# Accelerated Vehicle-to-Infrastructure (V2I) Safety Applications

## System Requirements Document

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**Final Report — July 18, 2012**
**FHWA-JPO-13-059**


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Research and Innovative Technology (RITA) ITS Joint Program Office

## Notice



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15. Supplementary Notes

16. Abstract

This document describes the system requirements for three connected vehicle V2I safety applications related to intersection safety and speed management. Specifically, these applications include:

- Red-Light Violation Warning (RLVW)
- Stop Sign Gap Assist (SSGA)
- Curve Speed Warning (CSW)

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| A | 06/04/2012 | Walkthrough Review Draft | All |
| B | 07/18/2012 | Updates based on Walkthrough | All |
| C | 03/26/2013 | Added source information for cover photos | Back of cover page |

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# Executive Summary

This document describes the System Requirements (SysReq) for three connected vehicle vehicle-to-infrastructure (V2I) safety applications, and the underlying connected vehicle system, for crash avoidance for the U.S. Department of Transportation (USDOT). The SysReq transforms the Connected Vehicle V2I Safety Applications Concept of Operations (ConOps) (100006441-22) into a set of system requirements for the applications described in the ConOps. The system requirements are focused on functional requirements of the system; performance requirements of the system are not included and will be defined later. The SysReq describes the requirements for the system of interest; describes the methods to be used during verification and outlines the verification method for each requirement; and provides traceability to stakeholder needs identified in the ConOps.

This document describes the SysReq for three connected vehicle V2I safety applications related to intersection safety and speed management; these applications include:

*Red-Light Violation Warning (RLVW)* – Application designed to warn drivers that they may violate an upcoming red light based on their speeds and distance to the signalized intersection.

*Stop Sign Gap Assist (SSGA)* – Application designed to warn stopped drivers at a stop-controlled intersection of oncoming cross-traffic.

*Curve Speed Warning (CSW)* – Application designed to warn drivers that the vehicle's current speed may be too high to safely traverse one or more upcoming curves.

Presently, many infrastructure-based countermeasures have been implemented by public agencies and vehicle-based countermeasures have been implemented by vehicle OEMs, both for the purpose of improving safety. These systems, until recently, have not typically integrated these infrastructure and vehicle data. Integrating roadside infrastructure and vehicle data and systems can provide a richer information set for identifying driving hazards and providing more accurate and timely warnings to drivers of unsafe conditions on the roadway. Connected vehicle systems have the advantage of collecting and sharing real-time data and warnings that are more likely to capture the attention of drivers due to their dynamic nature and improved reliability over static warning signs. As previously discussed, the purpose of this document is to develop the SysReq for three applications that either create new or expand existing safety improvement over the current practice by integrating these infrastructure and vehicle-based technologies.

These safety applications are sub-components of the larger connected vehicle program, which will produce other SysReq documents related to safety, mobility, and the environment. The safety applications in this document complement two other V2I safety applications: Spot Weather Information Warning (SWIW) and Reduced Speed/Work Zone Warning (RSZW), which were presented in a separate SysReq document. Other initiatives relevant to the larger USDOT connected vehicle program include the Smart Roadside Initiative, Signal Phase and Timing (SPaT) and Other Related Messages, Transit Connected Vehicles, and more recently the connected vehicle railroad program. This SysReq is limited to describing the expected functionality, operation, and rationale for existence of the three safety applications listed above.

Following is a brief description and graphical illustration of each of the three applications that are documented in this SysReq.

# Red-Light Violation Warning (RLVW)

The objective of RLVW is to provide a cooperative vehicle and infrastructure system that assists drivers in avoiding crashes at signalized intersections by providing a warning to the vehicle driver that, based on their speeds and distance to the intersection, they may violate an upcoming red light. An equipped vehicle approaching an equipped intersection receives messages about the signal phase and timing, intersection geometry, and position correction information. The driver is issued a warning if the application determines that, given current operating conditions, the driver is predicted to violate the red light. Figure ES-1 illustrates the proposed RLVW application design.

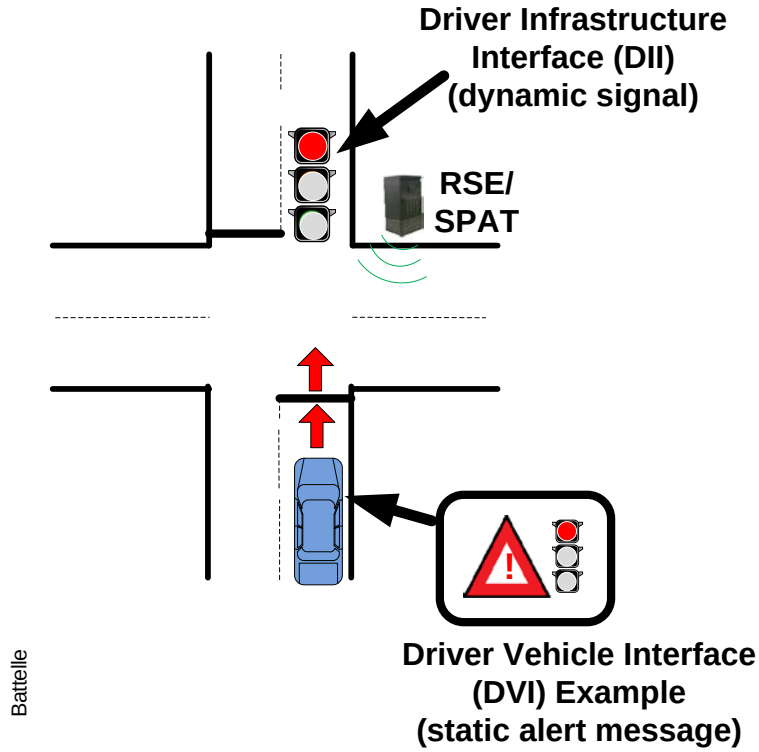


**Figure ES-1. RLVW Illustration**

# Stop Sign Gap Assist (SSGA)

The objective of SSGA is to provide a cooperative vehicle and infrastructure system that assists drivers in avoiding crashes by providing approaching cross-traffic information to support driver decisions in safely traversing stop-sign controlled intersections. The system will support stopped minor-road drivers in identifying unsafe gaps in cross-traffic at major road intersections. The infrastructure application will collect available infrastructure and vehicle data, most importantly from the major road vehicle detection system that detects the presence, distance, and speed of each vehicle within its coverage zone. The infrastructure application will process available data to post an appropriate advisory message, alert, and/or warning on the driver infrastructure interface (DII) signage when conditions are determined to be unsafe for minor road drivers to proceed into the intersection. An equipped vehicle stopped at an equipped stop-controlled intersection receives messages from the roadside equipment and will display an appropriate advisory message, alert, and/or warning for the driver on the in-vehicle driver vehicle interface (DVI). Figure ES-2 illustrates the proposed SSGA application design.

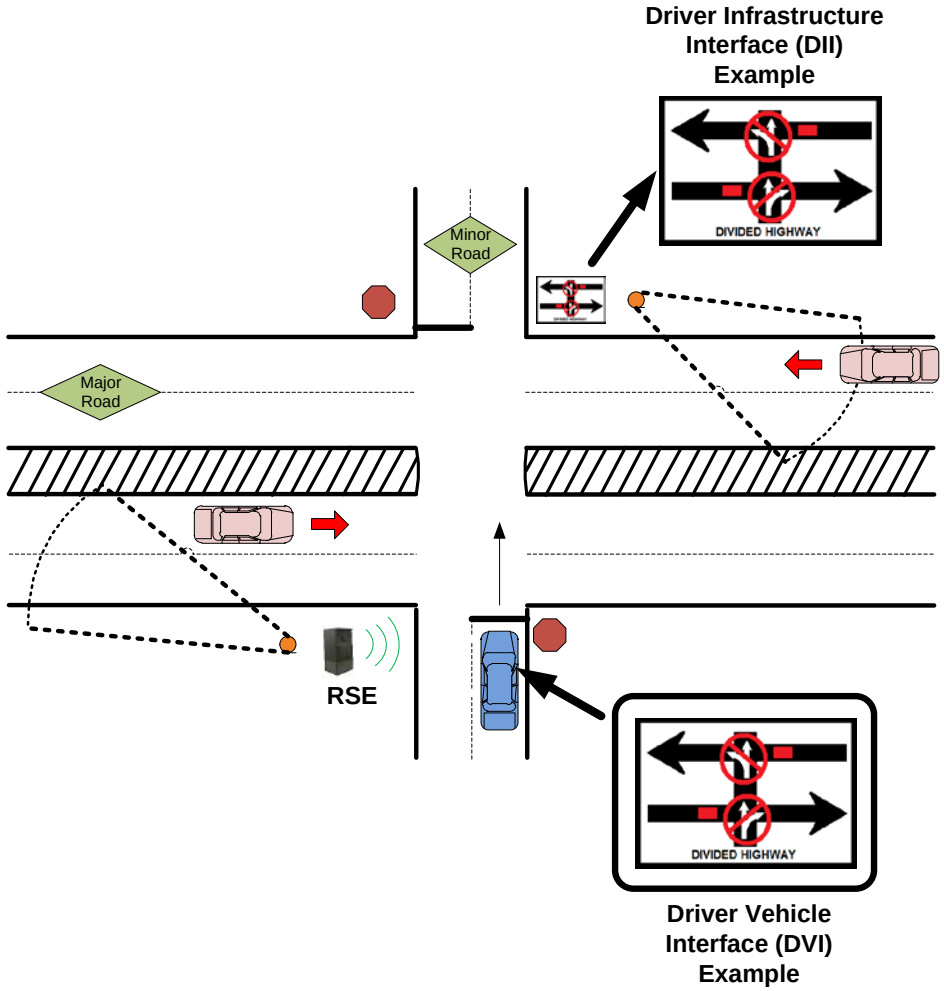


**Figure ES-2. SSGA Illustration**

# Curve Speed Warning (CSW)

The objective of CSW is to provide a cooperative vehicle and infrastructure system that assists drivers in avoiding crashes by warning the vehicle driver that the vehicle's current speed may be too high to safely traverse one or more upcoming curves. The infrastructure application component will collect available infrastructure and vehicle data, potentially from basic radar detection sensors or a combination of multiple types of sensors (e.g., radar and environmental sensors), then process available data to recommend an appropriate advisory message, alert, and/or warning to provide messages to drivers via DII signage. An equipped vehicle approaching an equipped curve receives messages from the roadside equipment and will display an appropriate advisory message, alert, and/or warning for the driver on the in-vehicle DVI. Figure ES-3 illustrates the proposed CSW application design.

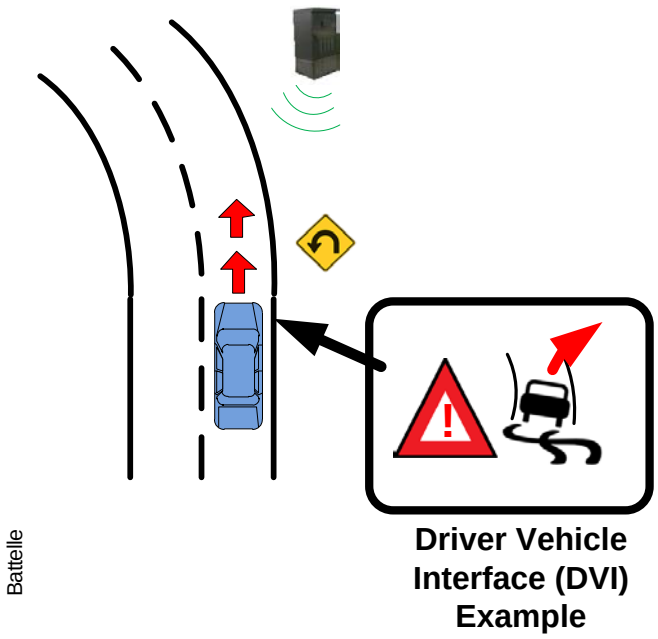


**Figure ES-3. CSW Illustration**

# Benefits

The most significant operational impact of these applications is their effect on increased roadway safety. Expected benefits include:

- Reductions in the number of roadway fatalities
- Reductions in the number and severity of roadway injuries
- Reductions in property damage associated with roadway incidents
- Reductions in the number of near-miss intersection conflict and run-off-road (ROR) incident scenarios.

Additional benefits may include:

- The development of a safety warning system that is deployable nationwide and found to be acceptable, understood, and useful to users, so as to elicit timely and appropriate driver response
- The development of a connected vehicle environment in which emerging technologies can utilize existing infrastructure to enhance safety benefits (eventually incorporating V2V concepts)
- The deployment of technology systems to establish a foundation of communication and technologies that will bridge the gap between current roadway safety conditions with non-equipped vehicles and a saturated connected vehicle environment
- Continued promotion of the institutional relationship between the public (e.g., U.S., state, and local DOTs) and private sectors (e.g., vehicle manufacturers) to further promote transportation safety.

The SysReq includes the following key descriptions and discussions pertinent to V2I safety applications for intersection and roadway safety:

- Section 2 (Referenced Documents) describes the external documentation referenced throughout this document.
- Section 3 (Requirements) describes the requirements for the system of interest.
- Section 4 (Verification) describes the methods to be used during verification and outlines the verification method for each requirement.
- Section 5 (Notes) provides traceability to stakeholder needs, definitions for terms, acronyms, and abbreviations used throughout the document.

# 1. Scope

This document describes the System Requirements (SysReq) for selected connected vehicle vehicle-to-infrastructure (V2I) safety applications, and the underlying connected vehicle system, for crash avoidance for the U.S. Department of Transportation (USDOT). This document transforms the Connected Vehicle Safety Concept of Operations Document (ConOps) (100006441-22) into a set of system requirements for the applications described in the ConOps. The system requirements are focused on functional requirements of the system. Performance requirements of the system are not included and will be defined later. The description of the system of interest is located in Section 3.1. 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.

This document describes the system requirements for three connected vehicle V2I safety applications related to intersection safety and speed management. Specifically, these applications include:

- Red-Light Violation Warning (RLVW)
- Stop Sign Gap Assist (SSGA)
- Curve Speed Warning (CSW)

These safety applications are sub-components to the larger connected vehicle program which expects to produce other ConOps documents related to safety and mobility applications. This SysReq is restricted to describing the expected functionality, operation, and rationale of the three safety applications in the bulleted list above.

## 1.1 Document Overview

The intended audience of this SysReq document includes: application developers, automotive, wireless and ITS equipment OEMs, State and local DOTs, and USDOT connected vehicle program managers who are managing the safety applications work.

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

Section 2 (Referenced Documents) describes the external documentation referenced throughout this document.

Section 3 (Requirements) describes the requirements for the system of interest.

Section 4 (Verification) describes the methods to be used during verification and outlines the verification method for each requirement.

Section 5 (Notes) provides traceability to stakeholder needs, definitions for terms, acronyms, and abbreviations used throughout the document.

# 2. Referenced Documents

The following documents form a part of this document to the extent specified herein.

Crash Avoidance Metrics Partnership (CAMP) on behalf of the Vehicle Safety Communications 2 (VSC2) Consortium

| | |
|---|---|
| CICAS-V ConOps | Cooperative Intersection Collision Avoidance System Limited to Stop Sign and Traffic Signal Violations (CICAS-V) Concept of Operations, v3.01 (2008) |
| CICAS-V System Requirements | Cooperative Intersection Collision Avoidance System Limited to Stop Sign and Traffic Signal Violations (CICAS-V), System Requirements Specification, v3.01, (2008) |

University of Minnesota (UMN)

| | |
|---|---|
| CICAS-SSA ConOps | Cooperative Intersection Collision Avoidance System – Stop Sign Assist (CICAS-SSA) Concept of Operations, Version 1.0 (2008) |
| UMN Report #1 | Determination of the Alert and Warning Timing for the Cooperative Intersection Collision Avoidance System – Stop Sign Assist Using Macroscopic and Microscopic Data: CICAS-SSA, Report #1 (2010) |
| UMN Report #2 | The Design of a Minimal Sensor Configuration for a Cooperative Intersection Collision Avoidance System – Stop Sign Assist: CICAS-SSA, Report #2 (2010) |
| UMN Report #3 | Macroscopic Review of Driver Gap Acceptance and Rejection Behavior at Rural Thru-Stop Intersections in the US – Data Collection Results in Eight States: CICAS-SSA, Report #3 (2010) |
| UMN Report #4 | Sign Comprehension, Considering Rotation and Location, using Random Gap Simulation for a Cooperative Intersection Collision Avoidance System – Stop Sign Assist: CICAS-SSA, Report #4 (2010) |
| UMN Report #5 | Validation Study – On-Road Evaluation of the Cooperative Intersection Collision Avoidance System – Stop Sign Assist Sign: CICAS-SSA, Report #5 (2010) |

U.S. Department of Transportation

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|---|---|
| MUTCD-09 | Manual on Uniform Traffic Control Devices for Streets and Highways, 2009 edition |
| FHWA-HOP-08-024 | Traffic Signal Timing Manual |
| NHTSA-2010-0053 | Visual-Manual NHTSA Driver Distraction Guidelines for In-Vehicle Electronic Devices |
| FHWA Reference Guide | FHWA Functional Classification Guidelines. Revised 1989. |
| DOT HS 808 964 | Kiefer, R.J., LeBlanc, D., Palmer, M., Salinger, J., Deering, R., & Shulman, M. 1999. *Forward Collision Warning Systems: Development and Validation of Functional Definitions and Evaluation Procedures for Collision Warning/Avoidance Systems* |
| DOT HS 809 716 | Lee, S.E., Knipling, R.R., DeHart, M.C., Perez, M.A., Holbrook, G.T., Brown, S.B., et al. (2004). *Vehicle-Based Countermeasures for Signal and Stop Sign Violations: Task 1. Intersection Control Violation Crash Analyses, Task 2. Top-Level system and Human Factors Requirements* |
| DOT HS 809 414 | Talmadge, S., Chu, R., Eberhard, C., Jordan, K., and Moffa, P. (2000). *Development of performance specifications for collision avoidance systems for lane change crashes* |
| DOT HS 810 697 | Campbell, J.L., Richard, C.M., Brown, J.L., & McCallum, M. (2007). *Crash Warning System Interfaces: Human Factors Insights and Lessons Learned* |

Battelle Drawings/Documents

| | |
|---|---|
| 100006441-001 | Project Management Plan for Connected Vehicle Safety Concept of Operations |
| 100006441-004 | Systems Engineering Management Plan (SEMP) for Connected Vehicle Safety Concept of Operations |
| 100006441-022 | Concept of Operations for Accelerated V2I Safety Applications |

Society of Automotive Engineers (SAE)

| | |
|---|---|
| J2735:2009 | Dedicated Short Range Communications (DSRC) Message Set Dictionary. |

Institute of Electrical and Electronics Engineers (IEEE)

| | |
|---|---|
| 1220-2005 | IEEE Standard for Application and Management of the Systems Engineering Process |
| 1362-1998 (R2007) | IEEE Standard for Information Technology – System Definition – Concept of Operations (ConOps) Document |

American Association of State Highway and Transportation Officials (AASHTO)

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

## 2.1 Order of Precedence

In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document however supersedes applicable laws and regulations unless a specific exemption has been obtained.

