidance when implementing the performance requirements specified in this document.

Table 3-3. Summary of Messages used by SWIW-RS Application Components

Message	Input Source	Output Recipient	Content Utilized	Data Description	Purpose
Infrastructure Component Messages					
SWIW-RS Infrastructure Systems Message	External Vehicle Detection System, Infra Data System – Road Surface, Infra Data System – Local Weather	Infra Application Component	Detection of approaching vehicles and their speed, road surface conditions, local weather conditions	Table A-2 SWIW-RS Infrastructure Systems Message Data Description	Used as input by SWIW-RS Infrastructure Application Component to determine if vehicles are approaching the adverse weather zone and the generic safe speed. Road surface and weather data are forwarded to the Vehicle Application Component through the SWIW-RS I2V Wireless Message
SWIW-RS Roadside Signage Message	Infra Application Component	Roadside Signage System	SWIW-RS Roadside Signage message content	Table A-3 SWIW-RS Roadside Signage Message Data Description	SWIW-RS message content to be displayed on dynamic roadside signage.
SWIW-RS Infrastructure Map Message	Local-Back Office Users Systems Interface	Infrastructure Map Message Handler	Detailed map of weather zone, including roadside signage	Table A-4 SWIW-RS Map Message Data Description	Used as input by SWIW-RS Vehicle Application Component to determine if subject vehicle is approaching the weather zone and the vehicle-specific safe speed. May be uploaded through an externally generated data file.
V2I/I2V Messages					
Basic Safety Message	Vehicle Basic Safety Message Generator	Infrastructure Application Component	Vehicle location, speed and heading	SAE J2735 Basic Safety Message	Data used by Infrastructure Application Component to determine if vehicles are approaching adverse weather reduced speed zone and, if so, their speed.
SWIW-RS I2V Wireless Message	Infra Application Component	Vehicle Application Component	SWIW-RS Operational Data, Road Surface Condition, Local Weather Data	Table A-5 SWIW-RS I2V Wireless Message Data Description	Data used by vehicle application component to determine vehicle-specific safe speed, assess weather conditions, and content and distance at which to issue advisories and alerts.
SWIW-RS	Infrastructure Map	Vehicle	Detailed map of	Table A-4 SWIW-RS	Used as input by SWIW-RS Vehicle Application Component

Table 3-3. Summary of Messages used by SWIW-RS Application Components (Continued)

Message	Input Source	Output Recipient	Content Utilized	Data Description	Purpose
Wireless Map Message	Message Handler	Application Component	weather zone, including roadside signage.	Map Message Data Description	to determine if subject vehicle is approaching the weather zone and the vehicle-specific safe speed.
Wireless Position Correction Message	Infrastructure Position Correction Message Handler	Vehicle GPS Message Handler	Differential GPS Correction Data	SAE J2735 RTCM Corrections Message	Used as input by vehicle application component to determine if advisories, alerts and warnings are warranted.
Vehicle Component Messages					
GPS Position Message	Vehicle GPS Position Message Handler	Vehicle Application Component	Location, speed, heading of subject vehicle	SAE J2735 Full Position Vector	Use by the SWIW-RS Vehicle Application Component to determine vehicle position, speed and heading to determine if and when to issue advisories, alerts, or warnings.
SWIW-RS Vehicle Systems Message	Vehicle Data Systems	Vehicle Application Component	Vehicle Characteristics, Vehicle Functional Status, Vehicle Environmental Data	Table A-6 SWIW-RS Vehicle Systems Message Data Description	Used as input by SWIW-RS Vehicle Application Component to determine the vehicle-specific safe speed.
SWIW-RS Driver Warning Message	Vehicle Application Component	Driver Warning System	SWIW-RS in-vehicle message content	Table A-7 SWIW-RS Driver Warning Message Data Description	SWIW-RS message content to be displayed on in-vehicle displays.

Source: Battelle

3.3.2 SWIW-RS Infrastructure Application Component Requirements

Table 3-4 catalogs the performance requirements for the SWIW-RS Infrastructure Application Component. These were developed based upon the integration strategy described in Section 3.3.1.4 above. It is expected that, as connected vehicle technology evolves and vehicle and infrastructure application component owners develop this and other V2I Safety Applications, the rationales, frameworks, and performance requirements presented here will evolve. Accordingly, before embarking upon design and development, application owners should update and refine the requirements to reflect current standards and policies. It is the responsibility of the designer to ensure that the resulting applications do not conflict with applicable published state and national regulations, policies, and guidelines.

Table 3-4. SWIW-RS Infrastructure Application Component Performance Requirements

Rqmt. No.	Requirement Title	Performance Requirement	Elaboration	Verif. Method (I,D,T,A)
5.01	**SWIW-RS Infrastructure Application Component Requirements**			
5.01.01	**SWIW-RS Infrastructure Application Component Interfaces and Interface Specifications**			
[5.01.01.01]	**SWIW-RS Infrastructure Systems Message Interface**	**The SWIW-RS Infrastructure Application Component shall obtain SWIW-RS Infrastructure Systems Messages through the Infrastructure Data Systems Interface.**		D
[5.01.01.02]	**Basic Safety Message Interface**	**The SWIW-RS Infrastructure Application Component shall obtain Basic Safety Messages through the Infrastructure Wireless Data Systems Interface.**		D
[5.01.01.03]	**SWIW-RS Local/Back Office User Data Interface**	**The SWIW-RS Infrastructure Application Component shall obtain SWIW-RS Local/Back Office User Data through the Local/Back Office User Systems Interface.**		D
[5.01.01.04]	**SWIW-RS I2V Wireless Message Interface**	**The SWIW-RS Infrastructure Application Component shall issue SWIW-RS I2V Wireless Messages through the Infrastructure Wireless Data Systems Interface.**		D
[5.01.01.05]	**SWIW-RS Roadside Signage Message Interface**	**The SWIW-RS Infrastructure Application Component shall issue SWIW-RS Roadside Signage Messages through the Roadside Signage System Interface.**		D

Table 3-4. SWIW-RS Infrastructure Application Component Performance Requirements (Continued)

Rqmt. No.	Requirement Title	Performance Requirement	Elaboration	Verif. Method (I,D,T,A)
5.01.02	**SWIW-RS Infrastructure Application Component Functional Requirements**			
[5.01.02.01]	**Common Infrastructure Application Component Requirements**	**The SWIW-RS Infrastructure Application Component shall adhere to Common Infrastructure Application Component Requirements.**		D
[5.01.02.02]	**SWIW-RS Infrastructure Systems Message Initiation**	**The SWIW-RS Infrastructure Application Component shall obtain SWIW-RS Infrastructure Systems Messages upon initiation of the component.**		D
[5.01.02.03]	**SWIW-RS Infrastructure Systems Data – Vehicle Speed**	**The SWIW-RS Infrastructure Application component shall obtain speed and distance of approaching vehicles from Infrastructure Data Systems before the vehicles are within the SWIW-RS DII Advisory Distance of the reduced speed zone entrance.**	*The SWIW-RS DII Advisory Distance is the distance from the beginning of the reduced speed zone defined in the MUTCD Table 2C-4, Guidelines for Advance Placement of Warning Signs plus the sign visibility distance. The SWIW-RS Infrastructure Application component does not correlate connected vehicle and infrastructure data. It processes each independently and issues advisories or alerts if any vehicle meets the relevant criteria.*	D
[5.01.02.04]	**SWIW-RS Infrastructure Systems Message Refresh Rate**	**The SWIW-RS Infrastructure Application Component shall refresh the SWIW-RS Infrastructure Systems Message at a configurable frequency.**	*Table (SWIW-RS Infrastructure) SWIW-RS Infrastructure Systems Data Description is referenced for guidance.*	D
[5.01.02.05]	**Basic Safety Message Initiation**	**The SWIW-RS Infrastructure Application Component shall obtain Basic Safety Messages upon initiation of the component.**	*The SWIW-RS Infrastructure Application component does not correlate connected vehicle and infrastructure data. It processes each independently and issues advisories or alerts if any vehicle meets the relevant criteria.*	D

Table 3-4. SWIW-RS Infrastructure Application Component Performance Requirements (Continued)

Rqmt. No.	Requirement Title	Performance Requirement	Elaboration	Verif. Method (I,D,T,A)
[5.01.02.06]	**Basic Safety Message Vehicle Speed**	**The SWIW-RS Infrastructure Application component shall obtain speed and distance of approaching vehicles from Basic Safety Messages before the vehicles are within the SWIW-RS DII Advisory Distance of the reduced speed zone entrance.**	*The SWIW-RS DII Advisory Distance is the distance from the beginning of the reduced speed zone defined in the MUTCD Table 2C-4, Guidelines for Advance Placement of Warning Signs plus the sign visibility distance. The SWIW-RS Infrastructure Application component does not correlate connected vehicle and infrastructure data. It processes each independently and issues advisories or alerts if any vehicle meets the relevant criteria.*	D
[5.01.02.07]	**Basic Safety Message Refresh Rate**	**The SWIW-RS Infrastructure Application Component shall refresh Basic Safety Messages at a configurable frequency.**	*Table (SWIW-RS Local-Back Office) SWIW-RS Local-Back Office User Systems Data Description is referenced for guidance.*	D
[5.01.02.08]	**SWIW-RS Local/Back Office User Data Initiation**	**The SWIW-RS Infrastructure Application Component shall obtain SWIW-RS Local/Back Office User Data upon initiation of the component.**		D
[5.01.02.09]	**GPS Position Accuracy**	**GPS Position data used by the SWIW-RS Vehicle Application Component shall be of at least Road Level Position Accuracy.**	*Road Level Position Accuracy is defined under Common Infrastructure Application Component Requirements.*	D
[5.01.02.10]	**SWIW-RS Local/Back Office User Data Refresh Rate**	**The SWIW-RS Infrastructure Application Component shall refresh SWIW-RS Local/Back Office User Data at a configurable frequency.**	*Table (SWIW-RS Local-Back Office) SWIW-RS Local-Back Office User Systems Data Description is referenced for guidance.*	D
[5.01.02.11]	**Map Data Accuracy**	**Map data used by SWIW-RS Vehicle Application Component shall be of at least Road Level Position Accuracy.**	*Road Level Position Accuracy is defined under Common Infrastructure Application Component Requirements.*	D
[5.01.02.12]	**Map Data Accuracy**	**Map data used by the SWIW-RS Infrastructure Application Component shall be of at least Road**	*Road Level Position Accuracy is defined under Common Infrastructure Application Component*	D

Table 3-4. SWIW-RS Infrastructure Application Component Performance Requirements (Continued)

Rqmt. No.	Requirement Title	Performance Requirement	Elaboration	Verif. Method (I,D,T,A)
		Level Position Accuracy.	*Requirements.*	
[5.01.02.13]	**Approaching Vehicle Characterization**	**The SWIW-RS Infrastructure Application Component shall assess SWIW-RS Infrastructure Systems Approaching Vehicle Data and SWIW-RS Vehicle Data and determine if vehicle(s) are approaching the inclement road weather zone, and, if so, the distance and approaching speed of each.**		D
[5.01.02.14]	**Determine Presence of Adverse Weather Conditions**	**The SWIW-RS Infrastructure Application Component shall determine the real-time weather conditions for the specified inclement road weather zone using infrastructure systems weather data.**		D
[5.01.02.15]	**Receive Back Office Verification of Adverse Weather Conditions**	**If the SWIW-RS Infrastructure Application Component determines adverse weather conditions are present in the inclement road weather zone, the local/back office shall assess current weather conditions, either confirming the weather conditions found by the infrastructure systems, or revising the conditions based on back office information.**		D
[5.01.02.16]	**Compute [Conditional] [Targeted] SWIW-RS DII Alert Speed**	**If the SWIW-RS DII advisories and SWIW-RS DII alerts are conditional (e.g. based upon weather or road conditions) and/or targeted (e.g. for specific vehicle classes) the SWIW-RS Infrastructure Application Component shall compute the [Conditional] [Targeted] SWIW-RS DII Alert Speed for the specified class of vehicles using current available SWIW-RS Infrastructure Data.**		D

Table 3-4. SWIW-RS Infrastructure Application Component Performance Requirements (Continued)

Rqmt. No.	Requirement Title	Performance Requirement	Elaboration	Verif. Method (I,D,T,A)
[5.01.02.17]	**Compute [Conditional] [Targeted] SWIW-RS DII Alert Deceleration Rates**	**If the SWIW-RS DII advisories and SWIW-RS DII alerts are conditional (e.g. based upon weather or road conditions) and/or targeted (e.g. for specific vehicle classes) the SWIW-RS Infrastructure Application Component shall compute the [Conditional] [Targeted] SWIW-RS DII Alert Deceleration Rate for the specified class of vehicles using current available SWIW-RS Infrastructure Data.**	*The following information is referenced for guidance: 0.34g is the uniform deceleration rate required to safely stop a fully loaded (new) tractor trailer as defined in NHTSA FMVSS 121. 0.56g is the uniform deceleration rate required to safely stop a fully passenger vehicle as defined in NHTSA FMVSS 135. Industry guidelines and/or local policy should provide guidance on deceleration rates for specific circumstances.*	D
[5.01.02.18]	**Compute [Conditional] [Targeted] SWIW-RS DII Alert Perception Reaction Time**	**If the SWIW-RS DII advisories and SWIW-RS DII alerts are conditional (e.g. based upon weather or road conditions) and/or targeted (e.g. for specific vehicle classes) the SWIW-RS Infrastructure Application Component shall compute the [Conditional] [Targeted] SWIW-RS DII Alert Perception Reaction Time for the specified class of vehicles using current available SWIW-RS Infrastructure Data.**		D
[5.01.02.19]	**Determine SWIW-RS DII Alert Speed**	**If the SWIW-RS Infrastructure Application Component determines and receives validation from the back/local office of adverse weather conditions, the SWIW-RS Infrastructure Application Component shall determine the SWIW-RS DII Alert Speed based on real-time conditions, (e.g. the posted speed, the 85th percentile speed or the [Conditional] [Targeted] SWIW-RS DII Alert Speed) for the specified inclement road weather zone.**		D

Table 3-4. SWIW-RS Infrastructure Application Component Performance Requirements (Continued)

Rqmt. No.	Requirement Title	Performance Requirement	Elaboration	Verif. Method (I,D,T,A)
[5.01.02.20]	**Determine SWIW-RS DII Alert Deceleration Rate**	**If the SWIW-RS Infrastructure Application Component determines and receives validation from the back/local office of adverse weather conditions, the SWIW-RS Infrastructure Application Component shall determine the SWIW-RS DII Alert Deceleration Rate based on real-time conditions, (e.g. the posted speed, the 85th percentile speed or the [Conditional] [Targeted] SWIW-RS DII Alert Speed) for the specified inclement road weather zone.**		D
[5.01.02.21]	**Determine SWIW-RS DII Alert Perception Reaction Time**	**If the SWIW-RS Infrastructure Application Component determines and receives validation from the back/local office of adverse weather conditions, the SWIW-RS Infrastructure Application Component shall determine the SWIW-RS DII Alert Perception Reaction Time based on real-time conditions, (e.g. the posted speed, the 85th percentile speed or the [Conditional] [Targeted] SWIW-RS DII Alert Speed) for the specified inclement road weather zone.**		D
[5.01.02.22]	**SWIW-RS DII Advisory Distance Definition**	**The SWIW-RS DII Advisory Distance shall be the distance from the beginning of the inclement road weather zone defined in the MUTCD Table 2C-4, Guidelines for Advance Placement of Warning Signs plus the sign visibility distance.**	*The DII Advisory Distance is typically static, defined by the MUTCD Table 2C-4.*	D
[5.01.02.23]	**SWIW-RS DII Alert Distance Definition**	**The SWIW-RS DII Alert Distance shall be the distance traveled during the SWIW-RS DII Alert Perception Reaction Time plus the distance required to slow the detected vehicle from its measured speed to the SWIW-RS DII Alert Speed, at a uniform deceleration equal to the SWIW-RS DII Alert Deceleration Rate.**		D

Table 3-4. SWIW-RS Infrastructure Application Component Performance Requirements (Continued)

Rqmt. No.	Requirement Title	Performance Requirement	Elaboration	Verif. Method (I,D,T,A)
[5.01.02.24]	**Compute SWIW-RS DII Advisory Distance**	**If the SWIW-RS Infrastructure Application Component determines and receives validation from the back/local office of adverse weather conditions, the SWIW-RS Infrastructure Application Component shall determine the SWIW-RS DII Advisory Distance based upon MUTCD guidelines.**		D
[5.01.02.25]	**Compute SWIW-RS DII Alert Distance**	**If the SWIW-RS Infrastructure Application Component determines and receives validation from the back/local office of adverse weather conditions, the SWIW-RS Infrastructure Application Component shall compute the SWIW-RS DII Alert Distance for each approaching vehicle using the SWIW-RS DII Alert Speed, the SWIW-RS Alert Deceleration Rate and the SWIW-RS DII Alert Perception Reaction Time.**		D
[5.01.02.26]	**SWIW-RS DII Content General**	**SWIW-RS DII content shall use a prohibitive frame, indicating that conditions may be unsafe.**	*SWIW-RS DII content shall not indicate that conditions are safe.*	D
[5.01.02.27]	**SWIW-RS DII Alert Criterion for Roadside Signage**	**If the distance of any approaching vehicle is less than its SWIW-RS DII Alert Distance then the SWIW-RS Infrastructure Application Component shall issue a SWIW-RS Roadside Signage Message containing a current SWIW-RS DII Alert to the Roadside Signage System Interface.**	*The DII Alert Distance is negative when vehicle speeds are below the DII Alert Speed, such that no alert is issued.*	D

Table 3-4. SWIW-RS Infrastructure Application Component Performance Requirements (Continued)

Rqmt. No.	Requirement Title	Performance Requirement	Elaboration	Verif. Method (I,D,T,A)
[5.01.02.28]	**SWIW-RS DII Advisory Criterion for Roadside Signage**	**If the distance of any approaching vehicle is less than the SWIW-RS DII Advisory Distance and greater than or equal to its SWIW-RS DII Alert Distance then the SWIW-RS Infrastructure Application Component shall issue a SWIW-RS Roadside Signage Message containing a current SWIW-RS DII Advisory to the Roadside Signage System Interface.**	*A DII Advisory message is issued to Roadside Signage Systems and Wireless Data Systems when a vehicle is within sight of an advisory sign (static).*	D
[5.01.02.29]	**SWIW-RS DII Alert Criterion for I2V Message**	**If the distance of any approaching vehicle is less than its SWIW-RS DII Alert Distance then the SWIW-RS Infrastructure Application Component shall issue a SWIW-RS I2V Message containing a current SWIW-RS DII Alert to the Infrastructure Wireless Data Systems Interface.**	*The DII Alert Distance is negative when vehicle speeds are below the DII Alert Speed, such that no alert is issued.*	D
[5.01.02.30]	**SWIW-RS DII Advisory Criterion for I2V Message**	**If the distance of any approaching vehicle is less than the SWIW-RS DII Advisory Distance and greater than or equal to its SWIW-RS DII Alert Distance then the SWIW-RS Infrastructure Application Component shall issue a SWIW-RS I2V Message containing a current SWIW-RS DII Advisory and the SWIW-RS DII Alert Speed to the Infrastructure Wireless Data Systems Interface.**	*A DII Advisory message is issued to Roadside Signage and Wireless Data when a vehicle is within sight of a caution advisory sign (static).*	D

Table 3-4. SWIW-RS Infrastructure Application Component Performance Requirements (Continued)

Rqmt. No.	Requirement Title	Performance Requirement	Elaboration	Verif. Method (I,D,T,A)
[5.01.02.31]	**SWIW-RS Infrastructure Application Component Caution (Error) Message for Roadside Signage Criterion**	**In the event of an input data, computational or other recoverable SWIW-RS Infrastructure Application Component error, preventing issuing of SWIW-RS DII advisories, or SWIW-RS DII alerts, the SWIW-RS Infrastructure Application Component shall issue a SWIW-RS Roadside Signage Message containing a SWIW-RS DII Caution (Error) and an indication of SWIW-RS Infrastructure Application Component Error to the Roadside Signage System Interface.**	*Caution message is displayed when denoting an error.*	D
[5.01.02.32]	**SWIW-RS Infrastructure Application Component Caution (Error) Criterion for I2V Message**	**In the event of an input data, computational or other recoverable SWIW-RS Infrastructure Application Component error, preventing issuing of SWIW-RS DII advisories, or SWIW-RS DII alerts, the SWIW-RS Infrastructure Application Component shall issue a SWIW-RS I2V Message containing a SWIW-RS DII Caution (Error) and an indication of SWIW-RS Infrastructure Application Component Error to the Infrastructure Wireless Data Systems Interface.**	*Caution message is displayed when denoting an error.*	D
[5.01.02.33]	**SWIW-RS Weather Condition Input Data Refresh Frequency**	**The SWIW-RS Infrastructure Application Component shall repeat validation of adverse weather conditions at a configurable frequency based on local TMC guidelines (e.g., time threshold, weather type).**	*The time thresholds for weather data being communicated from the infrastructure to the vehicle and the location of infrastructure component relative to the weather zone must allow for the vehicle application to calculate and issue timely and valid advisory, alert, and warning messages at the beginning of the weather zone.*	D