# 3. Requirements

## 3.1 System Description

This project is sponsored by the USDOT and has a goal of supporting the development and implementation of connected vehicle V2I safety applications. As part of this implementation, the USDOT identified priorities for V2I safety applications, which include intersection safety and speed management. The general framework for the connected vehicle V2I safety applications is shown in Figure 1. As shown, it includes both vehicle and infrastructure (roadside) application platforms that house the roadside and vehicle components of the V2I applications respectively. This same figure also shows external inputs into the system. The Vehicle Application Platform captures sensor data through the On Board Diagnostic version 2 (OBD-II) and Controller Area Network (CAN) networks for use by the applications. The Road Side Platform capture collects roadside data such as signal controller and road weather information for use by applications. Diagrams specific to individual safety applications are presented later in this document.

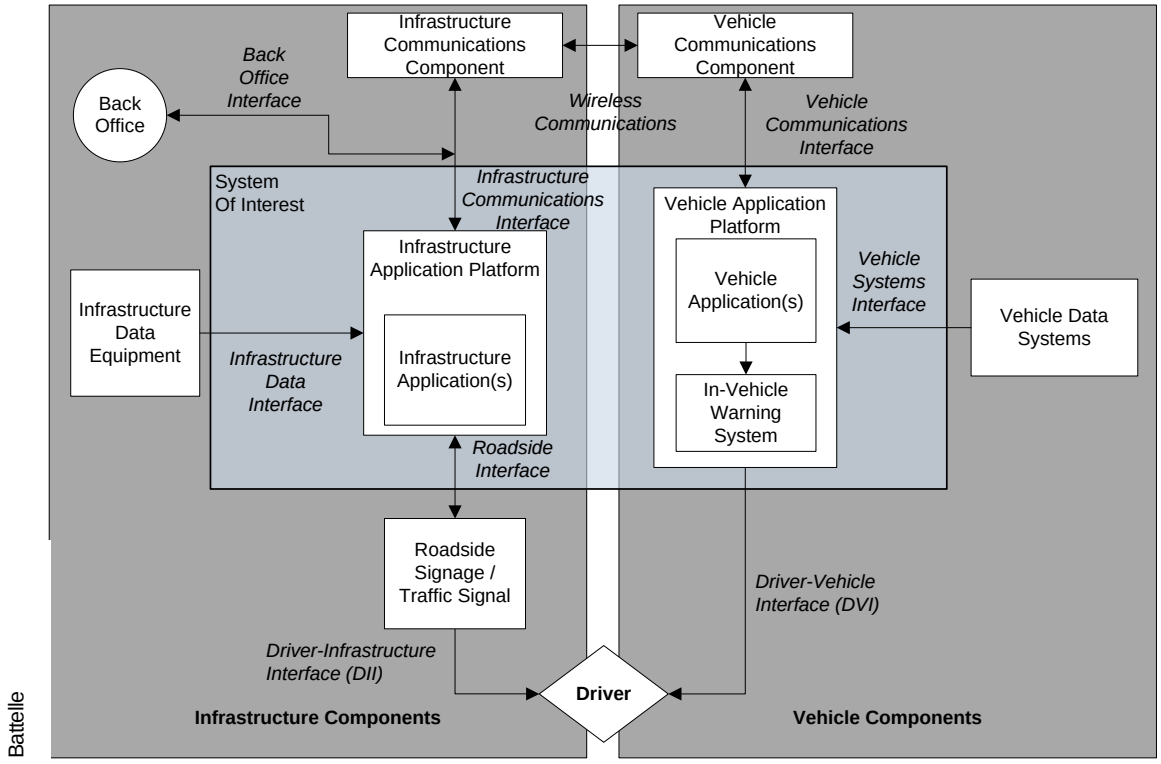


**Figure 1. General Framework for Connected Vehicle V2I Safety Applications**

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

- System-Of-Interest Components
  - Infrastructure Applications Platform
  - Infrastructure Application(s)
  - Vehicle Application Platform
  - Vehicle Application(s)
  - In-Vehicle Warning System
- Supporting Components
  - Infrastructure Communications Component
  - Vehicle Communications Component
  - Back Office
  - Infrastructure Data Equipment
  - Roadside Signage / Traffic Signal
  - Driver
  - Vehicle Data Systems
- Interfaces
  - Back Office Interface
  - Infrastructure Data Interface
  - Infrastructure Communications Interface
  - Roadside Interface
  - Driver-Infrastructure Interface (DII)
  - Wireless Communications
  - Vehicle Communications Interface
  - Vehicle Systems Interface
  - Driver-Vehicle Interface

***Infrastructure Application Platform***

The Infrastructure Application Platform will communicate with the Infrastructure Communications Component, accept information from the Infrastructure Data Equipment, host the infrastructure-based safety application(s), and communicate with the Roadside Signage/Traffic Signal.

***Infrastructure Application(s)***

The Infrastructure Application(s) is the infrastructure component of the safety application(s). This contains the infrastructure-based algorithm for one or more of the safety applications.

***Vehicle Application Platform***

The Vehicle Application Platform will communicate with the Vehicle Communications Component, accept information from the Vehicle Data Systems, host the vehicle-based safety application, and communicate with the In-Vehicle Warning System.

***Vehicle Application(s)***

The Vehicle Application(s) is the vehicle component of the safety application(s). This contains the vehicle-based algorithm for one or more of the safety applications.

***In-Vehicle Warning System***

The In-Vehicle Warning System is the necessary equipment that will provide the indication of a safety application alert and/or warning to the driver. Typically, the indication will be aural and/or visual; however, alternate indications such as haptic warnings may be provided. When multiple safety applications are hosted on the Vehicle Applications Platform, the In-Vehicle Warning System will prioritize alerts and warnings from the multiple safety applications.

***Infrastructure Communications Component***

The Infrastructure Communications Component is a wireless communications device that provides the Infrastructure Application Platform a means to communicate with a Connected Vehicle's Vehicle Communications Component.

***Vehicle Communications Component***

The Vehicle Communications Component is a wireless communications device that provides the Vehicle Application Platform a means to communicate with an equipped Infrastructure Communications Component.

***Back Office***

The Back Office represents a system that is located remote to the Infrastructure and is used by the maintainer of the Infrastructure Components. The Back Office may be an optional system due to cost constraints of the maintainer of the infrastructure. However, the Back Office system could be used to help facilitate the collection of diagnostic data from the Infrastructure Application. The Back Office may also provide a means to supply dynamic (current) data to the Infrastructure Application or even possibly a remote mechanism for updates to the Infrastructure Application.

***Infrastructure Data Equipment***

Infrastructure Data Equipment represents equipment that provides infrastructure information to the Infrastructure Application. Some examples may include: Weather Information, Surface Conditions, Visibility, and Vehicle Detection and Speed.

***Roadside Signage/Traffic Signal***

An integral part of the infrastructure interface with the driver is Roadside Signage and/or Traffic Signal. The Roadside Signage and Traffic Signal provide information capabilities for both equipped and non-equipped connected vehicles.

***Driver***

The Driver is the user of the safety application. The interface to the driver may convey information such as alerts, advisories, and warnings from the infrastructure and/or the vehicle.

***Vehicle Data Systems***

The Vehicle Data Systems represent systems within the vehicle that provide vehicle related information to the Vehicle Application. Information provided may come from a positioning system, vehicle data bus, sensors, actuators on the vehicle, or stability systems. Specific interfaces to vehicle systems will be dependent on specific information required to support the safety application.

***Back Office Interface***

The Back Office Interface is an optional interface that may be implemented when a Back Office is present. This interface may contain diagnostic information from Infrastructure Components. The interface is depicted in Figure 1 between the Infrastructure Communications Component and the

Infrastructure Applications Platform. The rationale behind depicting this interface in this manner is to allow implementers of a system the opportunity to decide whether the Back Office Interface will interface directly with the Infrastructure Communications Component or directly with the Infrastructure Applications Platform.

***Infrastructure Data Interface***

The Infrastructure Data Interface is the interface between the Infrastructure Application Platform and the Infrastructure Data Equipment. The Infrastructure Application Platform interfaces with equipment within the Infrastructure to receive information such as Weather Information, Surface Conditions, Visibility, Vehicle Detection, Signal Phase and Timing.

***Infrastructure Communications Interface***

The Infrastructure Communications Interface is the interface between the Infrastructure Application Platform and the Infrastructure Communications Component. This interface is used by the Infrastructure Applications Platform to transmit and receive information to nearby equipped vehicles.

***Roadside Interface***

The Roadside Interface is the interface between the Infrastructure Applications Platform and the Roadside Signage. The Infrastructure Applications Platform transmits information, via the Roadside Interface, to the Roadside Signage regarding alerts/warnings that need to be displayed to the driver.

***Driver-Infrastructure Interface (DII)***

The Driver-Infrastructure Interface is the interface between the Roadside Signage and the Driver. This interface is used to provide information indicated by the Roadside Signage to the Driver which may include status of application and any alerts/warnings.

***Wireless Communications Interface***

The Wireless Communications Interface is the interface between the Infrastructure Communications Component and the Vehicle Communications Component.

***Vehicle Communications Interface***

The Vehicle Communications Interface is the interface between the Vehicle Application Platform and the Vehicle Communications Component. This interface is used by the Vehicle Applications Platform to transmit information to and receive information from nearby equipped Infrastructure.

***Vehicle Systems Interface***

The Vehicle Systems Interface is the interface between the Vehicle Application Platform and the Vehicle Data Systems. The Vehicle Application Platform interfaces with equipment within the vehicle to receive such information as Position, Speed, Acceleration, and Heading.

***Driver-Vehicle Interface (DVI)***

The Driver-Vehicle Interface is the interface between the Vehicle Applications Platform and the Driver. This interface is used to provide information from the Vehicle Applications Platform to the Driver which may include status of application and any alerts/warnings.

### 3.1.1 System of Interest – Red Light Violation Warning Application

The RLWV application is intended to improve safety at signalized intersections through the integration of vehicle-based and infrastructure-based technologies to help drivers approaching an intersection understand the state of activities within that intersection. In particular, signal phase and timing (SPaT) information will inform drivers of a red or impending red light in time for the driver to bring the vehicle safely to a stop. This application will thus have the potential to warn drivers about likely violations of traffic signal devices. Figure 2 summarizes the proposed RLVW application design.

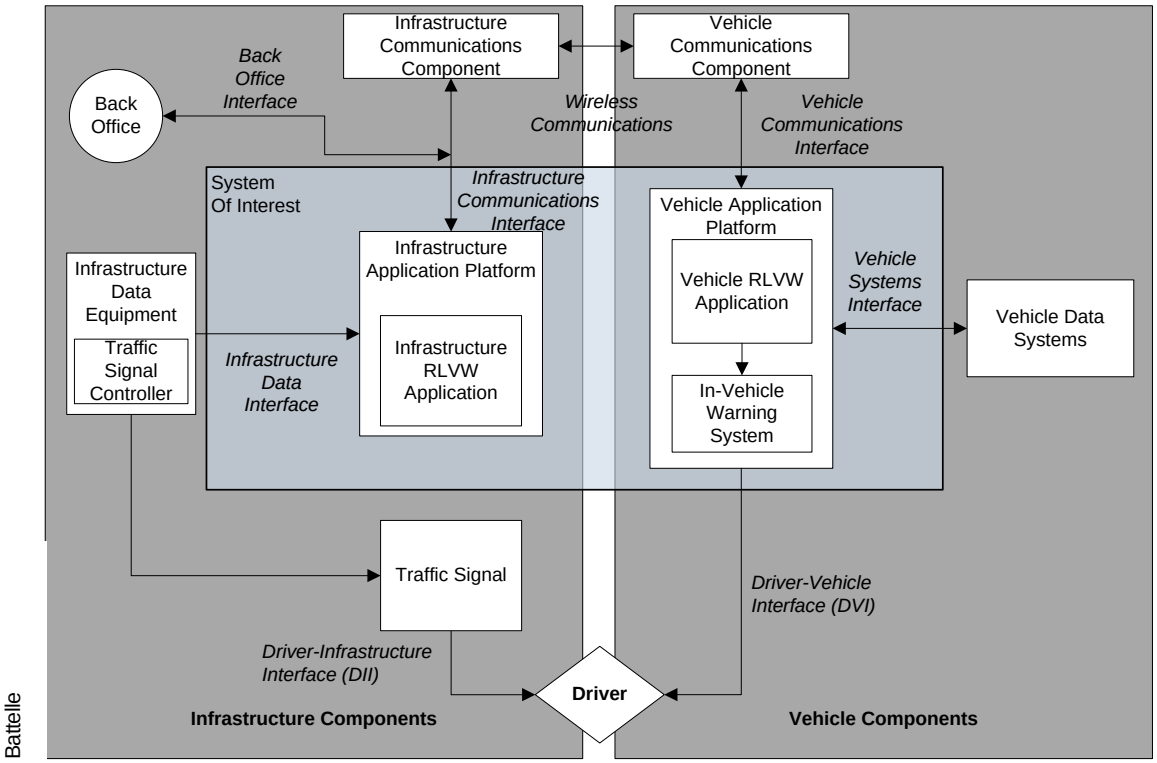


**Figure 2. Red-Light Violation Warning Application Diagram**

## 3.1.2 System of Interest – Stop Sign Gap Assist Application

The SSGA safety application is intended to improve safety at non-signalized intersections where only the minor road has posted stop signs. This will be achieved through the integration of both vehicle-based and infrastructure-based technologies, including both onboard and roadside signage warning systems. The application will help drivers on a minor road stopped at an intersection understand the state of activities associated with that intersection by providing a warning of unsafe gaps on the major road. In this way, the SSGA safety application will help drivers maneuver through cross traffic, reducing the number of conflicts and crashes. The SSGA application is configured for both equipped and non-equipped scenarios, and thus the vehicle components of the application can be optional. Figure 3 summarizes the proposed SSGA application design.

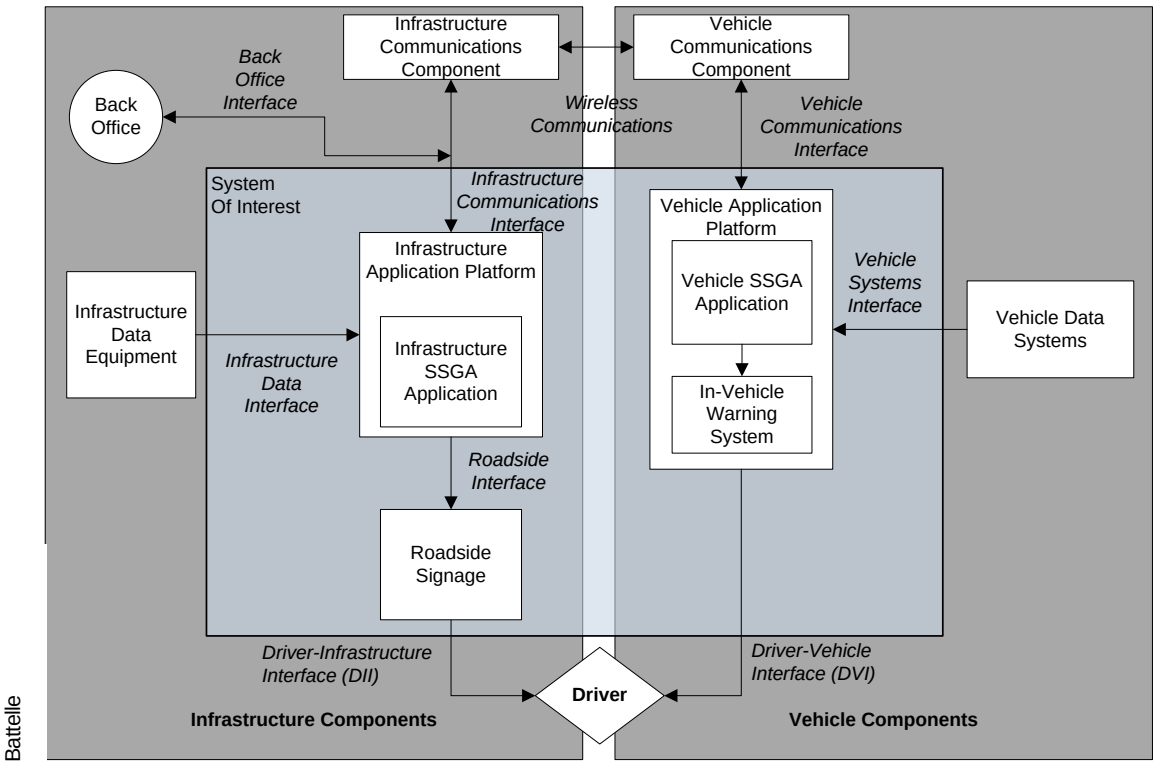


**Figure 3. Stop Sign Gap Assist Application Diagram**

### 3.1.3 System of Interest – Curve Speed Warning Application

The CSW safety application is intended to improve safety when traversing curves via the integration of vehicle-based and infrastructure-based technologies to help drivers approaching a curve travel through it at a safe speed based on the current road and weather conditions. In particular, the application is intended to warn drivers if they are exceeding the safe speed threshold which may result in a loss of vehicle stability and control, leading to a roadway departure and/or rollover crash. Figure 4 summarizes the proposed CSW application design.

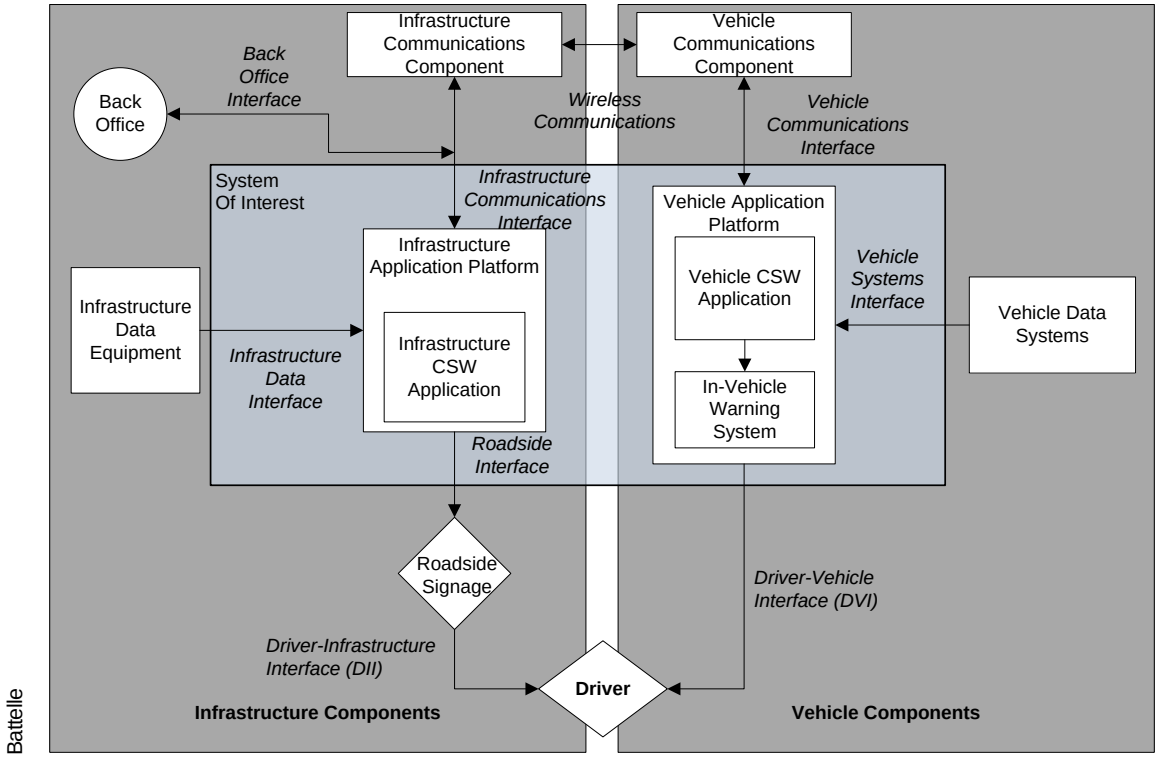


**Figure 4. Curve Speed Warning Application Diagram**

## 3.2 Common Requirements

The following list of requirements have been identified as being common to the three applications (RLVW, SSGA, and CSW) documented in this Systems Requirements document.

***Range of Driver Capabilities***

[SYS-REQ-001] The safety application shall be universal such that it supports all licensed drivers. (UN-COM-001)

***Affected Vehicles***

[SYS-REQ-002] The safety application shall be universal such that it will work in and with defined vehicle classes and types. (UN-COM-002)

***Environmental Conditions***

[SYS-REQ-003] The safety application shall function in all weather (pavement and atmospheric) and lighting conditions. (UN-COM-003)

***Performance Location***

[SYS-REQ-004] The safety application shall function on any public roadway regardless of geographic area. (No driveways) (UN-COM-004)

***Vehicle Position Accuracy***

[SYS-REQ-005] The vehicle position provided to the Vehicle Application shall be sufficiently accurate to support the needs of the specific application at a specific location. (UN-COM-005)

***Compatibility with other On-Board Systems***

[SYS-REQ-006] The safety application shall not preclude interoperability and integration with current in-vehicle safety systems, with other future connected vehicle-enabled systems, and other future in-vehicle safety systems. (UN-COM-006)

***False/Missed Alarms***

[SYS-REQ-007] Infrastructure data shall be sufficient to support an application's probability of false alarm (Pfa) of less than {TBD}[1]. A false alarm is defined as the situation where the safety application provides an alert/warning to a driver when the conditions do not warrant an alert/warning. (UN-COM-007)

[1] There is not a strong consensus in the Human Factors literature regarding acceptable false alarm (FA) rates. The acceptability of FAs depends in part on the severity of the reaction/consequences of receiving the FA; the more severe the reaction/consequences, the less tolerance there is for FAs. Warning modality can also affect the acceptable FA rate. Visual alerts are less likely to be annoying than auditory alerts because they are generally less obtrusive. Keifer et al., (1999) recommends a maximum of one FA per 200 miles for forward collision warning alerts (one FA per week assuming drivers average 201 miles per week of driving). Based on engineering judgment, Lee et al., (2004) estimates that all false alarms (FA and misses) should not exceed 10% of all warnings for an intersection collision avoidance (ICA) system. Talmadge et al., (2000) found that drivers did not consider the relatively high rate of 42 FAs per hour to be annoying for a lane collision warning. However, this alarm consisted of an unobtrusive visual alert only. It is likely that V2I will produce fewer false alarms than vehicle-sensor based systems do. It seems reasonable that the recommendations in Keifer et al, (1999) or Lee et al., (2004) are achievable with these technologies.

[SYS-REQ-008] Infrastructure data shall be sufficient to support an application's probability of missed alarm (Pma) of less than {TBD}[2]. A missed alarm is defined as the situation where the safety application does not provide an alert/warning to a driver when the conditions warrant an alert/warning. (UN-COM-007)

***Consideration of Human Factors***

[SYS-REQ-009] The safety application shall use alerts that conform to existing automotive human factors guidelines, OEMs' driver-vehicle interface principles and practices, and driver-vehicle interfaces that follow human factors guidelines issued by the FHWA, NHTSA, and SAE. (UN-COM-008)

***Self-Diagnostics (Infrastructure)***

[SYS-REQ-010] The Infrastructure Application shall perform self-diagnostics upon power up and at periodic predetermined intervals. Self-Diagnostics refers to the ability of the Infrastructure Application to determine whether it is capable of performing its intended function. (UN-COM-009)

[SYS-REQ-032] The Infrastructure Application shall determine the operating level/mode of operational, degraded, or failure based on the results of a self-diagnostic test. (UN-COM-009)

[SYS-REQ-033] The Infrastructure Application shall set the operational status corresponding to the operational level mode as follows:

1. Operational – online
2. Degraded – online
3. Failure – offline

   (UN-COM-009)

[SYS-REQ-011] The Infrastructure Application shall log self-diagnostic test information which contains, at a minimum, the following information:

1. online/offline status (set to offline if safety application cannot perform its intended function)
2. self-diagnostic test information
    a. date and time of test
    b. result of test (Pass/Fail)
    c. Additional information to the nature of a failed test including but not limited to the particular infrastructure component.

   (UN-COM-009, UN-COM-010)

[SYS-REQ-034] The Infrastructure Application shall maintain historical information of self-diagnostic tests for a predetermined period in non-volatile storage. Non-volatile storage refers to storage that remains intact even when there is no power. (It is left up to the implementer to determine if the retention of data is a fixed window of time or if it is based on a fixed amount of storage.) (UN-COM-009)

[2] No literature has been identified that has specifications for false negative (missed) alarm rates other than Lee et al. (2004), who estimate maximum FA rates of less than 10% of all warnings (FA and misses) for an intersection collision avoidance (ICA) system.

[SYS-REQ-012] The Infrastructure Application shall take itself off-line when the operating level/mode is failure. (UN-COM-009)

[SYS-REQ-013] The Infrastructure Application shall remain on-line when the operating level/mode is either operational or degraded. (UN-COM-009)

[SYS-REQ-030] (Optional) The Infrastructure Application may report operational status to the back office, when back office is present, at predetermined periodic intervals. (UN-COM-009)

[SYS-REQ-014] (Optional) The Infrastructure Components may provide a maintenance interface to facilitate installation, configuration, upgrades, and maintenance of the Infrastructure Application. (UN-COM-010)

[SYS-REQ-015] The Infrastructure Application Platform and Infrastructure Application shall not report inaccurate or misleading information to the driver in the event of a malfunction with the Infrastructure Application Platform or Infrastructure Application. (UN-COM-009)

***Self-Diagnostics (Vehicle)***

[SYS-REQ-016] The Vehicle Application shall perform self-diagnostics upon power up and at periodic intervals when the vehicle is operating. Self-Diagnostics refers to the ability of the Infrastructure Application to determine whether it is capable of performing its intended function. (UN-COM-009)

[SYS-REQ-035] The Vehicle Application shall determine the operating level/mode of operational, degraded, or failure based on the results of a self-diagnostic test. (UN-COM-009)

[SYS-REQ-036] The Vehicle Application shall set the operational status corresponding to the operational level mode as follows:

1. Operational – online
2. Degraded – online
3. Failure – offline

   (UN-COM-009)

[SYS-REQ-017] The Vehicle Application shall log self-diagnostic test failure which contains, at a minimum, the following information:

1. Date and time of test failure
2. Additional information to the nature of a failed test

   (UN-COM-009)

[SYS-REQ-037] The Vehicle Application shall maintain historical information of self-diagnostic test failures for a predetermined period in non-volatile storage. Non-volatile storage refers to storage that remains intact even when there is no power. (It is left up to the implementer to determine if the retention of data is a fixed window of time, if it is based on a fixed amount of storage, if it is until cleared.) (UN-COM-009)

[SYS-REQ-018] The Vehicle Application shall take itself off-line when the operating level/mode is failure. (UN-COM-009)

[SYS-REQ-019] The Vehicle Application shall restore or maintain itself on-line when the operating level/mode is either operational or degraded. (UN-COM-009)

***Integrity of the System***

[SYS-REQ-020] The Vehicle Application shall be disabled if physical tampering is detected. (UN-COM-014)

[SYS-REQ-021] The Infrastructure Components shall provide physical protection for access. (UN-COM-014)

[SYS-REQ-022] The Vehicle Components shall allow owners/operators of the components to identify that unauthorized physical access has been attempted or achieved. (UN-COM-015)

[SYS-REQ-023] The Infrastructure Components shall allow owners/operators of the components to identify that unauthorized physical access has been attempted or achieved. (UN-COM-015)

***Communications Security***

[SYS-REQ-024] The Infrastructure Communications and Vehicle Communications wireless link shall have communications security to ensure the authenticity of all its messages in accordance to the standards prescribed by the overall USDOT connected vehicle program. (UN-COM-016)

[SYS-REQ-025] The message authentication for Infrastructure Communications and Vehicle Communications wireless link shall be fast enough to support the objectives of the safety application. (UN-COM-017)

***System Upgrades***

[SYS-REQ-026] Vehicle and infrastructure component and application upgrades shall be compatible with and not adversely impact the performance of previous versions of the components and applications. (UN-COM-018)

***Class of Roadway***

[SYS-REQ-027] The Vehicle and infrastructure application shall perform effectively for all defined functional classes of roadway and levels of service (LOS) where the application is installed or is being used. {Note: The defined functional classes of roadways can be found in FHWA's "Functional Classification Guidelines". The defined LOS can be found in AASHTO's "A Policy on Geometric Design of Highways and Streets".} (UN-COM-019)

***Interoperability with other Infrastructure System***

[SYS-REQ-028] The application system shall be interoperable and support integration with current infrastructure safety systems, with other future connected vehicle-enabled systems, and other future infrastructure safety systems. (UN-COM-020)

***Issuance of Alerts and/or Warnings***

[SYS-REQ-029] The V2I safety application alerts and/or warnings shall only be issued when the current inputs to the application warrants an alert or warning. (UN-COM-021)

***Priority of Alerts and/or Warning***

[SYS-REQ-031] The vehicle application platform shall include a threat arbitrator for alerts/warnings presented to the driver in cases where multiple safety alerts/warnings are indicated simultaneously. (UN-COM-020)

# 3.3 Safety Applications Requirements

## 3.3.1 Red Light Violation Warning (RLVW) Application

[SYS-REQ-101] The RLVW application shall not violate the operating agency's policies. (OP-RLVW-09)

[SYS-REQ-102] All equipped systems involved in the RLVW application, including both in-vehicle and infrastructure components, shall utilize a common time source. (UN-RLV-009)

### ***Interface Requirements***

#### *Back Office Interface*

The Back Office system is an optional system that may be developed to support the Infrastructure RLVW Application. This section provides requirements for the interface to the Back Office, if one is implemented.

[SYS-REQ-103] (Optional) The interface between the Back Office and the Infrastructure Components, when a Back office is present, may have a secured communications link meeting the standards prescribed as defined by infrastructure owner/operator. (OC-RLVW-03)

[SYS-REQ-104] DELETED (duplicate of SYS-REQ-030)

#### *Infrastructure Data Interface*

[SYS-REQ-105] The Infrastructure Application Platform shall receive from the Infrastructure Data Equipment at a minimum the following RLVW information:

1. Intersection geometry information (e.g., Geometric Intersection Design (GID))
2. Signal Phase and Timing information of the traffic signal at the Intersection
3. Traffic law restrictions for the intersection (i.e., right- or left-turn on red prohibited, permitted without stopping or permitted after stopping)
4. Road conditions (if available)

   (UN-RLV-005)

[SYS-REQ-106] The Infrastructure Application Platform shall receive from the Infrastructure Data Equipment accurate and up-to-date intersection geometry information for a RLVW enabled intersection. {The operating agency (or a contractor operating on the agency's behalf) maintains and provides an accurate and up-to-date information for a RLVW enabled intersection.} (OP-RLVW-08)

#### *Roadside Interface*

No Roadside Interface Requirements Identified for RLVW

#### *Driver-Infrastructure Interface*

[SYS-REQ-107] DELETED

***Driver-Vehicle Interface***

[SYS-REQ-108] The Vehicle RLVW Application shall not require any driver-specific customization or learning features. {Note: The warning provided to the driver by the equipped vehicle may vary. The look and feel of the warning is dependent on the design selected and installed by the vehicle system supplier and/or vehicle manufacturer. Vehicle system suppliers and/or vehicle manufacturers may consider implementing driver-specific customization or learning features.}
(OC-RLVW-05, OC-RLVW-06)

[SYS-REQ-109] Signal Phase and Timing Information sent to the traffic signal shall not conflict with that sent to the RLVW equipped vehicle. {Note: Not all signalized intersections will have RLVW capabilities, not all connected intersections will have RLVW capabilities, and not all vehicles will be RLVW equipped.} (OC-RLVW-01, OC-RLVW-04)

[SYS-REQ-110] The RLVW Application DVI shall follow industry-accepted human factor guidelines such as those in table below to minimize the amount of driver training for using the application. (OP-RLVW-11).

Relevant guidelines include:

| | |
|---|---|
| Campbell, Richard, Brown, & McCallum (2007) | General DVI Design guidelines |
| Lee et al. (2004) | Guidelines for signal and stop sign violation |
| NHTSA-2010-0053 | Visual-Manual NHTSA Driver Distraction Guidelines for In-Vehicle Electronic Devices |

[SYS-REQ-111] The Vehicle RLVW Application shall not present inaccurate or misleading information in the event of a malfunction or failure if any of the components within the RLVW system are not working. (OP-RLVW-04)

[SYS-REQ-112] DELETED

***Vehicle Systems Interface***

[SYS-REQ-113] The Vehicle RLVW Application shall require positioning information from the host vehicle that is sufficiently accurate to provide alert/warnings when warranted. {Note: Depending on the intersection geometry, positioning to road level accuracy could be sufficient to create alert/warnings when warranted. In other intersection geometries, positioning to the roadway lane the host vehicle is in would be necessary to create alert/warnings when warranted so as to avoid false alerts/warnings.} (UN-COM-005)

[SYS-REQ-114] The Vehicle RLVW Application shall require data from the host vehicle platform which includes at a minimum the following:

1. Vehicle Positioning information
2. Vehicle Speed
3. Vehicle Acceleration
4. Vehicle Heading

   (UN-COM-006)

***Infrastructure Communications Interface***

[SYS-REQ-115] The Infrastructure Applications Platform shall be capable of transmitting and receiving information to a Vehicle Applications Platform that is {TBD or less} feet away. (UN-COM-006)

[SYS-REQ-116] The Infrastructure Applications Platform shall be capable of transmitting RLVW information received from the Infrastructure RLVW Application wirelessly to a Vehicle Applications Platform. (UN-COM-006)

[SYS-REQ-117] The Infrastructure Applications Platform shall be capable of transmitting to a Vehicle Applications Platform, at all times. (OP-RLVW-12)

[SYS-REQ-118] DELETED (addressed in revised SYS-REQ-115)

[SYS-REQ-119] DELETED (addressed in revised SYS-REQ-115)

[SYS-REQ-120] DELETED (duplicate of SYS-REQ-121)

[SYS-REQ-121] The Infrastructure Applications Platform shall be capable of using connected vehicle technology, as defined by USDOT, as its enabling foundation. (OP-RLVW-01)

[SYS-REQ-122] The Infrastructure Applications Platform shall communicate with an Infrastructure Communications Component that supports prioritization scheme as defined in J2735:2009 (or current version), to messages such that safety-enhancing messages will have priority over non-safety-enhancing messages if the Infrastructure Communications Component is used as a means of communication. (OP-RLVW-07)

#### *Vehicle Communications Interface*

[SYS-REQ-129] DELETED (addressed in revised SYS-REQ-115)

[SYS-REQ-130] DELETED (addressed in revised SYS-REQ-115)

[SYS-REQ-131] DELETED (addressed in revised SYS-REQ-115)