Table 3-4. SWIW-RS Infrastructure Application Component Performance Requirements (Continued)

Rqmt. No.	Requirement Title	Performance Requirement	Elaboration	Verif. Method (I,D,T,A)
5.01.03	**SWIW-RS Infrastructure Application Component Data Input Requirements**			
[5.01.03.01]	**SWIW-RS Infrastructure Systems Message Content**	**The SWIW-RS Infrastructure Systems Message shall contain data required to perform the calculations specified under SWIW-RS Infrastructure Application Functional Requirements.**	*Table (SWIW-RS Infrastructure) SWIW-RS Infrastructure Systems Message Data Description is referenced for guidance.*	D
[5.01.03.02]	**SWIW-RS Infrastructure Systems Message Specification for Vehicle Speed Sensors**	**The SWIW-RS Infrastructure Systems Message for capturing data from local Infrastructure-based Vehicle Speed Sensor Systems shall conform to NTCIP 1209 v02 Object Definitions for Transportation Sensor Systems (TSS).**		D
[5.01.03.03]	**SWIW-RS Infrastructure Systems Message Specification for Environmental Sensor Stations**	**The SWIW-RS Infrastructure Systems Message for capturing data from local ESS Interface shall conform to NTCIP 1204 v03 Object Definitions for Environmental Sensor Stations (ESS) Standard.**		D
[5.01.03.04]	**Basic Safety Message Specification**	**The Basic Safety Message messages shall conform to SAE J2735:2009-11 Dedicated Short Range Communications (DSRC) Message Set Dictionary.**		D
[5.01.03.05]	**SWIW-RS Local/Back Office User Data Content**	**The SWIW-RS Local/Back Office User Data shall contain data required to perform the calculations specified under SWIW-RS Infrastructure Application Functional Requirements.**	*Table (SWIW-RS Infrastructure) SWIW-RS Infrastructure Systems Message Data Description is referenced for guidance.*	D

Table 3-4. SWIW-RS Infrastructure Application Component Performance Requirements (Continued)

Rqmt. No.	Requirement Title	Performance Requirement	Elaboration	Verif. Method (I,D,T,A)
[5.01.03.06]	**SWIW-RS Local/Back Office User Data Specifications**	**The SWIW-RS Local/Back Office User Data and all Local/Back Office User System messages shall conform to Traffic Management Data Dictionary (TMDD) Standard v3.03 for the Center-to-Center Communications.**		D
[5.01.03.07]	**SWIW-RS Local/Back Office User Data Content Text**	**The SWIW-RS Local/Back Office User Data shall contain text used in SWIW-RS DII Advisory and SWIW-RS DII Alert roadway signage.**		D
[5.01.03.08]	**SWIW-RS Local/Back Office User Data Content Prohibitive Frame**	**SWIW-RS DII advisory and SWIW-RS DII alert text shall use a prohibitive frame indicating when unsafe conditions may exist.**	*Prohibitive frame means that DII advisory and DII alert messages shall not indicate that conditions may be safe.*	D
[5.01.03.09]	**SWIW-RS Local/Back Office User Data Content Graphics**	**The SWIW-RS Local/Back Office User Data shall contain shapes and graphics used in SWIW-RS DII Advisory and SWIW-RS DII Alert roadway signage.**		D
5.01.04	**SWIW-RS Infrastructure Application Component Data Output Requirements**			
[5.01.04.01]	**SWIW-RS I2V Wireless Message Content**	**The SWIW-RS I2V Wireless Message shall contain data required to perform the calculations specified under SWIW-RS Vehicle Application Functional Requirements.**	*Table (SWIW-RS Wireless) SWIW-RS I2V Wireless Message Data Description is referenced for guidance.*	D
[5.01.04.02]	**SWIW-RS I2V Wireless Message Specification**	**The SWIW-RS I2V Wireless Message shall conform to SAE J2735:2009-11 Dedicated Short Range Communications (DSRC) Message Set Dictionary.**		D

Table 3-4. SWIW-RS Infrastructure Application Component Performance Requirements (Continued)

Rqmt. No.	Requirement Title	Performance Requirement	Elaboration	Verif. Method (I,D,T,A)
[5.01.04.03]	**SWIW-RS I2V Wireless Message Content Text**	**The SWIW-RS I2V Wireless Message shall contain SWIW-RS DII Advisory, SWIW-RS DII Alert, and SWIW-RS DII Caution (Error) text used in roadway signage.**	*The Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) is referenced for guidance.*	D
[5.01.04.04]	**SWIW-RS I2V Wireless Message Prohibitive Frame**	**The SWIW-RS I2V Wireless Message content (SWIW-RS DII advisory, SWIW-RS DII alert, and SWIW-RS DII Caution (Error) messages) shall use a prohibitive frame indicating when unsafe conditions may exist.**	*Prohibitive frame means that DII advisory and alert messages shall not indicate that conditions may be safe.*	D
[5.01.04.05]	**SWIW-RS I2V Wireless Message Graphics**	**The SWIW-RS I2V Wireless Message shall contain SWIW-RS DII Advisory, SWIW-RS DII Alert, and SWIW-RS DII Caution (Error) shapes and graphics used in roadway signage.**	*The Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) is referenced for guidance.*	D
[5.01.04.06]	**SWIW-RS Roadside Signage Message Content**	**The SWIW-RS Roadside Signage Message shall contain the content to be displayed on dynamic roadside signage.**	*The SWIW-RS Roadside Signage Message shall contain one of three types of DII contents, a SWIW-RS DII Advisory, a SWIW-RS DII Alert, or a SWIW-RS DII Caution.* *Table (SWIW-RS Roadside) SWIW-RS Roadside Signage Message Data Description is referenced for guidance.*	D
[5.01.04.07]	**SWIW-RS Roadside Signage Message Specifications**	**The SWIW-RS Roadside Signage Message shall conform to NTCIP 1203 v02 Object Definitions for Dynamic Message Signs (DMS) Standard.**		D
[5.01.04.08]	**SWIW-RS Roadside Signage Message Text**	**The SWIW-RS Roadside Signage Message shall contain SWIW-RS DII Advisory, SWIW-RS DII Alert, and SWIW-RS DII Caution text.**	*The Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) is referenced for guidance.*	D

Table 3-4. SWIW-RS Infrastructure Application Component Performance Requirements (Continued)

Rqmt. No.	Requirement Title	Performance Requirement	Elaboration	Verif. Method (I,D,T,A)
[5.01.04.09]	**SWIW-RS Roadside Signage Message Prohibitive Frame**	**The SWIW-RS Roadside Signage Message (SWIW-RS DII advisory and SWIW-RS DII alert messages) shall use a prohibitive frame indicating when unsafe conditions may exist.**	*Prohibitive frame means that DII advisory and alert messages shall not indicate that conditions may be safe.*	D
[5.01.04.10]	**SWIW-RS Roadside Signage Message Graphics**	**The SWIW-RS Roadside Signage Message shall contain SWIW-RS DII Advisory, SWIW-RS DII Alert, and SWIW-RS DII Caution shapes and graphics.**	*The Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) is referenced for guidance.*	D

Source: Battelle

3.3.3 SWIW-RS Vehicle Application Component Requirements

Table 3-5 catalogs the performance requirements for the SWIW-RS Vehicle Application Component. These were developed based upon the integration strategy described in Section 3.3.1.4 above. It is expected that, as connected vehicle technology evolves and vehicle and infrastructure application component owners develop this and other V2I Safety Applications, the rationales, frameworks, and performance requirements presented here will evolve. Accordingly, before embarking upon design and development, application owners should update and refine the requirements to reflect current standards and policies. It is the responsibility of the designer to ensure that the resulting applications do not conflict with applicable published state and national regulations, policies, and guidelines.

Table 3-5. SWIW-RS Vehicle Application Component Performance Requirements

Rqmt. No.	Requirement Title	Performance Requirement	Elaboration	Verif. Method (I,D,T,A)
5.02	**SWIW-RS Vehicle Application Component Requirements**			
5.02.01	**SWIW-RS Vehicle Application Component Interfaces and Interface Specifications**			
[5.02.01.01]	**SWIW-RS I2V Wireless Message Interface**	**The SWIW-RS Vehicle Application Component shall obtain SWIW-RS I2V Wireless Messages through the Vehicle Wireless Data Systems Interface.**		D
[5.02.01.02]	**SWIW-RS Vehicle Data Interface**	**The SWIW-RS Vehicle Application Component shall obtain SWIW-RS Vehicle Data through the Vehicle Data Systems Interface.**		D
[5.02.01.03]	**SWIW-RS Driver Message Interface**	**The SWIW-RS Vehicle Application Component shall issue SWIW-RS Driver Messages through the Driver Warning System Interface.**		D
5.02.02	**SWIW-RS Vehicle Application Component Functional Requirements**			
[5.02.02.01]	**Common Vehicle Application Component Requirements**	**The SWIW-RS Vehicle Application Component shall adhere to Common Vehicle Application Component Requirements.**		D
[5.02.02.02]	**SWIW-RS Vehicle Application Component Initiation**	**The SWIW-RS Vehicle Application Component shall be initiated upon receipt of an SWIW-RS I2V Wireless Message by the Vehicle Wireless Data Systems.**		D
[5.02.02.03]	**SWIW-RS I2V Wireless Message Initiation**	**The SWIW-RS Vehicle Application Component shall obtain SWIW-RS I2V Wireless Messages upon initiation of the component.**		D
[5.02.02.04]	**SWIW-RS I2V Wireless Message Refresh Rate**	**The SWIW-RS Vehicle Application Component shall refresh the SWIW-RS I2V Wireless Message Input at a**		D

Table 3-5. SWIW-RS Vehicle Application Component Performance Requirements (Continued)

Rqmt. No.	Requirement Title	Performance Requirement	Elaboration	Verif. Method (I,D,T,A)
		configurable frequency.		
[5.02.02.05]	**SWIW-RS Vehicle Data Initiation**	**The SWIW-RS Vehicle Application Component shall obtain SWIW-RS Vehicle Data upon initiation of the component.**		D
[5.02.02.06]	**Vehicle Data Systems Refresh Rate**	**The SWIW-RS Vehicle Application Component shall refresh SWIW-RS Vehicle Data at a configurable frequency.**		D
[5.02.02.07]	**SWIW-RS Infrastructure Data**	**Upon receipt of a SWIW-RS I2V Wireless Message, the SWIW-RS Vehicle Application Component shall open the message and parse it for relevant SWIW-RS data.**		D
[5.02.02.08]	**SWIW-RS Positioning Accuracy Determination**	**The SWIW-RS Vehicle Application Component shall determine if the received Position Data and the Map Data meet the position accuracy requirements for the received SWIW-RS I2V Wireless Message.**		D
[5.02.02.09]	**SWIW-RS Positioning Accuracy Assessment**	**If the received Position Data and Map Data do not meet the position accuracy requirements for the SWIW-RS I2V Wireless Message, the SWIW-RS Vehicle Application Component shall refresh the Position Data and Map Data and continue processing.**	*The application should continue iteratively obtaining position and map data until SWIW-RS application position accuracy requirements are satisfied for the SWIW-RS I2V Wireless Message.*	D

Table 3-5. SWIW-RS Vehicle Application Component Performance Requirements (Continued)

Rqmt. No.	Requirement Title	Performance Requirement	Elaboration	Verif. Method (I,D,T,A)
[5.02.02.10]	**SWIW-RS Positioning Accuracy Message – Advisory**	**If the received Position Data and Map Data do not meet the position accuracy requirements for the received SWIW-RS I2V Wireless Message, the SWIW-RS Vehicle Application Component shall issue a SWIW-RS Driver Message containing a SWIW-RS DII Advisory to the Driver Warning System.**	*The SWIW-RS Application issues only advisory messages if position and map accuracy are not sufficient to support alert and warning calculations.*	D
[5.02.02.11]	**SWIW-RS I2V Message Applicability Determination**	**The SWIW-RS Vehicle Application Component shall determine if the received SWIW-RS I2V Wireless Message is applicable, based upon the subject vehicle's apparent path, the specified class of vehicles to which the message applies and other message criteria.**		D
[5.02.02.12]	**SWIW-RS I2V Message Applicability Assessment**	**If the received SWIW-RS I2V Wireless Message is not applicable, the SWIW-RS Vehicle Application Component shall refresh the SWIW-RS I2V Wireless Message and continue processing.**	*The application should continue iteratively obtaining SWIW-RS I2V Wireless Messages until a message applicable to current vehicle conditions is received.*	D
[5.02.02.13]	**Compute Vehicle-Specific Safe Speed**	**The SWIW-RS Vehicle Application Component shall compute the Vehicle-Specific Safe Speed based upon available SWIW-RS infrastructure and SWIW-RS vehicle data and published industry or OEM guidelines.**		D
[5.02.02.14]	**Compute [Conditional] SWIW-RS DVI Alert Deceleration Rates**	**The SWIW-RS Vehicle Application Component shall compute the SWIW-RS DVI Alert Deceleration Rate for the subject vehicle based upon available SWIW-RS infrastructure and SWIW-RS vehicle data and published industry or OEM guidelines.**		D

Table 3-5. SWIW-RS Vehicle Application Component Performance Requirements (Continued)

Rqmt. No.	Requirement Title	Performance Requirement	Elaboration	Verif. Method (I,D,T,A)
[5.02.02.15]	**Compute [Conditional] SWIW-RS DVI Alert Perception Reaction Time**	**The SWIW-RS Vehicle Application Component shall compute the SWIW-RS DVI Alert Perception Reaction Time for the subject vehicle based upon available SWIW-RS infrastructure and SWIW-RS vehicle data and published industry or OEM guidelines.**		D
[5.02.02.16]	**Determine SWIW-RS In-Vehicle Advisory Alert Speed**	**The SWIW-RS Vehicle Application Component shall determine the SWIW-RS in-vehicle advisory alert speed by selecting the lesser of the SWIW-RS DII alert speed and the SWIW-RS DVI alert speed.**	*Purpose is to ensure there are no conflicting DII and DVI messages.*	D
[5.02.02.17]	**Determine SWIW-RS DVI Alert Distance**	**The SWIW-RS Vehicle Application Component shall compute the SWIW-RS DVI Alert Distance for the subject vehicle corresponding to its current speed and available SWIW-RS Infrastructure and SWIW-RS Vehicle Data and published industry or OEM guidelines.**		D
[5.02.02.18]	**SWIW-RS DVI Alert Distance Equation**	**The SWIW-RS DVI Alert Distance shall be the distance traveled during the SWIW-RS DVI Alert Perception Reaction Time plus the distance required to slow the subject vehicle from its current speed to the SWIW-RS DVI Alert Speed, at a uniform deceleration equal to the SWIW-RS DVI Alert Deceleration Rate.**	*The following information is referenced for guidance: 0.34g is the uniform deceleration rate required to safely stop a fully loaded (new) tractor trailer as defined in NHTSA FMVSS 121. 0.56g is the uniform deceleration rate required to safely stop a fully passenger vehicle as defined in NHTSA FMVSS 135. Industry guidelines and/or local policy should provide guidance on deceleration rates for specific circumstances.*	D

Table 3-5. SWIW-RS Vehicle Application Component Performance Requirements (Continued)

Rqmt. No.	Requirement Title	Performance Requirement	Elaboration	Verif. Method (I,D,T,A)
[5.02.02.19]	**SWIW-RS DVI Alert Criterion**	**If the distance of the subject vehicle is less than the SWIW-RS DVI Alert Distance for its current speed then the SWIW-RS Vehicle Application Component shall issue a SWIW-RS Driver Message containing a SWIW-RS DVI Alert to the Driver Warning System.**		D
[5.02.02.20]	**SWIW-RS DII Alert Criterion**	**If the DVI Alert Distance is not positive and if the distance of the subject vehicle is less than SWIW-RS DII Alert Distance, the SWIW-RS Vehicle Application Component shall issue a SWIW-RS Driver Message containing a SWIW-RS DII Alert to the Driver Warning System.**	*The Vehicle component should issue a DII Alert or a DVI Alert, but not both.*	D
[5.02.02.21]	**SWIW-RS DII Advisory Criterion**	**If the distance of the subject vehicle is less than the SWIW-RS DII Advisory Distance and greater than or equal to the lesser of the SWIW-RS DII Alert Distance and the SWIW-RS DVI Alert Distance, the SWIW-RS Vehicle Application Component shall issue a SWIW-RS Driver Message containing a SWIW-RS DII Advisory and SWIW-RS In-Vehicle Advisory Alert Speed to the Driver Warning System.**		D
[5.02.02.22]	**SWIW-RS DII Advisory Termination**	**The SWIW-RS Vehicle Application Component shall cease issuing SWIW-RS DII advisories when the vehicle passes the end of the inclement road weather zone.**		D
[5.02.02.23]	**SWIW-RS DII Alert Termination**	**The SWIW-RS Vehicle Application Component shall cease issuing SWIW-RS DII alerts when the vehicle reaches the start of the inclement road weather zone.**		D
[5.02.02.24]	**SWIW-RS DVI Alert**	**The SWIW-RS Vehicle Application Component shall cease issuing SWIW-RS DVI Alert when the vehicle**		D

Table 3-5. SWIW-RS Vehicle Application Component Performance Requirements (Continued)

Rqmt. No.	Requirement Title	Performance Requirement	Elaboration	Verif. Method (I,D,T,A)
	Termination	**passes the end of the inclement road weather zone.**		
[5.02.02.25]	**SWIW-RS DVI and SWIW-RS DII Message Consistency**	**The SWIW-RS Vehicle Application Component shall not issue a less cautious SWIW-RS DII advisory or SWIW-RS DVI alert than the SWIW-RS Infrastructure Application components.**	*For example, vehicle applications may recommend slower speeds than the infrastructure applications, but not higher.*	D
[5.02.02.26]	**SWIW-RS DVI Message Precedence**	**The SWIW-RS Vehicle Application Component shall govern the message to be delivered to the Driver Warning System, based upon available SWIW-RS infrastructure and SWIW-RS vehicle data.**		D
[5.02.02.27]	**SWIW-RS Caution (Error) Message Definition**	**The SWIW-RS DVI Caution (Error) Message shall contain a blank or generic caution and an indication that the system is not operational.**		D
[5.02.02.28]	**SWIW-RS Vehicle Application Component Error**	**In the event of an input data error, a computational error or other non recoverable SWIW-RS Vehicle Application Component Error preventing issuing of SWIW-RS DVI advisories or SWIW-RS DVI alerts, or position and map accuracy requirements not being met, the SWIW-RS Vehicle Application Component shall issue a SWIW-RS Driver Message containing a SWIW-RS DVI Caution (Error) to the Driver Warning System.**		D

Table 3-5. SWIW-RS Vehicle Application Component Performance Requirements (Continued)

Rqmt. No.	Requirement Title	Performance Requirement	Elaboration	Verif. Method (I,D,T,A)
5.02.03	**SWIW-RS Vehicle Application Component Data Input Requirements**			
[5.02.03.01]	**SWIW-RS I2V Wireless Message Content**	**The SWIW-RS I2V Wireless Message shall contain the data required to perform the calculations specified under SWIW-RS Vehicle Application Functional Requirements.**	*Table (SWIW-RS Wireless) SWIW-RS I2V Wireless Message Data Description is referenced for guidance.*	D
[5.02.03.02]	**SWIW-RS I2V Wireless Message Specification**	**The SWIW-RS I2V Wireless Message shall conform to SAE J2735:2009-11 Dedicated Short Range Communications (DSRC) Message Set Dictionary.**		I
[5.02.03.03]	**SWIW-RS I2V Wireless Message Content Text**	**The SWIW-RS I2V Wireless Message shall contain SWIW-RS DII Advisory, SWIW-RS DII Alert, and SWIW-RS DII Caution (Error) text used in roadway signage.**	*The Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) is referenced for guidance.*	D
[5.02.03.04]	**SWIW-RS I2V Wireless Message Graphics**	**The SWIW-RS I2V Wireless Message shall contain SWIW-RS DII Advisory, SWIW-RS DII Alert, and SWIW-RS DII Caution (Error) shapes and graphics used in roadway signage.**	*The Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) is referenced for guidance.*	D
[5.02.03.05]	**SWIW-RS Vehicle Systems Message Content**	**The SWIW-RS Vehicle Systems Message shall contain data required to perform the calculations specified under SWIW-RS Vehicle Application Functional Requirements.**	*Table (SWIW-RS Vehicle) SWIW-RS Vehicle Systems Message Data Description is referenced for guidance.*	D

Table 3-5. SWIW-RS Vehicle Application Component Performance Requirements (Continued)