[SYS-REQ-132] The Vehicle Application Platform shall be capable of providing the received roadway information to the Vehicle RLVW Application. (UN-COM-006)

[SYS-REQ-133] DELETED (duplicate of SYS-REQ-134)

[SYS-REQ-134] The Vehicle Applications Platform shall be capable of using connected vehicle technology, as defined by USDOT, as its enabling foundation. (OP-RLVW-01)

[SYS-REQ-135] The Vehicle Applications Platform shall communicate with a Vehicle Communications Component that supports prioritization scheme as defined in J2735:2009 (or current version), to messages such that safety-enhancing messages will have priority over non-safety-enhancing messages if the Infrastructure Communications Component is used as a means of communication. (OP-RLVW-07)

### ***Infrastructure Components***

#### *Infrastructure RLVW Application*

[SYS-REQ-123] The Infrastructure RLVW Application shall function for all defined intersection geometries. {Note: The defined intersection geometries can be found in AASHTO's "A Policy on Geometric Design of Highways and Streets".} (UN-RLV-004, OP-RLVW-10):

[SYS-REQ-124] The Infrastructure RLVW Application shall be capable of being implemented at intersections controlled by traffic signals. (UN-RLV-001)

[SYS-REQ-125] The Infrastructure RLVW Application shall provide to the Infrastructure Communications Component, at a minimum, the following RLVW information to be transmitted to the vehicle:

1. Intersection geometric information (e.g., GID)
2. Signal Phase and Timing information of the traffic signal at the Intersection
3. Diagnostic information of Infrastructure Application
    a. online/offline status
4. Traffic law restrictions for the intersection (i.e., right- or left-turn on red prohibited, permitted without stopping or permitted after stopping)

    (UN-RLV-002)

[SYS-REQ-126] The Infrastructure RLVW Application shall provide to the Infrastructure Communications Component the RLVW information at a rate of {TBD}. {Note: This requirement is to allow for the information to be transmitted to the vehicle such that the vehicle will have the ability to receive, process and react if necessary.} (UN-COM-006)

[SYS-REQ-127] DELETED (Same as SYS-REQ-010)

[SYS-REQ-128] DELETED (Same as SYS-REQ-011)

## ***Vehicle Components***

### *Vehicle RLVW Application*

[SYS-REQ-136] The Vehicle RLVW Application shall only provide alerts and warnings for the individual host vehicle. {Note: RLVW application is single-vehicle based and does not detect other vehicles.} (OC-RLVW-07)

[SYS-REQ-137] The Vehicle RLVW Application shall use the following inputs, at a minimum, for the RLVW alerts:

1. Intersection geometric information (e.g., GID)
2. Signal Phase and Timing information of the traffic signal at the Intersection
3. Diagnostic information of Infrastructure Application
    a. online/offline status
4. Vehicle Data
    a. Vehicle Positioning information (Road Level Accuracy)
    b. Vehicle Speed (+/- TBD)
    c. Vehicle Acceleration (+/- TBD)
    d. Vehicle Heading (+/- TBD)
5. Traffic law restrictions for the intersection (i.e., right- or left-turn on red prohibited, permitted without stopping or permitted after stopping)

{Note: It is permissible to use additional inputs such as friction factor, vehicle parameters, roadway geometry, to name a few, to enhance the calculation of RLVW.} (UN-COM-006)

[SYS-REQ-138] The Vehicle RLVW Application shall be inactive if one or more of the following, but not limited to, conditions occur:

1. Vehicle position and accuracy information is not available
2. Vehicle Speed is not available
3. Infrastructure RLVW is off-line
4. SPaT information is not available
5. Communication failure between Vehicle and Infrastructure
6. Lack of Intersection GID information
7. Vehicle Heading information is not available

(UN-COM-009)

[SYS-REQ-139] The Vehicle RLVW Application shall generate an alert for a vehicle approaching a signalized intersection when it determines that a stop is required and the current vehicle speed and deceleration is not indicative of a stop. (UN-RLV-001)

[SYS-REQ-140] The Vehicle RLVW Application shall generate a warning (i.e., a more urgent alert) for a vehicle approaching a signalized intersection when it determines that a stop is required and the vehicle continues to approach the signal without making necessary corrections to come to a stop. (OP-RLVW-13)

[SYS-REQ-141] The Vehicle RLVW Application shall not require automatic braking. {Note: Brake *assist* may be considered as part of the initial prototyping and testing.} (OP-RLVW-03)

[SYS-REQ-142] The Vehicle RLVW Application shall not warn the driver if the vehicle has safely stopped at the intersection and subsequently accelerates such that a violation occurs. (OP-RLVW-06)

[SYS-REQ-143] The Vehicle RLVW Application shall not require recognizing the presence of pedestrians, bicyclists, and other vehicles moving in and around the intersection. {Note: Pedestrians may benefit, but RLVW has no specific countermeasure(s) to protect pedestrians, bicyclists, or other vehicles.} (OP-RLVW-05)

[SYS-REQ-144] The Vehicle RLVW Application shall be capable of being upgraded to be interoperable with an Infrastructure/Vehicle Application that notifies equipped, cross-traffic vehicles of a pending or occurring signal violation. (UN-COM-018)

[SYS-REQ-145] The Vehicle RLVW Application shall be capable of being upgraded to be interoperable with an Infrastructure/Vehicle Application that supports adaptive signal timing operations as affected by both legacy and modern applications. (UN-COM-018)

### *In-Vehicle Warning System*

[SYS-REQ-146] The In-Vehicle Warning System shall generate aural, visual, and/or haptic warnings within {TBD}[3] of being triggered by the Vehicle RLVW Application. {Note: The warning provided to the

[3] Note: The IVBSS Heavy Vehicle DVI design specification in Brown, McCallum, Campbell, & Richard (2007) specified 100 ms latency for its radar based FCW and LCW/LDW applications. Lee et al (2004) recommend 50 ms latency for a system that samples at 10 Hz (100 ms per sample). They recommend that system latency should be no more than one half of the update period. The 50 ms latency specified above assumes a 10 Hz update rate (i.e., 50 ms = 0.5*1/10Hz). The value can be adjusted accordingly.

driver by the equipped vehicle may vary. The look and feel of the warning is dependent on the design selected and installed by the vehicle system supplier and/or vehicle manufacturer.} (OC-RLVW-08)

[SYS-REQ-147] The In-Vehicle Warning System shall warn or alert, as determined by the application, likely violators of traffic signal control devices in time for the driver to take action for a required stop at a signalized intersection to avoid a potential crash. (UN-RLV-003)

## 3.3.2 Stop Sign Gap Assist (SSGA) Application

[SYS-REQ-201] Sufficient security measures shall be implemented such that the data quality provided by the enabled intersection is guaranteed. (OP-SSGA-15)

[SYS-REQ-202] The SSGA application shall not violate existing operational policies. (OP-SSGA-16)

[SYS-REQ-203] All equipped systems involved in the SSGA application, including both in-vehicle and infrastructure components, shall utilize a common time source. (UN-SSGA-010)

### ***Interface Requirements***

#### *Back Office Interface*

The Back Office system is an optional system that may be developed to support the Infrastructure SSGA Application. This section provides requirements for the interface to the Back Office, if one is implemented.

[SYS-REQ-204] (Optional) The interface between the Back Office and the Infrastructure Components, when a Back office is present, may have a secured communications link meeting the standards prescribed as defined by infrastructure owner/operator. (OC-SSGA-05)

[SYS-REQ-205] DELETED (duplicate of SYS-REQ-030)

#### *Infrastructure Data Interface*

[SYS-REQ-206] The Infrastructure Application Platform shall receive from the Infrastructure Data Equipment at a minimum the following SSGA information:

1. Intersection GID
2. Dynamic Detection of all Vehicles on major roads
    a. Detection of Vehicles
    b. Information for detected vehicles
        i. Position (Road Level Accuracy)
        ii. Heading (+/- TBD)
        iii. Speed (+/- TBD)

(UN-SSGA-008)

[SYS-REQ-207] The Infrastructure Application Platform shall receive from the Infrastructure Data Equipment the indication of vehicles detected on the major road within {TBD}. (UN-COM-006)

[SYS-REQ-265] DELETED

[SYS-REQ-208] The SSGA Application shall not impede traffic on the major road. (UN-SSGA-001).

[SYS-REQ-209] DELETED

***Roadside Interface***

The Roadside Interface requirements were moved to 0 Driver-Infrastructure Interface.

***Driver-Infrastructure Interface***

[SYS-REQ-210] The SSGA Application Roadside Signage shall alert the minor road driver of oncoming traffic to avoid entering the intersection within {TBD} of being triggered by the infrastructure SSGA Application. (UN-SSGA-003)

[SYS-REQ-211] The SSGA Application Roadside Signage shall use a prohibitive frame (i.e., indicating to a driver when it is not safe to proceed) (UN-SSGA-005, OC-SSGA-03).

[SYS-REQ-212] The SSGA Application Roadside Signage shall provide SSGA information and warnings to drivers of equipped and non-equipped vehicles, which include all vehicle classes and types. (OP-SSGA-09, OP-SSGA-19, OC-SSGA-04, OC-SSGA-06)

[SYS-REQ-213] The SSGA Application Roadside Signage shall be robust to outdoor roadside conditions that include, but are not limited to the following:

1. visible in winter conditions, such as blowing and drifting snow
2. withstand snow plowing and not interfere with snow plow operations
3. visible in direct sun light
4. meet NEMA requirements
5. visible at night

(OP-SSGA-05, OP-SSGA-06)

[SYS-REQ-214] The SSGA Application Roadside Signage shall provide indication to the driver that the SSGA Application is currently providing a warning. (UN-COM-009, UN-SSGA-009)

[SYS-REQ-215] The SSGA Application Roadside Signage shall revert to a fail-safe mode (e.g., remain blank) and not provide any SSGA information when the SSGA application or a critical component to the SSGA application has failed. (UN-COM-009)

[SYS-REQ-216] The SSGA Application shall only apply to drivers of vehicles that stop at the minor road of the intersection with the intent to either enter or cross the mainline traffic. (OC-SSGA-02)

[SYS-REQ-217] The SSGA Application shall function for all defined intersection geometries. {Note: The defined intersection geometries can be found in AASHTO's "A Policy on Geometric Design of Highways and Streets".} (UN-SSGA-006, UN-SSGA-007, OP-SSGA-01)

[SYS-REQ-218] The SSGA Application shall not impede traffic on the major road. (UN-SSGA-001, OP-SSGA-02).

[SYS-REQ-219] The SSGA Application shall require minimal additional infrastructure signage without compromising the purpose of the application. {Note: Any additional signage should be understandable without driver training.} (UN-SSGA-002, OP-SSGA-04)

[SYS-REQ-220] DELETED

[SYS-REQ-221] The SSGA Application shall serve as an advisory application and is not intended to serve as a traffic control application. {Note: Regulatory signs at the intersection control traffic flow; the SSGA system only assists the minor road driver in obeying traffic laws. The interface solutions are targeted toward the minor road driver and it is assumed that the minor road driver is responsible for any crash that would occur. Improving the decision making of minor road drivers will therefore reduce the likelihood that the same type of crash occurs.} (OC-SSGA-01)

***Driver-Vehicle Interface***

The following section describes the interface requirements if the interface is included in the safety application.

[SYS-REQ-222] The SSGA Application DVI shall use a prohibitive reference frame (i.e., indicating to a driver when it is not safe to proceed). (UN-SSGA-005, OC-SSGA-03)

[SYS-REQ-223] The SSGA Application DVI shall not require any driver-specific customization. {Note: The warning provided to the driver by the equipped vehicle may vary. The look and feel of the warning is dependent on the design selected and installed by the vehicle system supplier and/or vehicle manufacturer. Vehicle system suppliers and/or vehicle manufacturers may consider implementing driver-specific customization.} (OC-SSGA-07)

[SYS-REQ-224] The SSGA Application DVI shall provide SSGA information and warnings to the driver. (OP-SSGA-09)

[SYS-REQ-225] The SSGA Application DVI shall follow industry-accepted human factor guidelines such as those in table below to minimize the amount of driver training for using the application. (OP-SSGA-03).

Relevant guidelines include:

| | |
|---|---|
| Campbell, Richard, Brown, & McCallum (2007) | General DVI design guidelines |
| Lee et al. (2004) | Guidelines for signal and stop sign violation |
| NHTSA-2010-0053 | Visual-Manual NHTSA Driver Distraction Guidelines for In-Vehicle Electronic Devices |

[SYS-REQ-226] The SSGA Application DVI shall provide indication to the driver when the SSGA application or a critical component to the SSGA application has failed. (OP-SSGA-12)

[SYS-REQ-227] The SSGA Application DVI shall only apply to drivers of vehicles on the minor road of the intersection with the intent to either enter or cross the mainline traffic. (OC-SSGA-02)

***Vehicle Systems Interface***

The vehicle systems interface is optional and is left up to the manufacturer to determine if needed in the implementation of the safety application.

***Infrastructure Communications Interface***

[SYS-REQ-228] The Infrastructure Applications Platform shall be capable transmitting and receiving information to a Vehicle Applications Platform that is {TBD or less} feet away. (UN-COM-006)

[SYS-REQ-229] The Infrastructure Applications Platform shall be capable of transmitting SSGA information received from the Infrastructure SSGA Application wirelessly to a Vehicle Applications Platform. (UN-COM-006)

[SYS-REQ-230] The Infrastructure Applications Platform shall be capable of transmitting to a Vehicle Applications Platform, at all times. (OP-SSGA-17)

[SYS-REQ-231] DELETED (addressed in revised SYS-REQ-228)

[SYS-REQ-232] The Infrastructure Applications Platform shall be capable of using connected vehicle technology, as defined by USDOT, as its enabling foundation. (OP-SSGA-11)

[SYS-REQ-233] The Infrastructure Applications Platform shall communicate with an Infrastructure Communications Component that supports prioritization scheme as defined in J2735:2009 (or current version), to messages such that safety-enhancing messages will have priority over non-safety-enhancing messages if the Infrastructure Communications Component is used as a means of communication. (OP-SSGA-14)

[SYS-REQ-234] The Infrastructure Application Platform shall be capable of providing the received vehicle information to the Infrastructure SSGA Application. (UN-COM-006)

[SYS-REQ-235] DELETED (duplicate of SYS-REQ-232)

#### *Vehicle Communications Interface*

[SYS-REQ-250] DELETED (addressed in revised SYS-REQ-228)

[SYS-REQ-251] DELETED (addressed in revised SYS-REQ-228)

[SYS-REQ-252] DELETED (addressed in revised SYS-REQ-228)

[SYS-REQ-253] The Vehicle Applications Platform shall be capable of using connected vehicle technology, as defined by USDOT, as its enabling foundation. (OP-SSGA-11)

[SYS-REQ-254] The Vehicle Applications Platform shall communicate with a Vehicle Communications Component that supports prioritization scheme as defined in J2735:2009 or current, to messages such that safety-enhancing messages will have priority over non-safety-enhancing messages if the Infrastructure Communications Component is used as a means of communication. (OP-SSGA-14)

[SYS-REQ-255] The Vehicle Application Platform shall be capable of providing the received roadway information to the Vehicle SSGA Application. (UN-COM-006)

[SYS-REQ-256] DELETED (duplicate of SYS-REQ-253)

### ***Infrastructure Components***

#### *Infrastructure SSGA Application*

[SYS-REQ-236] (Optional) The Infrastructure SSGA Application may monitor the median (if applicable) for occupancy and accommodate major road traffic that exists at the minor road. (UN-SSGA-004)

[SYS-REQ-237] DELETED (duplicate of SYS-REQ-217)

[SYS-REQ-238] DELETED (duplicate of SYS-REQ-217)

[SYS-REQ-239] The Infrastructure SSGA Application shall provide a means to configure the minimum lag time of the vehicle nearest to the intersection (in time) below which the Infrastructure SSGA Application shall provide a warning. (UN-SSGA-003)

[SYS-REQ-266] The Infrastructure SSGA Application shall provide a means to configure the minimum lag time separately per each major road approach for each minor road approach. {NOTE: On a divided highway a minor road vehicle may need more warning time for a major road vehicle approaching on the far side of the median than for a major road vehicle approaching on the near side of the median.} (UN-SSGA-003)

[SYS-REQ-240] The SSGA Application shall not interfere with existing traffic control devices. (UN-SSGA-002, OP-SSGA-07)

[SYS-REQ-241] The Infrastructure SSGA Application shall provide to the Infrastructure Communications Component at a minimum the following SSGA information to be transmitted to the vehicle (if applicable):

1. Intersection GID
2. Dynamic Detection of Vehicles on major road
    a. Count of Detected Vehicles within {TBD} seconds of the intersection
    b. Information for each detected vehicles
        i. Position (Road Level Accuracy)
        ii. Heading (+/- TBD)
        iii. Speed (+/- TBD)
3. Diagnostic information of Infrastructure Application
    a. online/offline status
4. Infrastructure Signage Information
    a. same information as displayed on each infrastructure sign
    b. identifier of approach/movement as indicated in GID

    (UN-COM-006)

[SYS-REQ-242] The Infrastructure SSGA Application shall provide to the Infrastructure Communications Component the SSGA information at a frequency of {TBD} (if applicable). {Note: This requirement is to allow for the information to be transmitted to the vehicle such that the vehicle will have the ability to receive, process and react if necessary. This requirement is optional if the Vehicle Components are not being implemented as part of the safety application.} (UN-COM-006)

[SYS-REQ-243] DELETED (Same as SYS-REQ-010)

[SYS-REQ-244] DELETED (Same as SYS-REQ-011)

[SYS-REQ-245] DELETED

[SYS-REQ-246] The Infrastructure SSGA Application shall calculate every vehicle gap and lag on the major road. (OP-SSGA-08, OP-SSGA-10)

[SYS-REQ-247] DELETED

[SYS-REQ-248] The Infrastructure SSGA Application shall compute the time for each detected vehicle on the mainline to reach the intersection based on, at a minimum, the following information:

1. Position (Road Level Accuracy)
2. Speed (+/- TBD)
3. Heading (+/- TBD)

    (UN-SSGA-003)

[SYS-REQ-249] The Infrastructure SSGA Application shall generate a warning to the SSGA Application Roadside Signage when the computed time for a detected major road vehicle to cross the intersection is less than the minimum gap time as determined by the application. (UN-SSGA-003)

[SYS-REQ-267] The Infrastructure SSGA Application shall not generate a warning to the Roadside Signage once a detected main road vehicle has passed the intersection. (UN-SSGA-003)

## ***Vehicle Components***

For the SSGA Application, the Vehicle Components are optional. The following section describes the requirements for the Vehicle Components if an original equipment manufacturer (OEM) or a third-party aftermarket safety device (ASD) manufacturer decides to implement the vehicle SSGA application.