Rqmt. No.	Requirement Title	Performance Requirement	Elaboration	Verif. Method (I,D,T,A)
[5.02.03.06]	**Vehicle Data Systems Message Specifications**	**The SWIW-RS Vehicle Systems Message shall conform to the standards and guidelines specified by the vehicle Original Equipment Manufacturer.**	*Specific interfaces to the OEM vehicle systems will be dependent on specific information required to support the safety application. Examples of vehicle data communication system specifications include: ISO 14230-4, ISO 9141-2, SAE J1850 VPW, SAE J1850 PWM, ISO 15765, ISO 11898, and SAE J2178*	D
5.02.04	**SWIW-RS Vehicle Application Component Data Output Requirements**			
[5.02.04.01]	**SWIW-RS Driver Message Content**	**The SWIW-RS Driver Message shall contain the SWIW-RS DII Advisory, SWIW-RS DII Alert, SWIW-RS DII Caution, SWIW-RS DVI Alert, SWIW-RS DVI Warning, or SWIW-RS DVI Caution content to be displayed on the Driver Warning Interface.**	*Table (SWIW-RS Driver) SWIW-RS Driver Message Data Description is referenced for guidance.*	D
[5.02.04.02]	**SWIW-RS Driver Message Specifications**	**The following is referenced for guidance pertaining to SWIW-RS Driver Message Specifications: Campbell, J. L., Brown, J. L., Graving, J. S., Richard, C. M., Lichty, M. G., Sanquist, T., Bacon, L. P., … Morgan, J. F. (in press). Driver Vehicle Interface (DVI) Design Assistance for Advanced Technology Applications. (Final report to Virginia Tech Transportation Institute and National Highway Traffic Safety Administration). Seattle, WA: Battelle.**		D

Source: Battelle

APPENDIX A. SWIW-RS Application Message Candidate Data Elements

Appendix A suggests candidate data elements which may be included in these messages to support the SWIW-RS safety application algorithms. Table A-1 provides an explanation of the headers in candidate data tables. As noted in Table 3-3, Table A-2 through Table A-7 describe the candidate data elements for each of the messages. This information is provided for guidance when implementing the performance requirements specified in this document.

Table A-1. Explanation of Candidate Data Table Headers

Data Element Descriptor	Explanation	Example
Data Item Description	Name of obtainable measure or item,	Posted speed limit, number of lanes
Application	V2I Safety Application that the data element pertains to	RLVW, SWIW-RS
Type of Data	Identifies a general classification of the data element	Location data, speed data
Static/Dynamic	Distinguishes the frequency by which the data element is subject to changes	Static, Dynamic
Need	Identifies whether the data element is critical to the application function, versus those that can enhance it	Required, optional
Input Source	Identifies the component that supplies the data element	Vehicle Application Component, infrastructure data system
Output Recipient	Identifies the component that receives the data element	Vehicle Application Component, infrastructure application component
Unit of Measure (English)	Metric used to quantify the data element, English system of measurement	Feet, °F
Valid Range (English)	Span of values from minimum to maximum that are acceptable inputs, English system of measurement	5-20, (-30)-120
Accuracy/ Tolerance (English)	Degree of variance between actual and measured value that will be acceptable, English system of measurement	+/-5, +/-0.01
Unit of Measure (Metric)"	Metric used to quantify the data element, international system of measurement	Meter, °C
Valid Range (Metric)	Span of values from minimum to maximum that are acceptable inputs, international system of measurement	5-20, (-30)-120
Accuracy/Tolerance(Metric)"	Degree of variance between actual and measured value that will be acceptable, international system of measurement	+/-5, +/-0.01
Refresh Rate	Frequency that the data element is updated with a new external value	10 Hz, Annually
References	Source documents that contain supporting information	MUTCD
Notes	Supplemental explanation	Determined by MUTCD or Local Policy

Source: Battelle

Table A-2. Description of Candidate Data Elements for the SWIW-RS Infrastructure Data Systems Message

Data Item Description	Application	Type of Data	Static/ Dynamic	Need	Input Source	Output Recipient	Unit of Measure (English)	Valid Range (English)	Accuracy/ Tolerance (English)	Unit of Measure (Metric)	Valid Range (Metric)	Accuracy/ Tolerance (Metric)	Refresh Rate	References	Notes
Approaching Vehicle Data (Required)															
Target (#)	SWIW-RS	Approaching Vehicle	Dynamic	Required	External Vehicle Detection on System	Infra Application Component	Integer	1-15	NA	Integer	1-15	NA	10 Hz		The Application shall be capable of processing up to 15 simultaneous targets identified by Infrastructure Data Systems
Target (#) Range	SWIW-RS	Approaching Vehicle	Dynamic	Required	External Vehicle Detection System	Infra Application Component	ft	1-5000	+/- 2	m	0.3-1524	+/-0.6	10 Hz		The Application shall be capable of processing up to 15 simultaneous targets identified by Infrastructure Data Systems
Target (#) Range Rate	SWIW-RS	Approaching Vehicle	Dynamic	Required	External Vehicle Detection System	Infra Application Component	ft/s	1-200	+/- 1	m/s	0.3-61	0.3	10 Hz		The Application shall be capable of processing up to 15 simultaneous targets identified by Infrastructure Data Systems
Local Spot Weather Data															
Air Temperature	SWIW-RS	Local Weather Data	Dynamic	Optional	Infra Data System – Local Weather	Infra Application Component	°F	(-30)-120	+/- 2	°C	(-35)-49	+/-3.6	1 min		Temperature may be measured locally or estimated from nearby sensors
Temperature tolerance (if estimated)	SWIW-RS	Local Weather Data	Dynamic	Optional	Infra Data System – Local Weather	Infra Application Component	°F	(-30)-120	+/-5	°C	(-35)-49	+/-9	5 min		Temperature may be measured locally or estimated from nearby sensors
Current precipitation condition	SWIW-RS	Local Weather Data	Dynamic	Optional	Infra Data System – Local Weather	Infra Application Component	n/a	-	-	n/a	-	-	1 min		Precipitation may be measured locally or estimated from nearby sensors
Precipitation tolerance (if estimated)	SWIW-RS	Local Weather Data	Dynamic	Optional	Infra Data System – Local Weather	Infra Application Component	n/a	-	-	n/a	-	-	5 min		Precipitation may be measured locally or estimated from nearby sensors
Visibility	SWIW-RS	Local Weather Data	Dynamic	Optional	Infra Data System – Local Weather	Infra Application Component	ft	1-1000	+/- 2	m	0.3-305	+/-0.6	1 min		

Table A-2. Description of Candidate Data Elements for the SWIW-RS Infrastructure Data Systems Message (Continued)

Data Item Description	Application	Type of Data	Static/ Dynamic	Need	Input Source	Output Recipient	Unit of Measure (English)	Valid Range (English)	Accuracy/ Tolerance (English)	Unit of Measure (Metric)	Valid Range (Metric)	Accuracy/ Tolerance (Metric)	Refresh Rate	References	Notes
Visibility tolerance	SWIW-RS	Local Weather Data	Dynamic	Optional	Infra Data System – Local Weather	Infra Application Component	ft	1-1000	+/- 2	m	0.3-305	+/-0.6	1 min		
Wind Speed	SWIW-RS	Local Weather Data	Dynamic	One required from group	Infra Data System – Local Weather	Infra Application Component	mph	0-100	+/- 5	km/h	0-160	+/-9	1 min		
Precipitation rate	SWIW-RS	Local Weather Data	Dynamic	One required from group	Infra Data System – Local Weather	Infra Application Component	in./hr	0-20	+/- 0.5	cm/hr	0-51	+/-1.3	1 min		
Precipitation accumulation	SWIW-RS	Local Weather Data	Dynamic	One required from group	Infra Data System – Local Weather	Infra Application Component	in.	0-20	+/- 0.5	cm	0-51	+/-1.3	1 min		
Water depth	SWIW-RS	Local Weather Data	Dynamic	One required from group	Infra Data System – Local Weather	Infra Application Component	in.	0-20	+/- 0.5	cm	0-51	+/-1.3	10 min		
Snow depth	SWIW-RS	Local Weather Data	Dynamic	One required from group	Infra Data System – Local Weather	Infra Application Component	in.	0-20	+/- 0.5	cm	0-51	+/-1.3	10 min		
Local Weather Data Applicable Road Map Segments	SWIW-RS	Local Weather Data	Dynamic	Required	Infra Data System – Local Weather	Infra Application Component	TBD	TBD	TBD	TBD	TBD	TBD	TBD		
Local Weather Data Applicable Date and Time – Begin	SWIW-RS	Local Weather Data	Dynamic	Required	Infra Data System – Local Weather	Infra Application Component	Date & Time	Current + 30 days	+/- 1 min	Date & Time	Current + 30 days	+/- 1 min	1 min		
Local Weather Data Applicable Date and Time – End	SWIW-RS	Local Weather Data	Dynamic	Required	Infra Data System – Local Weather	Infra Application Component	Date & Time	Current + 30 days	+/- 1 min	Date & Time	Current + 30 days	+/- 1 min	1 min		

Table A-2. Description of Candidate Data Elements for the SWIW-RS Infrastructure Data Systems Message (Continued)

Data Item Description	Application	Type of Data	Static/ Dynamic	Need	Input Source	Output Recipient	Unit of Measure (English)	Valid Range (English)	Accuracy/ Tolerance (English)	Unit of Measure (Metric)	Valid Range (Metric)	Accuracy/ Tolerance (Metric)	Refresh Rate	References	Notes
Local Road Surface Data															
Road surface temperature	SWIW-RS	Road Surface Condition	Dynamic	One required from group	Infra Data System – Road Surface	Infra Application Component	°F	(-30)-120	+/- 2	°C	(-35)-49	+/-3.6	1 min		
Road surface wetness	SWIW-RS	Road Surface Condition	Dynamic	One required from group	Infra Data System – Road Surface	Infra Application Component	n/a	-	-	n/a	-	-	5 min		
Road surface friction coefficient	SWIW-RS	Road Surface Condition	Dynamic	Optional	Infra Data System – Road Surface	Infra Application Component	coefficient	-	+/- 0.01	coefficient	-	+/- 0.01	1 min		
Road Condition Data Applicable Road Map Segments	SWIW-RS	Road Surface Condition	Dynamic	Required	Infra Data System – Road Surface	Infra Application Component	TBD	TBD	TBD	TBD	TBD	TBD	1 min		
Road Condition Data Applicable Date and Time – Begin	SWIW-RS	Road Surface Condition	Dynamic	Required	Infra Data System – Road Surface	Infra Application Component	Date & Time	Current + 30 days	+/- 1 min	Date & Time	Current + 30 days	+/- 1 min	1 min		
Road Condition Data Applicable Date and Time – End	SWIW-RS	Road Surface Condition	Dynamic	Required	Infra Data System – Road Surface	Infra Application Component	Date & Time	Current + 30 days	+/- 1 min	Date & Time	Current + 30 days	+/- 1 min	1 min		

Source: Battelle

Table A-3. Description of Candidate Data Elements for the SWIW-RS Roadside Signage Message Data Description

Data Item Description	Application	Type of Data	Static/ Dynamic	Need	Input Source	Output Recipient	Unit of Measure (English)	Valid Range (English)	Accuracy/ Tolerance (English)	Unit of Measure (Metric)	Valid Range (Metric)	Accuracy/ Tolerance (Metric)	Refresh Rate	References	Notes
DII MUTCD Sign Number	SWIW-RS	SWIW-RS Roadside Signage Data	Dynamic	MUTCD Sign Number or Graphic and Text	Infra Application Component	Roadside Signage System	Integer	TBD	NA	Integer	TBD	NA	1 Hz		Determined by MUTCD, Local Policy, and Roadside Signage System manufacturer specifications
DII Graphic	SWIW-RS	SWIW-RS Roadside Signage Data	Dynamic	MUTCD Sign Number or Graphic and Text	Infra Application Component	Roadside Signage System	TBD	TBD	NA	TBD	TBD	NA	1 Hz		Determined by MUTCD, Local Policy, and Roadside Signage System manufacturer specifications
DII Text	SWIW-RS	SWIW-RS Roadside Signage Data	Dynamic	MUTCD Sign Number or Graphic and Text	Infra Application Component	Roadside Signage System	Alpha numeric, upper and lower case	A-Z, a-z, 0-9	NA	Alpha numeric, upper and lower case	A-Z, a-z, 0-9	NA	1 Hz		Max 3 Lines, 20 Characters each is typical for Roadside Dynamic Message Signs
DII Advisory Valid Time	SWIW-RS	SWIW-RS Roadside Signage Data	Dynamic	Required	Infra Application Component	Roadside Signage System	min	0.01-1440	+/- 0.01	min	0.01-1440	+/- 0.01	1 Hz		Determined by MUTCD, Local Policy, and Roadside Signage System manufacturer specifications

Source: Battelle

Table A-4. Description of Candidate Data Elements for the SWIW-RS Infrastructure Map Message and SWIW-RS Wireless Map Message

Data Item Description	Application	Type of Data	Static/ Dynamic	Need	Input Source	Output Recipient	Unit of Measure (English)	Valid Range (English)	Accuracy/ Tolerance (English)	Unit of Measure (Metric)	Valid Range (Metric)	Accuracy/ Tolerance (Metric)	Refresh Rate	References	Notes
Adverse Weather Reduced Speed Zone Geometry															
Adverse Weather Reduced Speed Zone Begin – Latitude	SWIW-RS	Reduced Speed Zone Geometry	Static	Required	Local User/Data Infrastructure	Infra Application Component	degrees	(-90)-90	+/- 0.000001	degrees	(-90)-90	+/- 0.000001	Reconstruction, Repaving, or Restriping		Static Data may be loaded through an externally generated data file.
Adverse Weather Reduced Speed Zone Begin – Longitude	SWIW-RS	Reduced Speed Zone Geometry	Static	Required	Local User/Data Infrastructure	Infra Application Component	degrees	(-180)-180	+/- 0.000001	degrees	(-180)-180	+/- 0.000001	Reconstruction, Repaving, or Restriping		Static Data may be loaded through an externally generated data file.
Adverse Weather Reduced Speed Zone Begin – Elevation	SWIW-RS	Reduced Speed Zone Geometry	Static	Required	Local User/Data Infrastructure	Infra Application Component	ft	(-150)-12,000	+/- 2	m	(-46)-3658	+/-0.6	Reconstruction, Repaving, or Restriping		Static Data may be loaded through an externally generated data file.
Adverse Weather Reduced Speed Zone End – Latitude	SWIW-RS	Reduced Speed Zone Geometry	Static	Required	Local User/Data Infrastructure	Infra Application Component	degrees	(-90)-90	+/- 0.000001	degrees	(-90)-90	+/- 0.000001	Reconstruction, Repaving, or Restriping		Static Data may be loaded through an externally generated data file.
Adverse Weather Reduced Speed Zone End – Longitude	SWIW-RS	Reduced Speed Zone Geometry	Static	Required	Local User/Data Infrastructure	Infra Application Component	degrees	(-180)-180	+/- 0.000001	degrees	(-180)-180	+/- 0.000001	Reconstruction, Repaving, or Restriping		Static Data may be loaded through an externally generated data file.
Adverse Weather Reduced Speed Zone End – Elevation	SWIW-RS	Reduced Speed Zone Geometry	Static	Required	Local User/Data Infrastructure	Infra Application Component	ft	(-150)-12,000	+/- 2	m	(-46)-3658	+/-0.6	Reconstruction, Repaving, or Restriping		Static Data may be loaded through an externally generated data file.

Table A-4. Description of Candidate Data Elements for the SWIW-RS Infrastructure Map Message and SWIW-RS Wireless Map Message (Continued)

Data Item Description	Application	Type of Data	Static/ Dynamic	Need	Input Source	Output Recipient	Unit of Measure (English)	Valid Range (English)	Accuracy/ Tolerance (English)	Unit of Measure (Metric)	Valid Range (Metric)	Accuracy/ Tolerance (Metric)	Refresh Rate	References	Notes
SWIW-RS Operational Data															
Posted Speed Limit	SWIW-RS	SWIW-RS Operational Data	Static	Required	Local User/Data Infrastructure	Infra Application Component	mph	25-90	+/- 2	km/h	40-145	+/-3.2	Speed Limit Revision		Static Data may be loaded through an externally generated data file.
Advisory Speed Limit	SWIW-RS	SWIW-RS Operational Data	Static	Required	Local User/Data Infrastructure	Infra Application Component	mph	5-65	+/- 2	km/h	8-105	+/-3.2	Speed Limit Revision		Static Data may be loaded through an externally generated data file.
SWIW-RS Roadside Signage Data															
Adverse Weather Reduced Speed Zone Begin – MUTCD Sign Number options for consideration to be used as DII Advisory Message	SWIW-RS	SWIW-RS Roadside Signage Data	Static	At Least One Required from Group	Local User/Data Infrastructure	Infra Application Component	Integer	NA	NA	Integer	NA	NA	Roadside Signage Revision		Determined by MUTCD and Local Policy. Static Data may be loaded through an externally generated data file.
Adverse Weather Reduced Speed Zone Begin – Graphic options for consideration to be used as DII Advisory Message	SWIW-RS	SWIW-RS Roadside Signage Data	Static	At Least One Required from Group	Local User/Data Infrastructure	Infra Application Component	TBD	TBD	TBD	TBD	TBD	TBD	Roadside Signage Revision		Determined by MUTCD and Local Policy. Static Data may be loaded through an externally generated data file.

Table A-4. Description of Candidate Data Elements for the SWIW-RS Infrastructure Map Message and SWIW-RS Wireless Map Message (Continued)

Data Item Description	Application	Type of Data	Static/ Dynamic	Need	Input Source	Output Recipient	Unit of Measure (English)	Valid Range (English)	Accuracy/ Tolerance (English)	Unit of Measure (Metric)	Valid Range (Metric)	Accuracy/ Tolerance (Metric)	Refresh Rate	References	Notes
Adverse Weather Reduced Speed Zone Begin – Advisory Text options for consideration to be used as DII Advisory Message	SWIW-RS	SWIW-RS Roadside Signage Data	Static	At Least One Required from Group	Local User/Data Infrastructure	Infra Application Component	Latin Alphabet	A-Z	NA	Latin Alphabet	A-Z	NA	Roadside Signage Revision		Determined by MUTCD and Local Policy. Static Data may be loaded through an externally generated data file.
Adverse Weather Reduced Speed Zone Begin – DII Advisory Sign Distance	SWIW-RS	SWIW-RS Roadside Signage Data	Static	Required	Local User/Data Infrastructure	Infra Application Component	ft	1-1000	+/- 2	m	0.3-305	+/-0.6	Roadside Signage Revision		Determined by MUTCD and Local Policy. Static Data may be loaded through an externally generated data file.
Adverse Weather Reduced Speed Zone Begin – DII Advisory Visibility Distance	SWIW-RS	SWIW-RS Roadside Signage Data	Static	Required	Local User/Data Infrastructure	Infra Application Component	ft	1-1000	+/- 2	m	0.3-305	+/-0.6	Roadside Signage Revision		Determined by MUTCD and Local Policy. Static Data may be loaded through an externally generated data file.
Adverse Weather Reduced Speed Zone Begin – MUTCD Sign Number options for consideration to be used as DII Alert Message	SWIW-RS	SWIW-RS Roadside Signage Data	Static	MUTCD Sign Number or Graphic and Text	Local User/Data Infrastructure	Infra Application Component	Integer	NA	NA	Integer	NA	NA	Roadside Signage Revision		Determined by MUTCD and Local Policy. Static Data may be loaded through an externally generated data file.

Table A-4. Description of Candidate Data Elements for the SWIW-RS Infrastructure Map Message and SWIW-RS Wireless Map Message (Continued)

Data Item Description	Application	Type of Data	Static/ Dynamic	Need	Input Source	Output Recipient	Unit of Measure (English)	Valid Range (English)	Accuracy/ Tolerance (English)	Unit of Measure (Metric)	Valid Range (Metric)	Accuracy/ Tolerance (Metric)	Refresh Rate	References	Notes
Adverse Weather Reduced Speed Zone Begin – Graphic options for consideration to be used as DII Alert Message	SWIW-RS	SWIW-RS Roadside Signage Data	Static	MUTCD Sign Number or Graphic and Text	Local User/Data Infrastructure	Infra Application Component	TBD	TBD	TBD	TBD	TBD	TBD	Roadside Signage Revision		Determined by MUTCD and Local Policy. Static Data may be loaded through an externally generated data file.
Adverse Weather Reduced Speed Zone Begin – Alert Text options for consideration to be used as DII Alert Message	SWIW-RS	SWIW-RS Roadside Signage Data	Static	MUTCD Sign Number or Graphic and Text	Local User/Data Infrastructure	Infra Application Component	Latin Alphabet	A-Z	NA	Latin Alphabet	A-Z	NA	Roadside Signage Revision		Determined by MUTCD and Local Policy. Static Data may be loaded through an externally generated data file.
Adverse Weather Reduced Speed Zone Begin – DII Alert Sign Distance	SWIW-RS	SWIW-RS Roadside Signage Data	Static	Optional	Local User/Data Infrastructure	Infra Application Component	ft	1-1000	+/- 2	m	0.3-305	+/-0.6	Roadside Signage Revision		Determined by MUTCD and Local Policy. Static Data may be loaded through an externally generated data file.
Adverse Weather Reduced Speed Zone Begin – DII Alert Visibility Distance	SWIW-RS	SWIW-RS Roadside Signage Data	Static	Optional	Local User/Data Infrastructure	Infra Application Component	ft	1-1000	+/- 2	m	0.3-305	+/-0.6	Roadside Signage Revision		Determined by MUTCD and Local Policy. Static Data may be loaded through an externally generated data file.