### *Vehicle SSGA Application*

[SYS-REQ-257] The Vehicle SSGA Application shall use the following inputs, at a minimum, for the determining the gap time (if vehicle computes alert and/or warning):

1. Intersection GID
2. Dynamic Detection of Vehicles on major road received from the Infrastructure SSGA Application
    a. Count of Detected Vehicles within {TBD} seconds of the intersection
    b. Information for each detected vehicles
        i. Position
        ii. Speed
        iii. Heading
3. Diagnostic information of Infrastructure Application
    a. online/offline status
4. Minor road vehicle data
    a. Vehicle Positioning information
    b. Vehicle Heading

    {Note: The implementation of the vehicle computation is left up to the implementer of the Vehicle SSGA Application. Since the implementer may take into account vehicle characteristics in the application's computation, there may be instances that the vehicle computed alert/warning or lack of alert/warning may be different than what is computed by the Infrastructure SSGA Application.} (UN-SSGA-003, UN-SSGA-006, UN-SSGA-007, UN-SSGA-008)

[SYS-REQ-258] The Vehicle SSGA Application shall use the following inputs, at a minimum, for the determining the gap time (if infrastructure computes alert and/or warning):

1. Intersection GID
2. Diagnostic information of Infrastructure Application
    a. online/offline status
3. Infrastructure Signage Information
    a. Type of message (i.e. warning, no warning)
    b. same information as what is displayed on infrastructure signage
    c. identifier of specific sign at intersection
4. Minor road vehicle data
    a. Vehicle Positioning information
    b. Vehicle Heading

    (UN-SSGA-003, UN-SSGA-006, UN-SSGA-007, UN-SSGA-008)

[SYS-REQ-259] DELETED

[SYS-REQ-260] The Vehicle SSGA Application shall not require recognizing the presence of pedestrians, bicyclists, and other vehicles moving in and around the intersection. {Note: Pedestrians may benefit, but SSGA has no specific countermeasure(s) to protect pedestrians, bicyclists, or other vehicles.} (OP-SSGA-13)

[SYS-REQ-261] The Vehicle SSGA Application shall issue a warning to the In-Vehicle Warning System when the computed lag time for the nearest (in time) detected vehicle on a major road approach is less than the configurable minimum lag time for that approach direction (if vehicle computes warning). {The warning is not based on how long it takes the minor road vehicle to cross the road. When a vehicle is approaching in the near lane (especially on a divided highway) the result would be a warning that is too long. In any case when a vehicle is approaching in the far lane the warning would be too short {zero safety factor)} (UN-SSGA-003)

[SYS-REQ-262] The Vehicle SSGA Application shall issue a warning to the In-Vehicle Warning System when Roadside Signage Information received indicates the computed time for a detected vehicle on the major road to cross the intersection is less than the minimum gap time (if infrastructure computes warning). (UN-SSGA-003)

**In-Vehicle Warning System**

[SYS-REQ-263] The In-Vehicle Warning System shall generate aural, visual, and/or haptic warnings within {TBD} of being triggered by the Vehicle SSGA Application. {Note: The warning provided to the driver by the equipped vehicle may vary. The look and feel of the warning is dependent on the design selected and installed by the vehicle system supplier and/or vehicle manufacturer.} (UN-SSGA-003, OC-SSGA-08)

[SYS-REQ-264] The In-Vehicle Warning System shall not be in conflict with the DII. (UN-SSGA-002, UN-SSGA-009)

## 3.3.3 Curve Speed Warning (CSW) Application

### ***Interface Requirements***

#### *Back Office Interface*

The Back Office system is an optional system that may be developed to support the Infrastructure CSW Application. This section provides requirements for the interface to the Back Office, if one is implemented.

[SYS-REQ-301] (Optional) The interface between the Back Office and the Infrastructure Components, when a Back office is present, may have a secured communications link meeting the standards prescribed as defined by infrastructure owner/operator. (UN-COM-020)

[SYS-REQ-302] DELETED (duplicate of SYS-REQ-030)

#### *Infrastructure Data Interface*

[SYS-REQ-303] The Infrastructure Application Platform shall receive from the Infrastructure Data Equipment at a minimum the following CSW information:

1. Curve location
    a. Latitude/Longitude
    b. divergent path or part of roadway

2. Curve geometry
    a. Curve radius
    b. Roadway Superelevation
    c. Slope
3. Roadway material
4. Posted Speed Limit (enforceable)
5. Advisory Speed

    (UN-CSW-001, UN-CSW-002)

[SYS-REQ-304] (Optional) The Infrastructure Application Platform may use, when available, the following information:

1. Current temperature
2. Wet and icy roadway conditions
3. Visibility concerns (fog, rain, snow)

    (UN-CSW-002)

[SYS-REQ-305] The Infrastructure Data Equipment shall provide to the Infrastructure Application Platform real time dynamic information that is not older than {1} minute.

***Roadside Interface***

[SYS-REQ-306] DELETED

[SYS-REQ-307] The CSW Application Roadside Signage shall be robust to outdoor roadside conditions that include, but are not limited to the following:

1. visible in winter conditions, such as blowing and drifting snow
2. withstand snow plowing and not interfere with snow plow operations
3. visible in direct sun light
4. meet NEMA requirements
5. visible at night

    (OP-CSW-10, OP-CSW-11)

[SYS-REQ-308] The CSW Application infrastructure signage shall use a prohibitive reference frame (e.g. indicating to a driver “Curve Ahead/Reduce Speed) (OC-CSW-07).

**Driver-Infrastructure Interface**

[SYS-REQ-309] The roadside signage shall provide real-time curve warnings to drivers of non-equipped vehicles to safely navigate an upcoming curve (OP-CSW-03, OP-CSW-12, OC-CSW-08). {Note: Not all vehicles will be equipped with DVI.}

***Driver-Vehicle Interface***

[SYS-REQ-310] DELETED

[SYS-REQ-311] The Vehicle CSW Application DVI shall not require any driver-specific customization. {Note: The warning provided to the driver by the equipped vehicle may vary. The look and feel of the warning is dependent on the design selected and installed by the vehicle system supplier and/or vehicle manufacturer. Vehicle system suppliers and/or vehicle manufacturers may consider

implementing driver-specific customization.} (OC-CSW-02, OC-CSW-05)

[SYS-REQ-312] DELETED

[SYS-REQ-313] DELETED

[SYS-REQ-314] Warnings generated shall not provide information conflicting with that of infrastructure roadside signage (e.g. non-equipped infrastructure) (OC-CSW-01). {Note: There are a limited number of and limited locations for CSW roadside infrastructure. Due to restricted financial resources, State and local DOTs, and private partners, in cooperation with the USDOT, must determine the number of- and the location for- roadside infrastructure. This decision will be based on several factors which include (but are not limited to): pre-existing infrastructure, retrofit capabilities, historic curve incident data, and impact potential.}

[SYS-REQ-315] The system status information (both infrastructure and vehicle status) shall be displayed to the driver. (OP-CSW-06)

[SYS-REQ-316] The Vehicle CSW Application shall display to the driver that the in-vehicle CSW application is not functioning properly. (OP-CSW-08).

[SYS-REQ-317] The Vehicle CSW Application shall use a prohibitive frame for displaying alerts to the driver. (OC-CSW-07).

***Vehicle Systems Interface***

[SYS-REQ-318] The CSW Application shall require positioning information from the host vehicle that is sufficiently accurate to provide alert/warnings when warranted. {Note: Depending on the intersection geometry, positioning to road level accuracy could be sufficient to create alert/warnings when warranted. In other intersection geometries, positioning to the roadway lane the host vehicle is in would be necessary to create alert/warnings when warranted so as to avoid false alerts/warnings.} (UN-CSW-005)

[SYS-REQ-319] The Vehicle CSW Application shall require data defining the vehicle which includes at a minimum the following:

1. Vehicle Positioning information
2. Vehicle Speed
3. Vehicle Acceleration
4. Vehicle Heading

(UN-CSW-003)

***Infrastructure Communications Interface***

[SYS-REQ-323] The Infrastructure Applications Platform shall be capable transmitting and receiving information to a Vehicle Applications Platform that is {TBD or less} feet away. (UN-COM-006)

[SYS-REQ-324] The Infrastructure Applications Platform shall be capable of transmitting CSW information received from the Infrastructure CSW Application wirelessly to a Vehicle Applications Platform. (UN-COM-006)

[SYS-REQ-325] DELETED (addressed in revised SYS-REQ-323)

[SYS-REQ-326] The Infrastructure Communications Component shall be capable of using connected vehicle technologies, as defined by USDOT, as its enabling foundation. (OP-CSW-07)

[SYS-REQ-327] The Infrastructure Application Platform shall be capable of providing the received vehicle information to the Infrastructure CSW Application. (UN-COM-006)

[SYS-REQ-328] DELETED (duplicate of SYS-REQ-326)

[SYS-REQ-329] The Infrastructure Applications Platform shall communicate with an Infrastructure Communications Component that supports prioritization scheme as defined in J2735:2009 or current, to messages such that safety-enhancing messages will have priority over non-safety-enhancing messages if the Infrastructure Communications Component is used as a means of communication. (OP-CSW-09)

#### *Vehicle Communications Interface*

[SYS-REQ-334] DELETED (addressed in revised SYS-REQ-115)

[SYS-REQ-335] The Vehicle Applications Platform shall be capable of transmitting SSGA information received from the Vehicle SSGA Application wirelessly to an Infrastructure Applications Platform. (UN-COM-006)

[SYS-REQ-336] DELETED (addressed in revised SYS-REQ-323)

[SYS-REQ-337] The Vehicle Applications Platform shall be capable of using connected vehicle technology, as defined by USDOT, as its enabling foundation. (OP-CSW-07)

[SYS-REQ-338] The Vehicle Application Platform shall be capable of providing the received roadway information to the Vehicle CSW Application. (UN-COM-006)

[SYS-REQ-339] DELETED (duplicate of SYS-REQ-337)

[SYS-REQ-340] The Vehicle Applications Platform shall communicate with a Vehicle Communications Component that supports prioritization scheme as defined in J2735:2009 or current, to messages such that safety-enhancing messages will have priority over non-safety-enhancing messages if the Infrastructure Communications Component is used as a means of communication. (OP-CSW-09)

### ***Infrastructure Components***

[SYS-REQ-320] DELETED

[SYS-REQ-321] The Infrastructure Applications Platform shall be capable of transmitting to a Vehicle Applications Platform, at all times. (OP-CSW-01)

[SYS-REQ-322] DELETED

#### *Infrastructure CSW Application*

[SYS-REQ-330] The Infrastructure CSW Application shall provide to the Infrastructure Communications Component at a minimum the following CSW information to be transmitted to the Vehicle Applications Platform:

1. Curve location
    a. Latitude/Longitude
    b. divergent path or part of roadway
2. Curve geometry
    a. Curve radius
    b. Roadway Superelevation
    c. Slope

3. Roadway material
4. Posted Speed Limit (enforceable)
5. Diagnostic information of Infrastructure Application
    a. online/offline status
6. Advisory Speed

(UN-COM-006)

[SYS-REQ-331] The Infrastructure CSW Application shall provide to the Infrastructure Communications Component the CSW information at a frequency {TBD} rate. {Note: This requirement is to allow for the information to be transmitted to the vehicle such that the vehicle will have the ability to receive, process and react if necessary}. (UN-COM-006)

[SYS-REQ-332] DELETED (Same as SYS-REQ-010)

[SYS-REQ-333] DELETED (Same as SYS-REQ-011)

## ***Vehicle Components***

Vehicle Components are comprised of a Vehicle Application Platform, Vehicle CSW Application, and an In-Vehicle Warning System.

### *Vehicle CSW Application*

[SYS-REQ-341] The Vehicle CSW Application shall only provide warnings for an individual host vehicle. {Note: CSW application is single-vehicle based and does not detect other vehicles.} (OC-CSW-03)

[SYS-REQ-342] The Vehicle CSW Application shall alert the driver in {TBD} time to reduce speed in order to safely negotiate the stretch of roadway with curve(s). (UN-CSW-008)

[SYS-REQ-343] DELETED

[SYS-REQ-344] The Vehicle CSW Application shall be able to determine using curve location information and vehicle positioning information if the vehicle is within a curve that is part of a roadway or is within the diverging path of a roadway (e.g., main road vs. exit ramp). {Note: It is permissible to enhance the determination by using additional telematics information (e.g., turn signal, steering angle).} (UN-CSW-004)

[SYS-REQ-345] The Vehicle CSW Application shall compute the maximum safe operating speed for the vehicle in the approaching curve. (UN-CSW-006, OP-CSW-04)

[SYS-REQ-346] The Vehicle CSW Application shall compute the maximum speed threshold at a {TBD} threshold distance from the curve entry. {Note: It is permissible to compute multiple threshold distances if a manufacture decides to provide more than one level or alert.} (UN-CSW-006)

[SYS-REQ-347] The Vehicle CSW Application shall alert the driver when it is determined that the warning threshold is below the vehicle's current speed at the threshold distance from the curve roadway entry. {Note: It is permissible for implementers of the application to have multiple threshold points and checks throughout the approach. Critical point could come from any point based on the vehicle and the distance.} (UN-CSW-006)

[SYS-REQ-348] The Vehicle CSW Application shall not activate warnings if it is unable to calculate a safe speed threshold. (UN-CSW-006)

[SYS-REQ-349] DELETED (duplicate of SYS-REQ-348)

[SYS-REQ-350] (Optional) (Other Vehicle Influences) The Vehicle CSW Application may factor in available V2V information to calculate a safe speed threshold. (UN-CSW-009)

***In-Vehicle Warning System***

[SYS-REQ-351] The In-Vehicle Warning System shall generate aural, visual, and/or haptic warnings within {TBD}[4] of being triggered by the Vehicle CSW Application. {Note: The warning provided to the driver by the equipped vehicle may vary. The look and feel of the warning is dependent on the design selected and installed by the vehicle system supplier and/or vehicle manufacturer.} (OC-CSW-05, UN-CSW-008)

[4] Note: The IVBSS Heavy Vehicle DVI design specification in Brown, McCallum, Campbell, & Richard (2007) specified 100 ms latency for its radar based FCW and LCW/LDW applications. Lee et al (2004) recommend 50 ms latency for a system that samples at 10 Hz (100 ms per sample). They recommend that system latency should be no more than one half of the update period. The 50 ms latency specified above assumes a 10 Hz update rate (i.e., 50 ms = 0.5*1/10Hz). The value can be adjusted accordingly.

# 4. Verification

This section describes how and when the system requirements will be verified in order to ascertain that the system of interest conforms to the requirements in Section 3 of this specification. The specification developer is to include the verification requirements and boundary conditions that will be used to verify each requirement. Section 4 should be arranged in an orderly sequence that will indicate clearly the method of verification that will be applied for each requirement. A cross reference matrix will provide correlation of each Section 3 requirement to the appropriate Section 4 verification method.

## 4.1 Verification Methods

Acceptable methods of verification are documented in this section.

### 4.1.1 Analysis (A)

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.

### 4.1.2 Demonstration (D)

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.

### 4.1.3 Inspection (I)

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.

### 4.1.4 Test (T)

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.

## 4.2 Verification of Product Conformance

This section specifies the verification requirement and/or approach per requirement type. Where testing standards apply, they will be documented. Each requirement in Section 3 shall be reflected in Section 4 along with the verification method that will be used. Verification classes for the product reflect first article test, environmental qualification, and acceptance test.