Source: Battelle

Table A-5. Description of Candidate Data Elements for the SWIW-RS I2V Wireless Message Data Description

Data Item Description	Application	Type of Data	Static/ Dynamic	Need	Input Source	Output Recipient	Unit of Measure (English)	Valid Range (English)	Accuracy/ Tolerance (English)	Unit of Measure (Metric)	Valid Range (Metric)	Accuracy/ Tolerance (Metric)	Refresh Rate	References	Notes
SWIW-RS Operational Data															
SWIW-RS Applicable Date and Time – Begin	SWIW-RS	SWIW-RS Operational Data	Dynamic	Required	Infra Application Component	Vehicle Application Component	Date & Time	Current + 30 days	+/- 1 min	Date & Time	Current + 30 days	+/- 1 min	1 min		
SWIW-RS Applicable Date and Time – End	SWIW-RS	SWIW-RS Operational Data	Dynamic	Required	Infra Application Component	Vehicle Application Component	Date & Time	Current + 30 days	+/- 1 min	Date & Time	Current + 30 days	+/- 1 min	1 min		
SWIW-RS Applicable Road Map Segments	SWIW-RS	SWIW-RS Operational Data	Dynamic	Required	Infra Application Component	Vehicle Application Component	TBD	TBD	TBD	TBD	TBD	TBD	TBD		Data format is based upon segments in SWIW-RS Road Map
Local Spot Weather Data															
Air Temperature	SWIW-RS	Local Weather Data	Dynamic	Optional	Infra Data System – Local Weather	Infra Application Component	°F	(-30)-120	+/- 2	°C	(-35)-49	+/-3.6	1 min		Temperature may be measured locally or estimated from nearby sensors
Temperature tolerance (if estimated)	SWIW-RS	Local Weather Data	Dynamic	Optional	Infra Data System – Local Weather	Infra Application Component	°F	(-30)-120	+/-5	°C	(-35)-49	+/-9	5 min		Temperature may be measured locally or estimated from nearby sensors
Current precipitation condition	SWIW-RS	Local Weather Data	Dynamic	Optional	Infra Data System – Local Weather	Infra Application Component	n/a	-	-	n/a	-	-	1 min		Precipitation may be measured locally or estimated from nearby sensors
Precipitation tolerance (if estimated)	SWIW-RS	Local Weather Data	Dynamic	Optional	Infra Data System – Local Weather	Infra Application Component	n/a	-	-	n/a	-	-	5 min		Precipitation may be measured locally or estimated from nearby sensors

Table A-5. Description of Candidate Data Elements for the SWIW-RS I2V Wireless Message Data Description (Continued)

Data Item Description	Application	Type of Data	Static/ Dynamic	Need	Input Source	Output Recipient	Unit of Measure (English)	Valid Range (English)	Accuracy/ Tolerance (English)	Unit of Measure (Metric)	Valid Range (Metric)	Accuracy/ Tolerance (Metric)	Refresh Rate	References	Notes
Visibility	SWIW-RS	Local Weather Data	Dynamic	Optional	Infra Data System – Local Weather	Infra Application Component	ft	1-1000	+/- 2	m	0.3-305	+/-0.6	1 min		
Visibility tolerance	SWIW-RS	Local Weather Data	Dynamic	Optional	Infra Data System – Local Weather	Infra Application Component	ft	1-1000	+/- 2	m	0.3-305	+/-0.6	1 min		
Wind Speed	SWIW-RS	Local Weather Data	Dynamic	One required from group	Infra Data System – Local Weather	Infra Application Component	mph	0-100	+/- 5	km/h	0-160	+/-9	1 min		
Precipitation rate	SWIW-RS	Local Weather Data	Dynamic	One required from group	Infra Data System – Local Weather	Infra Application Component	in./hr	0-20	+/- 0.5	cm/hr	0-51	+/-1.3	1 min		
Precipitation accumulation	SWIW-RS	Local Weather Data	Dynamic	One required from group	Infra Data System – Local Weather	Infra Application Component	in.	0-20	+/- 0.5	cm	0-51	+/-1.3	1 min		
Water depth	SWIW-RS	Local Weather Data	Dynamic	One required from group	Infra Data System – Local Weather	Infra Application Component	in.	0-20	+/- 0.5	cm	0-51	+/-1.3	10 min		
Snow depth	SWIW-RS	Local Weather Data	Dynamic	One required from group	Infra Data System – Local Weather	Infra Application Component	in.	0-20	+/- 0.5	cm	0-51	+/-1.3	10 min		
Local Weather Data Applicable Road Map Segments	SWIW-RS	Local Weather Data	Dynamic	Required	Infra Data System – Local Weather	Infra Application Component	TBD	TBD	TBD	TBD	TBD	TBD	TBD		
Local Weather Data Applicable Date and Time – Begin	SWIW-RS	Local Weather Data	Dynamic	Required	Infra Data System – Local Weather	Infra Application Component	Date & Time	Current + 30 days	+/- 1 min	Date & Time	Current + 30 days	+/- 1 min	1 min		
Local Weather Data Applicable Date and Time – End	SWIW-RS	Local Weather Data	Dynamic	Required	Infra Data System – Local Weather	Infra Application Component	Date & Time	Current + 30 days	+/- 1 min	Date & Time	Current + 30 days	+/- 1 min	1 min		

Table A-5. Description of Candidate Data Elements for the SWIW-RS I2V Wireless Message Data Description (Continued)

Data Item Description	Application	Type of Data	Static/ Dynamic	Need	Input Source	Output Recipient	Unit of Measure (English)	Valid Range (English)	Accuracy/ Tolerance (English)	Unit of Measure (Metric)	Valid Range (Metric)	Accuracy/ Tolerance (Metric)	Refresh Rate	References	Notes
Road Surface Condition															
Road surface temperature	SWIW-RS	Road Surface Condition	Dynamic	Optional	Infra Data System – Road Surface	Infra Application Component	°F	(-30)-120	+/- 2	°C	(-35)-49	+/-3.6	1 min		
Road surface wetness	SWIW-RS	Road Surface Condition	Dynamic	Optional	Infra Data System – Road Surface	Infra Application Component	TBD	TBD	TBD	TBD	TBD	TBD	1 min		
Road Condition Data Applicable Date and Time – Begin	SWIW-RS	Road Surface Condition	Dynamic	Optional	Infra Data System – Road Surface	Infra Application Component	Date & Time	Current + 30 days	+/- 1 min	Date & Time	Current + 30 days	+/- 1 min	1 min		
Road Condition Data Applicable Date and Time – End	SWIW-RS	Road Surface Condition	Dynamic	Optional	Infra Data System – Road Surface	Infra Application Component	Date & Time	Current + 30 days	+/- 1 min	Date & Time	Current + 30 days	+/- 1 min	1 min		
Road Condition Data Applicable Road Map Segments	SWIW-RS	Road Surface Condition	Dynamic	Optional	Infra Data System – Road Surface	Infra Application Component	TBD	TBD	TBD	TBD	TBD	TBD	TBD		Road Condition Data format is based upon segments in SWIS-RS Road Map

Source: Battelle

Table A-6. Description of Candidate Data Elements for the SWIW-RS Vehicle Systems Message Data Descriptions

Data Item Description	Application	Type of Data	Static/ Dynamic	Need	Input Source	Output Recipient	Unit of Measure (English)	Valid Range (English)	Accuracy/ Tolerance (English)	Unit of Measure (Metric)	Valid Range (Metric)	Accuracy/ Tolerance (Metric)	Refresh Rate	References	Notes
Vehicle Characteristics															
Vehicle mass	SWIW-RS	Vehicle Characteristics	Quasi-Static (per vehicle trip)	Optional	Vehicle Data Systems	Vehicle Application Component	lb.	100-100000	+/- 25	kg	45-45360	+/- 11.3	Upon Power On		Assumes Mass, Length and Height are constant during trip, defined as vehicle start up/shut down cycle.
Vehicle length	SWIW-RS	Vehicle Characteristics	Quasi-Static (per vehicle trip)	Optional	Vehicle Data Systems	Vehicle Application Component	ft	0-200	+/- 2	m	0-61	+/-0.6	Upon Power On		Assumes Mass, Length and Height are constant during trip, defined as vehicle start up/shut down cycle.
Vehicle CG Height	SWIW-RS	Vehicle Characteristics	Quasi-Static (per vehicle trip)	Optional	Vehicle Data Systems	Vehicle Application Component	in	0-300	+/- 2	cm	0-7620	+/- 50.8	Upon Power On		Assumes Mass, Length and Height are constant during trip, defined as vehicle start up/shut down cycle.
Average Deceleration Rate	SWIW-RS	Vehicle Characteristics	Quasi-Static (per vehicle trip)	Optional	Vehicle Data Systems	Vehicle Application Component	ft/s^2	0-32.2	+/- 1	m/s^2	0-9.81	+/- 0.304	Upon Power On		Assumes Mass, Length and Height are constant during trip, defined as vehicle start up/shut down cycle.
Maximum Deceleration Rate	SWIW-RS	Vehicle Characteristics	Quasi-Static (per vehicle trip)	Optional	Vehicle Data Systems	Vehicle Application Component	ft/s^2	0-32.2	+/- 1	m/s^2	0-9.81	+/- 0.304	Upon Power On		Assumes Mass, Length and Height are constant during trip, defined as vehicle start up/shut down cycle.
Vehicle Functional Status															
Vehicle Speed Current	SWIW-RS	Vehicle Functional Status	Dynamic	Optional	Vehicle Data Systems	Vehicle Application Component	mph	0-120	+/- 2	km/h	0-194	+/-3.2	10 Hz		
Vehicle acceleration Current	SWIW-RS	Vehicle Functional Status	Dynamic	Optional	Vehicle Data Systems	Vehicle Application Component	ft/s^2	0-50	+/- 2	m/s^2	0-15	+/-0.6	10 Hz		
Brake activation	SWIW-RS	Vehicle Functional Status	Dynamic	Optional	Vehicle Data Systems	Vehicle Application Component	on/off	n/a	n/a	on/off	n/a	n/a	10 Hz		
Steering wheel angle	SWIW-RS	Vehicle Functional	Dynamic	Optional	Vehicle Data Systems	Vehicle Application	degrees	(-70)-70	+/- 2	degrees	(-70)-70	+/- 2	10 Hz		

Table A-6. Description of Candidate Data Elements for the SWIW-RS Vehicle Systems Message Data Descriptions (Continued)

Data Item Description	Application	Type of Data	Static/ Dynamic	Need	Input Source	Output Recipient	Unit of Measure (English)	Valid Range (English)	Accuracy/ Tolerance (English)	Unit of Measure (Metric)	Valid Range (Metric)	Accuracy/ Tolerance (Metric)	Refresh Rate	References	Notes
		Status				Component									
Vehicle traction control activation	SWIW-RS	Vehicle Functional Status	Dynamic	Optional	Vehicle Data Systems	Vehicle Application Component	on/off	n/a	n/a	on/off	n/a	n/a	10 Hz		
Antilock brake system activation	SWIW-RS	Vehicle Functional Status	Dynamic	Optional	Vehicle Data Systems	Vehicle Application Component	on/off	n/a	n/a	on/off	n/a	n/a	10 Hz		
Electronic stability control activation	SWIW-RS	Vehicle Functional Status	Dynamic	Optional	Vehicle Data Systems	Vehicle Application Component	on/off	n/a	n/a	on/off	n/a	n/a	10 Hz		
Vehicle Environmental Data															
Temperature (Air)	SWIW-RS	Vehicle Environmental Data	Dynamic	Optional	Vehicle Data Systems	Vehicle Application Component	°F	(-30)-120	+/- 2	°C	(-35)-49	+/-3.6	1 Hz		Potential for Ice
Rain Sensor Status	SWIW-RS	Vehicle Environmental Data	Dynamic	Optional	Vehicle Data Systems	Vehicle Application Component	0,1,2,3,4	n/a	n/a	0,1,2,3,4	n/a	n/a	1 Hz		Potential for Slippery Roads/Low Visibility
Windshield Wiper Status	SWIW-RS	Vehicle Environmental Data	Dynamic	Optional	Vehicle Data Systems	Vehicle Application Component	0,1,2,3,4	n/a	n/a	0,1,2,3,4	n/a	n/a	1 Hz		Potential for Slippery Roads/Low Visibility
Headlight Status	SWIW-RS	Vehicle Environmental Data	Dynamic	Optional	Vehicle Data Systems	Vehicle Application Component	0,1,2,3,4	n/a	n/a	0,1,2,3,4	n/a	n/a	1 Hz		Potential for Low Visibility

Source: Battelle

Table A-7. Description of Candidate Data Elements for the SWIW-RS Driver Warning Message Data Description

Data Item Description	Application	Type of Data	Static/ Dynamic	Need	Input Source	Output Recipient	Unit of Measure (English)	Valid Range (English)	Accuracy/ Tolerance (English)	Unit of Measure (Metric)	Valid Range (Metric)	Accuracy/ Tolerance (Metric)	Refresh Rate	References	Notes
DVI MUTCD Sign Number	SWIW-RS	SWIW-RS Driver Warning Message Data	Dynamic	At Least One Required From Group	Vehicle Application Component	Driver Warning System	Integer	TBD	NA	Integer	TBD	NA	10 Hz		Determined by MUTCD, Local Policy, and Driver Warning System manufacturer specifications
DVI Graphic	SWIW-RS	SWIW-RS Driver Warning Message Data	Dynamic	At Least One Required From Group	Vehicle Application Component	Driver Warning System	TBD	TBD	NA	TBD	TBD	NA	10 Hz		Determined by MUTCD, Local Policy, and Roadside Signage System manufacturer specifications
DVI Text	SWIW-RS	SWIW-RS Driver Warning Message Data	Dynamic	At Least One Required From Group	Vehicle Application Component	Driver Warning System	Alpha numeric, upper and lower case	A-Z, a-z, 0-9	NA	Alpha numeric, upper and lower case	A-Z, a-z, 0-9	NA	10 Hz		Determined by Roadside Signage System manufacturer specifications
DVI Message Valid Time	SWIW-RS	SWIW-RS Driver Warning Message Data	Dynamic	Required	Vehicle Application Component	Driver Warning System	min	0.01 to 1440	+/- 0.01	min	0.01 to 1440	+/- 0.01	10 Hz		Determined by Roadside Signage System manufacturer specifications
DVI Message Priority	SWIW-RS	SWIW-RS Driver Warning Message Data	Dynamic	Required	Vehicle Application Component	Driver Warning System	Integer	TBD	NA	Integer	TBD	NA	10 Hz		Determined by Roadside Signage System manufacturer specifications

Source: Battelle

APPENDIX B. Acronyms and Abbreviations

AAHSTO	American Associated of State Highway and Transportation Officials
CAN	Controller Area Network
ConOps	Concept of Operations
CSW	Curve Speed Warning
DII	Driver-Infrastructure Interface
DMS	Dynamic Message Signs
DoCAN	Diagnostic Communication Over Controller Area Network
DOT	Department of Transportation
DSRC	Dedicated Short Range Communications
DVI	Driver-Vehicle Interface
ESS	Environmental Sensor Station
FHWA	Federal Highway Administration
GNSS	Global Navigation Satellite Systems
ISO	International Organization for Standardization
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation Systems
MUTCD	Manual on Uniform Traffic Control Devices
NCHRP	National Cooperative Highway Research Program
NTCIP	National Transportation Communications for Intelligent Transportation System Protocol
OEMs	Original Equipment Manufacturers
PRT	Perception Reaction Time
RLVW	Red Light Violation Warning
RSZW/LC	Reduced Speed Zone Warning with Lane Closure
RTCM	Radio Technical Commission for Maritime Services
RWIS	Road-Weather Information System
SAE	Society of Automotive Engineers
SOI	System-of-Interest
SSGA	Stop Sign Gap Assist
SWIW-D	Spot Weather Information Warning – Diversion

SWIW-RS	Spot Weather Information Warning – Reduced Speed
TBD	To Be Determined
TMC	Traffic Management Center
TMDD	Traffic Management Data Dictionary
TRB	Transportation Research Board
TSS	Transportation Sensor Systems
U.S. DOT	United States Department of Transportation
UTC	Universal Time, Coordinated
V2I	Vehicle-to-Infrastructure

APPENDIX C. Terms and Definitions

Advisory Message – An informative message to the driver regarding current roadway conditions; less urgent, i.e., not necessarily crash-imminent, than an alert or warning.

Alert – A cautionary message about an anticipated crash scenario and/or vehicle conflict; more urgent than an advisory message, less urgent than a warning.

Connected Vehicle – In the context of this document, refers to the methods, data and technologies used in the bi-directional exchange of information between infrastructure and vehicles for purposes of improving safety, mobility and environmental conditions.

Degraded – Mode of the safety application where it is capable of providing a subset of its intended function(s).

Failure – Mode of the safety application where the safety application is incapable of providing any of its intended function(s).

False Alarm – Situation where the safety application provides an alert/warning to the driver when the conditions to not warrant an alert/warning.

Functional Class of Roadway – The functional class of roadways are defined in FHWA "Functional Classification Guidelines". Revised 1989.

Missed Alarm – Situation where the safety application does not provide an alert/warning to a driver when the conditions warrant an alert/warning.

Non-volatile Storage – Type of storage that remains intact even when there is no power.

Offline – State of the safety application where the safety application is not processing data or providing advisories, alerts and/or warnings.

Online – State of the safety application where the safety application is functioning and providing advisories, alerts and/or warnings.

Operational – Mode of the safety application where the safety application is capable of providing all of its intended function(s).

Perform – To work in a manner to achieve the desired outcome.

Physical Security – Describes measures that are designed to deny access to unauthorized personnel (including attackers or even accidental intruders) from physically accessing a building, facility, resource, or stored information; and guidance on how to design structures to resist potentially hostile acts.[3] Physical security can be as simple as a locked door on a roadside cabinet.

Prohibitive Reference Frame – Indicates when *unsafe* conditions are present, as opposed to "safe" conditions; "unsafe" is much easier to quantify than "safe," indicates the requirement that users also apply their own judgment, and can lessen liability issues as compared to indicating a more definitive 'permissive' notification of when conditions are "safe".

[3] Task Committee; Structural Engineering Institute (1999). *Structural Design for Physical Security*. ASCE. ISBN 978-0-7844-0457-7.

Roadside Configuration Data – Data provided from the infrastructure data equipment or back office that details the lane(s), roadway geometry, and/or map of the area needed by a safety application

Road Weather Information – Data on road and weather conditions that may impact vehicle safety including visibility, wind speed, precipitation, air and road surface temperature, road surface condition, etc.

Roadway Work Zone Configuration Information – Data on work zone configuration elements that may impact vehicle safety including lane shifts, lane reductions, etc.

Roadway Work Zone Operations Information – Data on work zone operational elements that may impact vehicle safety including buffer zones, traffic control setup, temporary pavement markings, temporary traffic barriers, road closures, changed lighting conditions (during night work),etc.

Threshold – A point in both time and/or location, depending on the specific application, that the application would reach a decision point resulting in an action being taken. This action would typically be expected to include alerts and/or warnings issued to the driver, but could also include additional actions.

Vehicle Type – Identification of vehicle role (e.g., ambulance, police cruiser, maintenance vehicle, etc.) as specific class of vehicle satisfies in the surface transportation system. A specific, standardized nomenclature does not exist.

Vehicle Class – One of 13 FHWA designations of motorized vehicles ranging in size from a Class 1 Motorcycle through a Class 13 – Seven or more axle truck.[4]

Vehicle Telematics Data – Data made available from vehicle electronic systems that could be utilized by the connected vehicle in-vehicle application. Examples include vehicle operating speed; operational status of windshield wipers, headlights, etc.; driver application of brakes or accelerator; etc.

Warning – An urgent message for a more immediate, potentially crash imminent scenario and/or vehicle conflict; more urgent than both an advisory message and alert.

[4] Traffic Monitoring Guide, U.S. DOT, May 2001, http://www.fhwa.dot.gov/ohim/tmguide/tmg4.htm#app4c

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