**Table 1. Requirements Verification Matrix**

Requirement/Verification Cross-Reference Matrix

METHOD OF VERIFICATION
NA – NOT APPLICABLE
A – ANALYSIS
D – DEMONSTRATION
I – INSPECTION

CLASSES OF VERIFICATION
I – FIRST ARTICLE TEST
II – ENVIRONMENTAL QUALIFICATION
III – ACCEPTANCE TEST
IV – VERIFICATION AT A HIGHER LEVEL
T – TEST

| Section 3 Requirement | | Requirement ID | Verification Class | | | |
|---|---|---|---|---|---|---|
| Para. | Title | | I | II | III | IV |
| 3 | REQUIRMENTS | N/A | | | | |
| 3.1 | System Description | N/A | | | | |
| 3.1.1 | System of Interest – Curve Speed Warning Application | N/A | | | | |
| 3.1.2 | System of Interest – Stop Sign Gap Assist Application | N/A | | | | |
| 3.1.3 | System of Interest – Red Light Violation Warning Application | N/A | | | | |
| 3.2 | Common Requirements | [SYS-REQ-001] | A | | | |
| 3.2 | Common Requirements | [SYS-REQ-002] | A | | | |
| 3.2 | Common Requirements | [SYS-REQ-003] | D | | | |
| 3.2 | Common Requirements | [SYS-REQ-004] | A | | | |
| 3.2 | Common Requirements | [SYS-REQ-005] | D | | | |
| 3.2 | Common Requirements | [SYS-REQ-006] | A | | | |
| 3.2 | Common Requirements | [SYS-REQ-007] | A | | | |
| 3.2 | Common Requirements | [SYS-REQ-008] | A | | | |
| 3.2 | Common Requirements | [SYS-REQ-009] | A | | | |
| 3.2 | Common Requirements | [SYS-REQ-032] | D | | | |
| 3.2 | Common Requirements | [SYS-REQ-033] | D | | | |
| 3.2 | Common Requirements | [SYS-REQ-010] | D | | | |
| 3.2 | Common Requirements | [SYS-REQ-011] | D | | | |
| 3.2 | Common Requirements | [SYS-REQ-034] | T | | | |
| 3.2 | Common Requirements | [SYS-REQ-012] | D | | | |
| 3.2 | Common Requirements | [SYS-REQ-013] | D | | | |
| 3.2 | Common Requirements | [SYS-REQ-030] | T | | | |
| 3.2 | Common Requirements | [SYS-REQ-014] | D | | | |
| 3.2 | Common Requirements | [SYS-REQ-015] | D | | | |
| 3.2 | Common Requirements | [SYS-REQ-016] | D | | | |
| 3.2 | Common Requirements | [SYS-REQ-035] | D | | | |
| 3.2 | Common Requirements | [SYS-REQ-036] | D | | | |
| 3.2 | Common Requirements | [SYS-REQ-017] | D | | | |
| 3.2 | Common Requirements | [SYS-REQ-037] | T | | | |
| 3.2 | Common Requirements | [SYS-REQ-018] | D | | | |
| 3.2 | Common Requirements | [SYS-REQ-019] | D | | | |

**Table 1. Requirements Verification Matrix (Continued)**

Requirement/Verification Cross-Reference Matrix

METHOD OF VERIFICATION
NA – NOT APPLICABLE
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CLASSES OF VERIFICATION
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III – ACCEPTANCE TEST
IV – VERIFICATION AT A HIGHER LEVEL
T – TEST

| Section 3 Requirement | | Requirement ID | Verification Class | | | |
|---|---|---|---|---|---|---|
| Para. | Title | | I | II | III | IV |
| 3.2 | Common Requirements | [SYS-REQ-020] | D | | | |
| 3.2 | Common Requirements | [SYS-REQ-021] | D | | | |
| 3.2 | Common Requirements | [SYS-REQ-022] | D | | | |
| 3.2 | Common Requirements | [SYS-REQ-023] | D | | | |
| 3.2 | Common Requirements | [SYS-REQ-024] | T | | | |
| 3.2 | Common Requirements | [SYS-REQ-025] | D | | | |
| 3.2 | Common Requirements | [SYS-REQ-026] | A | | | |
| 3.2 | Common Requirements | [SYS-REQ-027] | A | | | |
| 3.2 | Common Requirements | [SYS-REQ-028] | D | | | |
| 3.2 | Common Requirements | [SYS-REQ-029] | D | | | |
| 3.2 | Common Requirements | [SYS-REQ-031] | D | | | |
| 3.3 | Safety Applications Requirements | N/A | | | | |
| 3.3.1 | Red Light Violation Warning (RLVW) Application | [SYS-REQ-101] | A | | | |
| 3.3.1 | Red Light Violation Warning (RLVW) Application | [SYS-REQ-102] | D | | | |
| 3.3.1.1 | Interface Requirements | N/A | | | | |
| 3.3.1.1.1 | Back Office Interface | [SYS-REQ-103] | T | | | |
| ~~3.3.1.1.1~~ | ~~Back Office Interface~~ | ~~[SYS-REQ-104]~~ | | | | |
| 3.3.1.1.2 | Infrastructure Data Interface | [SYS-REQ-105] | D | | | |
| 3.3.1.1.2 | Infrastructure Data Interface | [SYS-REQ-106] | A | | | |
| 3.3.1.1.3 | Roadside Interface | N/A | | | | |
| ~~3.3.1.1.4~~ | ~~Driver-Infrastructure Interface~~ | ~~[SYS-REQ-107]~~ | | | | |
| 3.3.1.1.5 | Driver-Vehicle Interface | [SYS-REQ-108] | D | | | |
| 3.3.1.1.5 | Driver-Vehicle Interface | [SYS-REQ-109] | D | | | |
| 3.3.1.1.5 | Driver-Vehicle Interface | [SYS-REQ-110] | D | | | |
| 3.3.1.1.5 | Driver-Vehicle Interface | [SYS-REQ-111] | D | | | |
| ~~3.3.1.1.5~~ | ~~Driver-Vehicle Interface~~ | ~~[SYS-REQ-112]~~ | | | | |
| 3.3.1.1.6 | Vehicle Systems Interface | [SYS-REQ-113] | D | | | |
| 3.3.1.1.6 | Vehicle Systems Interface | [SYS-REQ-114] | D | | | |
| 3.3.1.1.7 | Infrastructure Communications Interface | [SYS-REQ-115] | T | | | |
| 3.3.1.1.7 | Infrastructure Communications Interface | [SYS-REQ-116] | D | | | |
| 3.3.1.1.7 | Infrastructure Communications Interface | [SYS-REQ-117] | D | | | |
| ~~3.3.1.1.7~~ | ~~Infrastructure Communications Interface~~ | ~~[SYS-REQ-118]~~ | | | | |
| ~~3.3.1.1.7~~ | ~~Infrastructure Communications Interface~~ | ~~[SYS-REQ-119]~~ | | | | |
| ~~3.3.1.1.7~~ | ~~Infrastructure Communications Interface~~ | ~~[SYS-REQ-120]~~ | | | | |

**Table 1. Requirements Verification Matrix (Continued)**

Requirement/Verification Cross-Reference Matrix

METHOD OF VERIFICATION
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CLASSES OF VERIFICATION
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III – ACCEPTANCE TEST
IV – VERIFICATION AT A HIGHER LEVEL
T – TEST

| Section 3 Requirement | | Requirement ID | Verification Class | | | |
|---|---|---|---|---|---|---|
| Para. | Title | | I | II | III | IV |
| 3.3.1.1.7 | Infrastructure Communications Interface | [SYS-REQ-121] | D | | | |
| 3.3.1.1.7 | Infrastructure Communications Interface | [SYS-REQ-122] | D | | | |
| ~~3.3.1.1.8~~ | ~~Vehicle Communications Interface~~ | ~~[SYS-REQ-129]~~ | | | | |
| ~~3.3.1.1.8~~ | ~~Vehicle Communications Interface~~ | ~~[SYS-REQ-130]~~ | | | | |
| ~~3.3.1.1.8~~ | ~~Vehicle Communications Interface~~ | ~~[SYS-REQ-131]~~ | | | | |
| 3.3.1.1.8 | Vehicle Communications Interface | [SYS-REQ-132] | D | | | |
| ~~3.3.1.1.8~~ | ~~Vehicle Communications Interface~~ | ~~[SYS-REQ-133]~~ | | | | |
| 3.3.1.1.8 | Vehicle Communications Interface | [SYS-REQ-134] | D | | | |
| 3.3.1.1.8 | Vehicle Communications Interface | [SYS-REQ-135] | D | | | |
| 3.3.1.2 | Infrastructure Components | N/A | | | | |
| 3.3.1.2.1 | Infrastructure RLVW Application | [SYS-REQ-123] | D | | | |
| 3.3.1.2.1 | Infrastructure RLVW Application | [SYS-REQ-124] | D | | | |
| 3.3.1.2.1 | Infrastructure RLVW Application | [SYS-REQ-125] | D | | | |
| 3.3.1.2.1 | Infrastructure RLVW Application | [SYS-REQ-126] | T | | | |
| ~~3.3.1.2.1~~ | ~~Infrastructure RLVW Application~~ | ~~[SYS-REQ-127]~~ | | | | |
| ~~3.3.1.2.1~~ | ~~Infrastructure RLVW Application~~ | ~~[SYS-REQ-128]~~ | | | | |
| 3.3.1.3 | Vehicle Components | N/A | | | | |
| 3.3.1.3.1 | Vehicle RLVW Application | [SYS-REQ-136] | D | | | |
| 3.3.1.3.1 | Vehicle RLVW Application | [SYS-REQ-137] | D | | | |
| 3.3.1.3.1 | Vehicle RLVW Application | [SYS-REQ-138] | D | | | |
| 3.3.1.3.1 | Vehicle RLVW Application | [SYS-REQ-139] | D | | | |
| 3.3.1.3.1 | Vehicle RLVW Application | [SYS-REQ-140] | D | | | |
| 3.3.1.3.1 | Vehicle RLVW Application | [SYS-REQ-141] | A | | | |
| 3.3.1.3.1 | Vehicle RLVW Application | [SYS-REQ-142] | D | | | |
| 3.3.1.3.1 | Vehicle RLVW Application | [SYS-REQ-143] | A | | | |
| 3.3.1.3.1 | Vehicle RLVW Application | [SYS-REQ-144] | A | | | |
| 3.3.1.3.1 | Vehicle RLVW Application | [SYS-REQ-145] | A | | | |
| 3.3.1.3.2 | In-Vehicle Warning System | [SYS-REQ-146] | T | | | |
| 3.3.1.3.2 | In-Vehicle Warning System | [SYS-REQ-147] | D | | | |
| 3.3.2 | Stop Sign Gap Assist (SSGA) Application | [SYS-REQ-201] | A | | | |
| 3.3.2 | Stop Sign Gap Assist (SSGA) Application | [SYS-REQ-202] | A | | | |
| 3.3.2 | Stop Sign Gap Assist (SSGA) Application | [SYS-REQ-203] | T | | | |
| 3.3.2.1 | Interface Requirements | N/A | | | | |
| 3.3.2.1.1 | Back Office Interface | [SYS-REQ-204] | D | | | |
| ~~3.3.2.1.1~~ | ~~Back Office Interface~~ | ~~[SYS-REQ-205]~~ | | | | |
| 3.3.2.1.2 | Infrastructure Data Interface | [SYS-REQ-206] | T | | | |

**Table 1. Requirements Verification Matrix (Continued)**

Requirement/Verification Cross-Reference Matrix

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CLASSES OF VERIFICATION
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III – ACCEPTANCE TEST
IV – VERIFICATION AT A HIGHER LEVEL
T – TEST

| Section 3 Requirement | | Requirement ID | Verification Class | | | |
|---|---|---|---|---|---|---|
| Para. | Title | | I | II | III | IV |
| 3.3.2.1.2 | Infrastructure Data Interface | [SYS-REQ-207] | T | | | |
| ~~3.3.2.1.2~~ | ~~Infrastructure Data Interface~~ | ~~[SYS-REQ-265]~~ | | | | |
| 3.3.2.1.2 | Infrastructure Data Interface | [SYS-REQ-208] | D | | | |
| ~~3.3.2.1.2~~ | ~~Infrastructure Data Interface~~ | ~~[SYS-REQ-209]~~ | | | | |
| 3.3.2.1.3 | Roadside Interface | [SYS-REQ-210] | T | | | |
| 3.3.2.1.3 | Roadside Interface | [SYS-REQ-211] | D | | | |
| 3.3.2.1.3 | Roadside Interface | [SYS-REQ-212] | D | | | |
| 3.3.2.1.3 | Roadside Interface | [SYS-REQ-213] | T | | | |
| 3.3.2.1.3 | Roadside Interface | [SYS-REQ-214] | D | | | |
| 3.3.2.1.3 | Roadside Interface | [SYS-REQ-215] | D | | | |
| 3.3.2.1.3 | Roadside Interface | [SYS-REQ-216] | D | | | |
| 3.3.2.1.3 | Roadside Interface | [SYS-REQ-217] | D | | | |
| 3.3.2.1.4 | Driver-Infrastructure Interface | [SYS-REQ-218] | D | | | |
| 3.3.2.1.4 | Driver-Infrastructure Interface | [SYS-REQ-219] | D | | | |
| ~~3.3.2.1.4~~ | ~~Driver-Infrastructure Interface~~ | ~~[SYS-REQ-220]~~ | | | | |
| 3.3.2.1.4 | Driver-Infrastructure Interface | [SYS-REQ-221] | D | | | |
| 3.3.2.1.5 | Driver-Vehicle Interface | [SYS-REQ-222] | D | | | |
| 3.3.2.1.5 | Driver-Vehicle Interface | [SYS-REQ-223] | D | | | |
| 3.3.2.1.5 | Driver-Vehicle Interface | [SYS-REQ-224] | D | | | |
| 3.3.2.1.5 | Driver-Vehicle Interface | [SYS-REQ-225] | I | | | |
| 3.3.2.1.5 | Driver-Vehicle Interface | [SYS-REQ-226] | D | | | |
| 3.3.2.1.5 | Driver-Vehicle Interface | [SYS-REQ-227] | D | | | |
| 3.3.2.1.6 | Vehicle Systems Interface | N/A | | | | |
| 3.3.2.1.7 | Infrastructure Communications Interface | [SYS-REQ-228] | T | | | |
| 3.3.2.1.7 | Infrastructure Communications Interface | [SYS-REQ-229] | D | | | |
| 3.3.2.1.7 | Infrastructure Communications Interface | [SYS-REQ-230] | D | | | |
| ~~3.3.2.1.7~~ | ~~Infrastructure Communications Interface~~ | ~~[SYS-REQ-231]~~ | | | | |
| 3.3.2.1.7 | Infrastructure Communications Interface | [SYS-REQ-232] | D | | | |
| 3.3.2.1.7 | Infrastructure Communications Interface | [SYS-REQ-233] | D | | | |
| 3.3.2.1.7 | Infrastructure Communications Interface | [SYS-REQ-234] | D | | | |
| ~~3.3.2.1.7~~ | ~~Infrastructure Communications Interface~~ | ~~[SYS-REQ-235]~~ | | | | |
| ~~3.3.2.1.8~~ | ~~Vehicle Communications Interface~~ | ~~[SYS-REQ-250]~~ | | | | |
| ~~3.3.2.1.8~~ | ~~Vehicle Communications Interface~~ | ~~[SYS-REQ-251]~~ | | | | |
| ~~3.3.2.1.8~~ | ~~Vehicle Communications Interface~~ | ~~[SYS-REQ-252]~~ | | | | |
| 3.3.2.1.8 | Vehicle Communications Interface | [SYS-REQ-253] | D | | | |
| 3.3.2.1.8 | Vehicle Communications Interface | [SYS-REQ-254] | D | | | |

**Table 1. Requirements Verification Matrix (Continued)**

Requirement/Verification Cross-Reference Matrix

METHOD OF VERIFICATION
NA – NOT APPLICABLE
A – ANALYSIS
D – DEMONSTRATION
I – INSPECTION

CLASSES OF VERIFICATION
I – FIRST ARTICLE TEST
II – ENVIRONMENTAL QUALIFICATION
III – ACCEPTANCE TEST
IV – VERIFICATION AT A HIGHER LEVEL
T – TEST

| Section 3 Requirement | | Requirement ID | Verification Class | | | |
|---|---|---|---|---|---|---|
| Para. | Title | | I | II | III | IV |
| 3.3.2.1.8 | Vehicle Communications Interface | [SYS-REQ-255] | D | | | |
| ~~3.3.2.1.8~~ | ~~Vehicle Communications Interface~~ | ~~[SYS-REQ-256]~~ | | | | |
| 3.3.2.2 | Infrastructure Components | N/A | | | | |
| 3.3.2.2.1 | Infrastructure SSGA Application | [SYS-REQ-236] | A | | | |
| ~~3.3.2.2.1~~ | ~~Infrastructure SSGA Application~~ | ~~[SYS-REQ-237]~~ | | | | |
| ~~3.3.2.2.1~~ | ~~Infrastructure SSGA Application~~ | ~~[SYS-REQ-238]~~ | | | | |
| 3.3.2.2.1 | Infrastructure SSGA Application | [SYS-REQ-239] | D | | | |
| 3.3.2.2.1 | Infrastructure SSGA Application | [SYS-REQ-266] | D | | | |
| 3.3.2.2.1 | Infrastructure SSGA Application | [SYS-REQ-240] | D | | | |
| 3.3.2.2.1 | Infrastructure SSGA Application | [SYS-REQ-241] | D | | | |
| 3.3.2.2.1 | Infrastructure SSGA Application | [SYS-REQ-242] | T | | | |
| ~~3.3.2.2.1~~ | ~~Infrastructure SSGA Application~~ | ~~[SYS-REQ-243]~~ | | | | |
| ~~3.3.2.2.1~~ | ~~Infrastructure SSGA Application~~ | ~~[SYS-REQ-244]~~ | | | | |
| ~~3.3.2.2.1~~ | ~~Infrastructure SSGA Application~~ | ~~[SYS-REQ-245]~~ | | | | |
| 3.3.2.2.1 | Infrastructure SSGA Application | [SYS-REQ-246] | D | | | |
| ~~3.3.2.2.1~~ | ~~Infrastructure SSGA Application~~ | ~~[SYS-REQ-247]~~ | | | | |
| 3.3.2.2.1 | Infrastructure SSGA Application | [SYS-REQ-248] | D | | | |
| 3.3.2.2.1 | Infrastructure SSGA Application | [SYS-REQ-249] | D | | | |
| 3.3.2.2.1 | Infrastructure SSGA Application | [SYS-REQ-267] | D | | | |
| 3.3.2.3 | Vehicle Components | N/A | | | | |
| 3.3.2.3.1 | Vehicle SSGA Application | [SYS-REQ-257] | D | | | |
| 3.3.2.3.1 | Vehicle SSGA Application | [SYS-REQ-258] | D | | | |
| ~~3.3.2.3.1~~ | ~~Vehicle SSGA Application~~ | ~~[SYS-REQ-259]~~ | | | | |
| 3.3.2.3.1 | Vehicle SSGA Application | [SYS-REQ-260] | A | | | |
| 3.3.2.3.1 | Vehicle SSGA Application | [SYS-REQ-261] | D | | | |
| 3.3.2.3.1 | Vehicle SSGA Application | [SYS-REQ-262] | D | | | |
| 3.3.2.3.2 | In-Vehicle Warning System | [SYS-REQ-263] | T | | | |
| 3.3.2.3.2 | In-Vehicle Warning System | [SYS-REQ-264] | D | | | |
| 3.3.3 | Curve Speed Warning (CSW) Application | N/A | | | | |
| 3.3.3.1 | Interface Requirements | N/A | | | | |
| 3.3.3.1.1 | Back Office Interface | [SYS-REQ-301] | D | | | |
| ~~3.3.3.1.1~~ | ~~Back Office Interface~~ | ~~[SYS-REQ-302]~~ | | | | |
| 3.3.3.1.2 | Infrastructure Data Interface | [SYS-REQ-303] | D | | | |
| 3.3.3.1.2 | Infrastructure Data Interface | [SYS-REQ-304] | D | | | |
| 3.3.3.1.2 | Infrastructure Data Interface | [SYS-REQ-305] | T | | | |
| ~~3.3.3.1.3~~ | ~~Roadside Interface~~ | ~~[SYS-REQ-306]~~ | | | | |

**Table 1. Requirements Verification Matrix (Continued)**

Requirement/Verification Cross-Reference Matrix

METHOD OF VERIFICATION
NA – NOT APPLICABLE
A – ANALYSIS
D – DEMONSTRATION
I – INSPECTION

CLASSES OF VERIFICATION
I – FIRST ARTICLE TEST
II – ENVIRONMENTAL QUALIFICATION
III – ACCEPTANCE TEST
IV – VERIFICATION AT A HIGHER LEVEL
T – TEST

| Section 3 Requirement | | Requirement ID | Verification Class | | | |
|---|---|---|---|---|---|---|
| Para. | Title | | I | II | III | IV |
| 3.3.3.1.3 | Roadside Interface | [SYS-REQ-307] | T | | | |
| 3.3.3.1.3 | Roadside Interface | [SYS-REQ-308] | D | | | |
| 3.3.3.1.4 | Driver-Infrastructure Interface | [SYS-REQ-309] | D | | | |
| ~~3.3.3.1.5~~ | ~~Driver-Vehicle Interface~~ | ~~[SYS-REQ-310]~~ | | | | |
| 3.3.3.1.5 | Driver-Vehicle Interface | [SYS-REQ-311] | D | | | |
| ~~3.3.3.1.5~~ | ~~Driver-Vehicle Interface~~ | ~~[SYS-REQ-312]~~ | | | | |
| ~~3.3.3.1.5~~ | ~~Driver-Vehicle Interface~~ | ~~[SYS-REQ-313]~~ | | | | |
| 3.3.3.1.5 | Driver-Vehicle Interface | [SYS-REQ-314] | D | | | |
| 3.3.3.1.5 | Driver-Vehicle Interface | [SYS-REQ-315] | D | | | |
| 3.3.3.1.5 | Driver-Vehicle Interface | [SYS-REQ-316] | D | | | |
| 3.3.3.1.5 | Driver-Vehicle Interface | [SYS-REQ-317] | D | | | |
| 3.3.3.1.6 | Vehicle Systems Interface | [SYS-REQ-318] | D | | | |
| 3.3.3.1.6 | Vehicle Systems Interface | [SYS-REQ-319] | D | | | |
| 3.3.3.1.7 | Infrastructure Communications Interface | [SYS-REQ-323] | T | | | |
| 3.3.3.1.7 | Infrastructure Communications Interface | [SYS-REQ-324] | D | | | |
| ~~3.3.3.1.7~~ | ~~Infrastructure Communications Interface~~ | ~~[SYS-REQ-325]~~ | | | | |
| 3.3.3.1.7 | Infrastructure Communications Interface | [SYS-REQ-326] | D | | | |
| 3.3.3.1.7 | Infrastructure Communications Interface | [SYS-REQ-327] | D | | | |
| ~~3.3.3.1.7~~ | ~~Infrastructure Communications Interface~~ | ~~[SYS-REQ-328]~~ | | | | |
| 3.3.3.1.7 | Infrastructure Communications Interface | [SYS-REQ-329] | D | | | |
| ~~3.3.3.1.8~~ | ~~Vehicle Communications Interface~~ | ~~[SYS-REQ-334]~~ | | | | |
| 3.3.3.1.8 | Vehicle Communications Interface | [SYS-REQ-335] | D | | | |
| ~~3.3.3.1.8~~ | ~~Vehicle Communications Interface~~ | ~~[SYS-REQ-336]~~ | | | | |
| 3.3.3.1.8 | Vehicle Communications Interface | [SYS-REQ-337] | D | | | |
| 3.3.3.1.8 | Vehicle Communications Interface | [SYS-REQ-338] | D | | | |
| ~~3.3.3.1.8~~ | ~~Vehicle Communications Interface~~ | ~~[SYS-REQ-339]~~ | | | | |
| 3.3.3.1.8 | Vehicle Communications Interface | [SYS-REQ-340] | D | | | |
| ~~3.3.3.2~~ | ~~Infrastructure Components~~ | ~~[SYS-REQ-320]~~ | | | | |
| 3.3.3.2 | Infrastructure Components | [SYS-REQ-321] | D | | | |
| ~~3.3.3.2~~ | ~~Infrastructure Components~~ | ~~[SYS-REQ-322]~~ | | | | |
| 3.3.3.2.2 | Infrastructure CSW Application | [SYS-REQ-330] | D | | | |
| 3.3.3.2.2 | Infrastructure CSW Application | [SYS-REQ-331] | T | | | |
| ~~3.3.3.2.2~~ | ~~Infrastructure CSW Application~~ | ~~[SYS-REQ-332]~~ | | | | |
| ~~3.3.3.2.2~~ | ~~Infrastructure CSW Application~~ | ~~[SYS-REQ-333]~~ | | | | |
| 3.3.3.3 | Vehicle Components | N/A | | | | |
| 3.3.3.3.1 | Vehicle CSW Application | [SYS-REQ-341] | D | | | |

**Table 1. Requirements Verification Matrix (Continued)**

Requirement/Verification Cross-Reference Matrix

METHOD OF VERIFICATION
NA – NOT APPLICABLE
A – ANALYSIS
D – DEMONSTRATION
I – INSPECTION

CLASSES OF VERIFICATION
I – FIRST ARTICLE TEST
II – ENVIRONMENTAL QUALIFICATION
III – ACCEPTANCE TEST
IV – VERIFICATION AT A HIGHER LEVEL
T – TEST

| Section 3 Requirement | | Requirement ID | Verification Class | | | |
|---|---|---|---|---|---|---|
| Para. | Title | | I | II | III | IV |
| 3.3.3.3.1 | Vehicle CSW Application | [SYS-REQ-342] | D | | | |
| ~~3.3.3.3.1~~ | ~~Vehicle CSW Application~~ | ~~[SYS-REQ-343]~~ | | | | |
| 3.3.3.3.1 | Vehicle CSW Application | [SYS-REQ-344] | D | | | |
| 3.3.3.3.1 | Vehicle CSW Application | [SYS-REQ-345] | D | | | |
| 3.3.3.3.1 | Vehicle CSW Application | [SYS-REQ-346] | T | | | |
| 3.3.3.3.1 | Vehicle CSW Application | [SYS-REQ-347] | T | | | |
| 3.3.3.3.1 | Vehicle CSW Application | [SYS-REQ-348] | D | | | |
| ~~3.3.3.3.1~~ | ~~Vehicle CSW Application~~ | ~~[SYS-REQ-349]~~ | | | | |
| ~~3.3.3.3.1~~ | ~~Vehicle CSW Application~~ | ~~[SYS-REQ-350]~~ | | | | |
| 3.3.3.3.2 | In-Vehicle Warning System | [SYS-REQ-351] | T | | | |

# 5. NOTES

## 5.1 Traceability Matrix

**Table 2. Requirements to User Need, Operational Policies, and Operation Constraints Matrix**

| Section 3 Requirement | | Requirement ID | Need, Policy, Constraint |
|---|---|---|---|
| Para. | Title | | |
| 3 | REQUIRMENTS | N/A | |
| 3.1 | System Description | N/A | |
| 3.1.1 | System of Interest – Curve Speed Warning Application | N/A | |
| 3.1.2 | System of Interest – Stop Sign Gap Assist Application | N/A | |
| 3.1.3 | System of Interest – Red Light Violation Warning Application | N/A | |
| 3.2 | Common Requirements | [SYS-REQ-001] | UN-COM-001 |
| 3.2 | Common Requirements | [SYS-REQ-002] | UN-COM-002 |
| 3.2 | Common Requirements | [SYS-REQ-003] | UN-COM-003 |
| 3.2 | Common Requirements | [SYS-REQ-004] | UN-COM-004 |
| 3.2 | Common Requirements | [SYS-REQ-005] | UN-COM-005 |
| 3.2 | Common Requirements | [SYS-REQ-006] | UN-COM-006 |
| 3.2 | Common Requirements | [SYS-REQ-007] | UN-COM-007 |
| 3.2 | Common Requirements | [SYS-REQ-008] | UN-COM-007 |
| 3.2 | Common Requirements | [SYS-REQ-009] | UN-COM-008 |
| 3.2 | Common Requirements | [SYS-REQ-010] | UN-COM-009 |
| 3.2 | Common Requirements | [SYS-REQ-032] | UN-COM-009 |
| 3.2 | Common Requirements | [SYS-REQ-033] | UN-COM-009 |
| 3.2 | Common Requirements | [SYS-REQ-011] | UN-COM-009, UN-COM-010 |
| 3.2 | Common Requirements | [SYS-REQ-034] | UN-COM-009 |
| 3.2 | Common Requirements | [SYS-REQ-012] | UN-COM-009 |
| 3.2 | Common Requirements | [SYS-REQ-013] | UN-COM-009 |
| 3.2 | Common Requirements | [SYS-REQ-030] | UN-COM-009 |
| 3.2 | Common Requirements | [SYS-REQ-014] | UN-COM-010 |
| 3.2 | Common Requirements | [SYS-REQ-015] | UN-COM-009 |
| 3.2 | Common Requirements | [SYS-REQ-016] | UN-COM-009 |
| 3.2 | Common Requirements | [SYS-REQ-035] | UN-COM-009 |
| 3.2 | Common Requirements | [SYS-REQ-036] | UN-COM-009 |
| 3.2 | Common Requirements | [SYS-REQ-017] | UN-COM-009 |
| 3.2 | Common Requirements | [SYS-REQ-037] | UN-COM-009 |
| 3.2 | Common Requirements | [SYS-REQ-018] | UN-COM-009 |
| 3.2 | Common Requirements | [SYS-REQ-019] | UN-COM-009 |

**Table 2. Requirements to User Need, Operational Policies, and Operation Constraints Matrix (Continued)**

| Section 3 Requirement | | Requirement ID | Need, Policy, Constraint |
|---|---|---|---|
| Para. | Title | | |
| 3.2 | Common Requirements | [SYS-REQ-020] | UN-COM-014 |
| 3.2 | Common Requirements | [SYS-REQ-021] | UN-COM-014 |
| 3.2 | Common Requirements | [SYS-REQ-022] | UN-COM-015 |
| 3.2 | Common Requirements | [SYS-REQ-023] | UN-COM-015 |
| 3.2 | Common Requirements | [SYS-REQ-024] | UN-COM-016 |
| 3.2 | Common Requirements | [SYS-REQ-025] | UN-COM-017 |
| 3.2 | Common Requirements | [SYS-REQ-026] | UN-COM-018 |
| 3.2 | Common Requirements | [SYS-REQ-027] | UN-COM-019 |
| 3.2 | Common Requirements | [SYS-REQ-028] | UN-COM-020 |
| 3.2 | Common Requirements | [SYS-REQ-029] | UN-COM-021 |
| 3.2 | Common Requirements | [SYS-REQ-031] | UN-COM-020 |
| 3.3 | Safety Applications Requirements | N/A | |
| 3.3.1 | Red Light Violation Warning (RLVW) Application | [SYS-REQ-101] | OP-RLVW-09 |
| 3.3.1 | Red Light Violation Warning (RLVW) Application | [SYS-REQ-102] | UN-RLV-009 |
| 3.3.1.1 | Interface Requirements | N/A | |
| 3.3.1.1.1 | Back Office Interface | [SYS-REQ-103] | OC-RLVW-03 |
| ~~3.3.1.1.1~~ | ~~Back Office Interface~~ | ~~[SYS-REQ-104]~~ | |
| 3.3.1.1.2 | Infrastructure Data Interface | [SYS-REQ-105] | UN-RLV-005 |
| 3.3.1.1.2 | Infrastructure Data Interface | [SYS-REQ-106] | OP-RLVW-08 |
| 3.3.1.1.3 | Roadside Interface | N/A | |
| ~~3.3.1.1.4~~ | ~~Driver-Infrastructure Interface~~ | ~~[SYS-REQ-107]~~ | OP-RLVW-11 |
| 3.3.1.1.5 | Driver-Vehicle Interface | [SYS-REQ-108] | OC-RLVW-05, OC-RLVW-06 |
| 3.3.1.1.5 | Driver-Vehicle Interface | [SYS-REQ-109] | OC-RLVW-01, OC-RLVW-04 |
| 3.3.1.1.5 | Driver-Vehicle Interface | [SYS-REQ-110] | OP-RLVW-11 |
| 3.3.1.1.5 | Driver-Vehicle Interface | [SYS-REQ-111] | OP-RLVW-04 |
| ~~3.3.1.1.5~~ | ~~Driver-Vehicle Interface~~ | ~~[SYS-REQ-112]~~ | OP-RLVW-13 |
| 3.3.1.1.6 | Vehicle Systems Interface | [SYS-REQ-113] | UN-COM-005 |
| 3.3.1.1.6 | Vehicle Systems Interface | [SYS-REQ-114] | UN-COM-006 |
| 3.3.1.1.7 | Infrastructure Communications Interface | [SYS-REQ-115] | UN-COM-006 |
| 3.3.1.1.7 | Infrastructure Communications Interface | [SYS-REQ-116] | UN-COM-006 |
| 3.3.1.1.7 | Infrastructure Communications Interface | [SYS-REQ-117] | OP-RLVW-12 |
| ~~3.3.1.1.7~~ | ~~Infrastructure Communications Interface~~ | ~~[SYS-REQ-118]~~ | |
| ~~3.3.1.1.7~~ | ~~Infrastructure Communications Interface~~ | ~~[SYS-REQ-119]~~ | |
| ~~3.3.1.1.7~~ | ~~Infrastructure Communications Interface~~ | ~~[SYS-REQ-120]~~ | |
| 3.3.1.1.7 | Infrastructure Communications Interface | [SYS-REQ-121] | OP-RLVW-01 |
| 3.3.1.1.7 | Infrastructure Communications Interface | [SYS-REQ-122] | OP-RLVW-07 |
| ~~3.3.1.1.8~~ | ~~Vehicle Communications Interface~~ | ~~[SYS-REQ-129]~~ | |
| ~~3.3.1.1.8~~ | ~~Vehicle Communications Interface~~ | ~~[SYS-REQ-130]~~ | |
| ~~3.3.1.1.8~~ | ~~Vehicle Communications Interface~~ | ~~[SYS-REQ-131]~~ | |
| 3.3.1.1.8 | Vehicle Communications Interface | [SYS-REQ-132] | UN-COM-006 |
| ~~3.3.1.1.8~~ | ~~Vehicle Communications Interface~~ | ~~[SYS-REQ-133]~~ | |

**Table 2. Requirements to User Need, Operational Policies, and Operation Constraints Matrix (Continued)**

| Section 3 Requirement | | Requirement ID | Need, Policy, Constraint |
|---|---|---|---|
| Para. | Title | | |
| 3.3.1.1.8 | Vehicle Communications Interface | [SYS-REQ-134] | OP-RLVW-01 |
| 3.3.1.1.8 | Vehicle Communications Interface | [SYS-REQ-135] | OP-RLVW-07 |
| 3.3.1.2 | Infrastructure Components | N/A | |
| 3.3.1.2.1 | Infrastructure RLVW Application | [SYS-REQ-123] | UN-RLV-004, OP-RLVW-10 |
| 3.3.1.2.1 | Infrastructure RLVW Application | [SYS-REQ-124] | UN-RLV-001 |
| 3.3.1.2.1 | Infrastructure RLVW Application | [SYS-REQ-125] | UN-RLV-002 |
| 3.3.1.2.1 | Infrastructure RLVW Application | [SYS-REQ-126] | UN-COM-006 |
| ~~3.3.1.2.1~~ | ~~Infrastructure RLVW Application~~ | ~~[SYS-REQ-127]~~ | |
| ~~3.3.1.2.1~~ | ~~Infrastructure RLVW Application~~ | ~~[SYS-REQ-128]~~ | |
| 3.3.1.3 | Vehicle Components | N/A | |
| 3.3.1.3.1 | Vehicle RLVW Application | [SYS-REQ-136] | OC-RLVW-07 |
| 3.3.1.3.1 | Vehicle RLVW Application | [SYS-REQ-137] | UN-COM-006 |
| 3.3.1.3.1 | Vehicle RLVW Application | [SYS-REQ-138] | UN-COM-009 |
| 3.3.1.3.1 | Vehicle RLVW Application | [SYS-REQ-139] | UN-RLV-001 |
| 3.3.1.3.1 | Vehicle RLVW Application | [SYS-REQ-140] | OP-RLVW-13 |
| 3.3.1.3.1 | Vehicle RLVW Application | [SYS-REQ-141] | OP-RLVW-03 |
| 3.3.1.3.1 | Vehicle RLVW Application | [SYS-REQ-142] | OP-RLVW-06 |
| 3.3.1.3.1 | Vehicle RLVW Application | [SYS-REQ-143] | OP-RLVW-05 |
| 3.3.1.3.1 | Vehicle RLVW Application | [SYS-REQ-144] | UN-COM-018 |
| 3.3.1.3.1 | Vehicle RLVW Application | [SYS-REQ-145] | UN-COM-018 |
| 3.3.1.3.2 | In-Vehicle Warning System | [SYS-REQ-146] | OC-RLVW-08 |
| 3.3.1.3.2 | In-Vehicle Warning System | [SYS-REQ-147] | UN-RLV-003 |
| 3.3.2 | Stop Sign Gap Assist (SSGA) Application | [SYS-REQ-201] | OP-SSGA-15 |
| 3.3.2 | Stop Sign Gap Assist (SSGA) Application | [SYS-REQ-202] | OP-SSGA-16 |
| 3.3.2 | Stop Sign Gap Assist (SSGA) Application | [SYS-REQ-203] | UN-SSGA-010 |
| 3.3.2.1 | Interface Requirements | N/A | |
| 3.3.2.1.1 | Back Office Interface | [SYS-REQ-204] | OC-SSGA-05 |
| ~~3.3.2.1.1~~ | ~~Back Office Interface~~ | ~~[SYS-REQ-205]~~ | |
| 3.3.2.1.2 | Infrastructure Data Interface | [SYS-REQ-206] | UN-SSGA-008 |
| 3.3.2.1.2 | Infrastructure Data Interface | [SYS-REQ-207] | UN-COM-006 |
| ~~3.3.2.1.2~~ | ~~Infrastructure Data Interface~~ | ~~[SYS-REQ-265]~~ | |
| 3.3.2.1.2 | Infrastructure Data Interface | [SYS-REQ-208] | UN-SSGA-001 |
| ~~3.3.2.1.2~~ | ~~Infrastructure Data Interface~~ | ~~[SYS-REQ-209]~~ | OP-SSGA-18 |
| 3.3.2.1.3 | Roadside Interface | [SYS-REQ-210] | UN-SSGA-003 |
| 3.3.2.1.3 | Roadside Interface | [SYS-REQ-211] | UN-SSGA-005, OC-SSGA-03 |
| 3.3.2.1.3 | Roadside Interface | [SYS-REQ-212] | OP-SSGA-09, OP-SSGA-19, OC-SSGA-04, OC-SSGA-06 |
| 3.3.2.1.3 | Roadside Interface | [SYS-REQ-213] | OP-SSGA-05, OP-SSGA-06 |
| 3.3.2.1.4 | Driver-Infrastructure Interface | [SYS-REQ-214] | UN-COM-009, UN-SSGA-009 |
| 3.3.2.1.4 | Driver-Infrastructure Interface | [SYS-REQ-215] | UN-COM-009 |
| 3.3.2.1.4 | Driver-Infrastructure Interface | [SYS-REQ-216] | OC-SSGA-02 |
| 3.3.2.1.4 | Driver-Infrastructure Interface | [SYS-REQ-217] | UN-SSGA-006, UN-SSGA-007, OP-SSGA-01 |

**Table 2. Requirements to User Need, Operational Policies, and Operation Constraints Matrix (Continued)**

| Section 3 Requirement | | Requirement ID | Need, Policy, Constraint |
|---|---|---|---|
| Para. | Title | | |
| 3.3.2.1.4 | Driver-Infrastructure Interface | [SYS-REQ-218] | UN-SSGA-001, OP-SSGA-02 |
| 3.3.2.1.4 | Driver-Infrastructure Interface | [SYS-REQ-219] | UN-SSGA-002, OP-SSGA-04 |
| ~~3.3.2.1.4~~ | ~~Driver-Infrastructure Interface~~ | ~~[SYS-REQ-220]~~ | OP-SSGA-03 |
| 3.3.2.1.4 | Driver-Infrastructure Interface | [SYS-REQ-221] | OC-SSGA-01 |
| 3.3.2.1.5 | Driver-Vehicle Interface | [SYS-REQ-222] | UN-SSGA-005, OC-SSGA-03 |
| 3.3.2.1.5 | Driver-Vehicle Interface | [SYS-REQ-223] | OC-SSGA-07 |
| 3.3.2.1.5 | Driver-Vehicle Interface | [SYS-REQ-224] | OP-SSGA-09 |
| 3.3.2.1.5 | Driver-Vehicle Interface | [SYS-REQ-225] | OP-SSGA-03 |
| 3.3.2.1.5 | Driver-Vehicle Interface | [SYS-REQ-226] | OP-SSGA-12 |
| 3.3.2.1.5 | Driver-Vehicle Interface | [SYS-REQ-227] | OC-SSGA-02 |
| 3.3.2.1.6 | Vehicle Systems Interface | N/A | |
| 3.3.2.1.7 | Infrastructure Communications Interface | [SYS-REQ-228] | UN-COM-006 |
| 3.3.2.1.7 | Infrastructure Communications Interface | [SYS-REQ-229] | UN-COM-006 |
| 3.3.2.1.7 | Infrastructure Communications Interface | [SYS-REQ-230] | OP-SSGA-17 |
| ~~3.3.2.1.7~~ | ~~Infrastructure Communications Interface~~ | ~~[SYS-REQ-231]~~ | |
| 3.3.2.1.7 | Infrastructure Communications Interface | [SYS-REQ-232] | OP-SSGA-11 |
| 3.3.2.1.7 | Infrastructure Communications Interface | [SYS-REQ-233] | OP-SSGA-14 |
| 3.3.2.1.7 | Infrastructure Communications Interface | [SYS-REQ-234] | UN-COM-006 |
| ~~3.3.2.1.7~~ | ~~Infrastructure Communications Interface~~ | ~~[SYS-REQ-235]~~ | |
| ~~3.3.2.1.8~~ | ~~Vehicle Communications Interface~~ | ~~[SYS-REQ-250]~~ | |
| ~~3.3.2.1.8~~ | ~~Vehicle Communications Interface~~ | ~~[SYS-REQ-251]~~ | UN-COM-006 |
| ~~3.3.2.1.8~~ | ~~Vehicle Communications Interface~~ | ~~[SYS-REQ-252]~~ | |
| 3.3.2.1.8 | Vehicle Communications Interface | [SYS-REQ-253] | OP-SSGA-11 |
| 3.3.2.1.8 | Vehicle Communications Interface | [SYS-REQ-254] | OP-SSGA-14 |
| 3.3.2.1.8 | Vehicle Communications Interface | [SYS-REQ-255] | UN-COM-006 |
| ~~3.3.2.1.8~~ | ~~Vehicle Communications Interface~~ | ~~[SYS-REQ-256]~~ | |
| 3.3.2.2 | Infrastructure Components | N/A | |
| 3.3.2.2.1 | Infrastructure SSGA Application | [SYS-REQ-236] | UN-SSGA-004 |
| ~~3.3.2.2.1~~ | ~~Infrastructure SSGA Application~~ | ~~[SYS-REQ-237]~~ | |
| ~~3.3.2.2.1~~ | ~~Infrastructure SSGA Application~~ | ~~[SYS-REQ-238]~~ | |
| 3.3.2.2.1 | Infrastructure SSGA Application | [SYS-REQ-239] | UN-SSGA-003 |
| 3.3.2.2.1 | Infrastructure SSGA Application | [SYS-REQ-266] | UN-SSGA-003 |
| 3.3.2.2.1 | Infrastructure SSGA Application | [SYS-REQ-240] | UN-SSGA-002, OP-SSGA-07 |
| 3.3.2.2.1 | Infrastructure SSGA Application | [SYS-REQ-241] | UN-COM-006 |
| 3.3.2.2.1 | Infrastructure SSGA Application | [SYS-REQ-242] | UN-COM-006 |
| ~~3.3.2.2.1~~ | ~~Infrastructure SSGA Application~~ | ~~[SYS-REQ-243]~~ | |
| ~~3.3.2.2.1~~ | ~~Infrastructure SSGA Application~~ | ~~[SYS-REQ-244]~~ | |
| ~~3.3.2.2.1~~ | ~~Infrastructure SSGA Application~~ | ~~[SYS-REQ-245]~~ | UN-SSGA-009 |
| 3.3.2.2.1 | Infrastructure SSGA Application | [SYS-REQ-246] | OP-SSGA-08, OP-SSGA-10 |
| ~~3.3.2.2.1~~ | ~~Infrastructure SSGA Application~~ | ~~[SYS-REQ-247]~~ | OP-SSGA-08 |
| 3.3.2.2.1 | Infrastructure SSGA Application | [SYS-REQ-248] | UN-SSGA-003 |
| 3.3.2.2.1 | Infrastructure SSGA Application | [SYS-REQ-249] | UN-SSGA-003 |
| 3.3.2.2.1 | Infrastructure SSGA Application | [SYS-REQ-267] | UN-SSGA-003 |

**Table 2. Requirements to User Need, Operational Policies, and Operation Constraints Matrix (Continued)**

| Section 3 Requirement | | Requirement ID | Need, Policy, Constraint |
|---|---|---|---|
| Para. | Title | | |
| 3.3.2.3 | Vehicle Components | N/A | |
| 3.3.2.3.1 | Vehicle SSGA Application | [SYS-REQ-257] | UN-SSGA-003, UN-SSGA-006, UN-SSGA-007, UN-SSGA-008 |
| 3.3.2.3.1 | Vehicle SSGA Application | [SYS-REQ-258] | UN-SSGA-003, UN-SSGA-006, UN-SSGA-007, UN-SSGA-008 |
| ~~3.3.2.3.1~~ | ~~Vehicle SSGA Application~~ | ~~[SYS-REQ-259]~~ | |
| 3.3.2.3.1 | Vehicle SSGA Application | [SYS-REQ-260] | OP-SSGA-13 |
| 3.3.2.3.1 | Vehicle SSGA Application | [SYS-REQ-261] | UN-SSGA-003 |
| 3.3.2.3.1 | Vehicle SSGA Application | [SYS-REQ-262] | UN-SSGA-003 |
| 3.3.2.3.2 | In-Vehicle Warning System | [SYS-REQ-263] | UN-SSGA-003, OC-SSGA-08 |
| 3.3.2.3.2 | In-Vehicle Warning System | [SYS-REQ-264] | UN-SSGA-002, UN-SSGA-009 |
| 3.3.3 | Curve Speed Warning (CSW) Application | N/A | |
| 3.3.3.1 | Interface Requirements | N/A | |
| 3.3.3.1.1 | Back Office Interface | [SYS-REQ-301] | UN-COM-020 |
| ~~3.3.3.1.1~~ | ~~Back Office Interface~~ | ~~[SYS-REQ-302]~~ | |
| 3.3.3.1.2 | Infrastructure Data Interface | [SYS-REQ-303] | UN-CSW-001, UN-CSW-002 |
| 3.3.3.1.2 | Infrastructure Data Interface | [SYS-REQ-304] | UN-CSW-002 |
| 3.3.3.1.2 | Infrastructure Data Interface | [SYS-REQ-305] | UN-COM-006 |
| ~~3.3.3.1.3~~ | ~~Roadside Interface~~ | ~~[SYS-REQ-306]~~ | |
| 3.3.3.1.3 | Roadside Interface | [SYS-REQ-307] | OP-CSW-10, OP-CSW-11 |
| 3.3.3.1.3 | Roadside Interface | [SYS-REQ-308] | OC-CSW-07 |
| 3.3.3.1.4 | Driver-Infrastructure Interface | [SYS-REQ-309] | OP-CSW-03, OP-CSW-12, OC-CSW-08 |
| ~~3.3.3.1.5~~ | ~~Driver-Vehicle Interface~~ | ~~[SYS-REQ-310]~~ | |
| 3.3.3.1.5 | Driver-Vehicle Interface | [SYS-REQ-311] | OC-CSW-02, OC-CSW-05 |
| ~~3.3.3.1.5~~ | ~~Driver-Vehicle Interface~~ | ~~[SYS-REQ-312]~~ | |
| ~~3.3.3.1.5~~ | ~~Driver-Vehicle Interface~~ | ~~[SYS-REQ-313]~~ | OC-CSW-05 |
| 3.3.3.1.5 | Driver-Vehicle Interface | [SYS-REQ-314] | OC-CSW-01 |
| 3.3.3.1.5 | Driver-Vehicle Interface | [SYS-REQ-315] | OP-CSW-06 |
| 3.3.3.1.5 | Driver-Vehicle Interface | [SYS-REQ-316] | OP-CSW-08 |
| 3.3.3.1.5 | Driver-Vehicle Interface | [SYS-REQ-317] | OC-CSW-07 |
| 3.3.3.1.6 | Vehicle Systems Interface | [SYS-REQ-318] | UN-CSW-005 |
| 3.3.3.1.6 | Vehicle Systems Interface | [SYS-REQ-319] | UN-CSW-003 |
| 3.3.3.1.7 | Infrastructure Communications Interface | [SYS-REQ-323] | UN-COM-006 |
| 3.3.3.1.7 | Infrastructure Communications Interface | [SYS-REQ-324] | UN-COM-006 |
| ~~3.3.3.1.7~~ | ~~Infrastructure Communications Interface~~ | ~~[SYS-REQ-325]~~ | |
| 3.3.3.1.7 | Infrastructure Communications Interface | [SYS-REQ-326] | OP-CSW-07 |
| 3.3.3.1.7 | Infrastructure Communications Interface | [SYS-REQ-327] | UN-COM-006 |
| ~~3.3.3.1.7~~ | ~~Infrastructure Communications Interface~~ | ~~[SYS-REQ-328]~~ | |
| 3.3.3.1.7 | Infrastructure Communications Interface | [SYS-REQ-329] | OP-CSW-09 |
| ~~3.3.3.1.8~~ | ~~Vehicle Communications Interface~~ | ~~[SYS-REQ-334]~~ | |
| 3.3.3.1.8 | Vehicle Communications Interface | [SYS-REQ-335] | UN-COM-006 |
| ~~3.3.3.1.8~~ | ~~Vehicle Communications Interface~~ | ~~[SYS-REQ-336]~~ | |

**Table 2. Requirements to User Need, Operational Policies, and Operation Constraints Matrix (Continued)**

| Section 3 Requirement | | Requirement ID | Need, Policy, Constraint |
|---|---|---|---|
| Para. | Title | | |
| 3.3.3.1.8 | Vehicle Communications Interface | [SYS-REQ-337] | OP-CSW-07 |
| 3.3.3.1.8 | Vehicle Communications Interface | [SYS-REQ-338] | UN-COM-006 |
| ~~3.3.3.1.8~~ | ~~Vehicle Communications Interface~~ | ~~[SYS-REQ-339]~~ | |
| 3.3.3.1.8 | Vehicle Communications Interface | [SYS-REQ-340] | OP-CSW-09 |
| ~~3.3.3.2~~ | ~~Infrastructure Components~~ | ~~[SYS-REQ-320]~~ | |
| 3.3.3.2 | Infrastructure Components | [SYS-REQ-321] | OP-CSW-01 |
| ~~3.3.3.2~~ | ~~Infrastructure Components~~ | ~~[SYS-REQ-322]~~ | OP-CSW-02 |
| 3.3.3.2.1 | Infrastructure CSW Application | [SYS-REQ-330] | UN-COM-006 |
| 3.3.3.2.1 | Infrastructure CSW Application | [SYS-REQ-331] | UN-COM-006 |
| ~~3.3.3.2.1~~ | ~~Infrastructure CSW Application~~ | ~~[SYS-REQ-332]~~ | |
| ~~3.3.3.2.1~~ | ~~Infrastructure CSW Application~~ | ~~[SYS-REQ-333]~~ | |
| 3.3.3.3 | Vehicle Components | N/A | |
| 3.3.3.3.1 | Vehicle CSW Application | [SYS-REQ-341] | OC-CSW-03 |
| 3.3.3.3.1 | Vehicle CSW Application | [SYS-REQ-342] | UN-CSW-008 |
| ~~3.3.3.3.1~~ | ~~Vehicle CSW Application~~ | ~~[SYS-REQ-343]~~ | OP-CSW-04 |
| 3.3.3.3.1 | Vehicle CSW Application | [SYS-REQ-344] | UN-CSW-004 |
| 3.3.3.3.1 | Vehicle CSW Application | [SYS-REQ-345] | UN-CSW-006, OP-CSW-04 |
| 3.3.3.3.1 | Vehicle CSW Application | [SYS-REQ-346] | UN-CSW-006 |
| 3.3.3.3.1 | Vehicle CSW Application | [SYS-REQ-347] | UN-CSW-006 |
| 3.3.3.3.1 | Vehicle CSW Application | [SYS-REQ-348] | UN-CSW-006 |
| ~~3.3.3.3.1~~ | ~~Vehicle CSW Application~~ | ~~[SYS-REQ-349]~~ | |
| ~~3.3.3.3.1~~ | ~~Vehicle CSW Application~~ | ~~[SYS-REQ-350]~~ | UN-CSW-009 |
| 3.3.3.3.2 | In-Vehicle Warning System | [SYS-REQ-351] | OC-CSW-05, UN-CSW-008 |

## 5.2 Acronyms and Abbreviations

| | |
|---|---|
| AAHSTO | American Associated of State Highway and Transportation Officials |
| ASD | Aftermarket Safety Device |
| CAMP | Crash Avoidance Metrics Partnership |
| CAN | Controller Area Network |
| CICAS | Cooperative Intersection Collision Avoidance Systems |
| CICAS-SSA | Cooperative Intersection Collision Avoidance System-Stop Sign Assist |
| CICAS-V | Cooperative Intersection Collision Avoidance System Violations |
| ConOps | Concept of Operations |
| CSW | Curve Speed Warning |
| DII | Driver-Infrastructure Interface |
| DOTs | Departments of Transportation |
| DSRC | Dedicated Short Range Communications |
| DVI | Driver-Vehicle Interface |
| GID | Geometric Intersection Design |
| GPS | Global Positioning System |
| IEEE | Institute of Electrical and Electronics Engineers |
| ISTEA | Intermodal Surface Transportation Efficiency Act |
| ITS | Intelligent Transportation Systems |
| LOS | Levels of Service |
| Mn/DOT | Minnesota Department of Transportation |
| MUTCD | Manual on Uniform Traffic Control Devices |
| NEMA | National Electrical Manufacturers Association |
| NTHSA | National Highway Traffic Safety Administration's |
| OBD2 | On Board Data II |
| OEMs | Original Equipment Manufacturers |
| RLVW | Red-Light Violation Warning |
| RSE | Road Side Equipment |
| SAE | Society of Automotive Engineers |
| SEMP | Systems Engineering Management Plan |
| SPaT | Signal Phase and Timing |
| SSGA | Stop Sign Gap Assist |
| UMN | University of Minnesota |
| USDOT | United States Department of Transportation |
| V2I | Vehicle-to-Infrastructure |
| V2V | Vehicle-to-Vehicle |
| VSC2 | Vehicle Safety Communications 2 |

## 5.3 Terms and Definitions

| | |
|---|---|
| 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. |
| Levels of Service | The levels of service are defined in AASHTO "A Policy on Geometric Design of Highways and Streets", 6th edition. Chapter 9 – Intersections. 2011 |
| 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. |
| 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". |

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