Smart Roadside Initiative

System Requirements Specifications

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16. Abstract This document describes the system requirements specifications (SyRS) for the Smart Roadside Initiative (SRI) Prototype for the delivery of capabilities related to wireless roadside inspections, electronic screening/virtual weigh stations, universal electronic commercial vehicle identification, and truck parking. The SRI program is a multi-faceted US Department of Transportation (USDOT) initiative aimed at improving the efficiency and safety of the Nation's roadways by providing for the exchange of important safety and operational information among the users and caretakers of the system.			
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Chapter 1. Introduction

This document describes the 2015 update to the approved system requirements specifications (SyRS) for the Smart Roadside Initiative (SRI) Prototype in 2012 for the delivery of capabilities related to wireless roadside inspections, electronic screening/virtual weigh stations, universal electronic commercial vehicle identification, and truck parking. The SRI program is a multi-faceted US Department of Transportation (USDOT) initiative aimed at improving the efficiency and safety of the Nation's roadways by providing for the exchange of important safety and operational information among the users and caretakers of the system.

The 2012 SyRS document described a comprehensive set of requirements for SRI at full development and deployment. At the time of approval, the complete list of SRI SyRS were denoted as applying to one of two deployment sites (Michigan or Colorado) or a future site (one that could not be demonstrated at either site). Since the approval of the 2012 SRI SyRS, Colorado had to drop out of the test due to external priorities. Maryland became the second test location. In addition, due to a reduction in vendor participation, the project scope was subsequently revised to emphasize systems integration and the development of software applications. The revised project scope focuses on developing an SRI framework and testing data exchange and communications functions to validate that the framework can integrate with certain technologies now and expanded SRI applications in the future.

This document describes what changes were made in the SRI Prototype System test to implement the revised Scope of Work and the modifications that were in turn made to the 2012 SyRS. The Research Team notes that SyRS developed in 2012 continues to reflect expected SRI full development capabilities and remains applicable for future SRI deployment. Any italicized text indicates a modification to the original SyRS document.

The structure of this SyRS is based on the Institute of Electrical and Electronics Engineers (IEEE) Standard *1233-1998 IEEE Guide for Developing System Requirements Specifications*. Consistent with this standard, this SyRS document consists of the following sections:

- Section 1 provides an introduction to the document and an overview of the system purpose and scope.
- Section 2 provides a general system description, including the system's capabilities as well as its constraints, user characteristics, and operating scenarios. Lastly, this section summarizes the Research Team's assumptions related to the development of the SyRS.

- Section 3 details the system requirements for the SRI prototype: physical, performance, security, data, information management, and operating requirements.
- Section 4 discusses the required interfaces for the SRI prototype.
- Section 5 summarizes all requirements and interfaces in the Requirements Traceability Matrix (RTM).

The intended audience for this SyRS includes: USDOT, application developers, and potential core system acquirers, implementers, operators, and maintainers.

System Purpose

SRI is part of the USDOT's connected vehicle initiative. Connected vehicle technology can change our transportation system as we know it by enabling safe, interoperable, networked, wireless communications among vehicles, infrastructure and passengers' personal communication devices. Connected vehicle technology will enable cars, trucks, buses and other vehicles to "talk" to each other with in-vehicle or aftermarket devices that continuously share important safety and mobility information. This wireless communication will be able to talk to roadside weigh/inspection stations as well.

The ideal Smart Roadside "system," when deployed, will improve the safety, mobility, and efficiency of truck movements and operations on the roadway by facilitating:

- The integration of external systems that enhance the exchange of information for commercial vehicle operations to support roadside operations at weigh stations[1] (i.e., the integration of roadside applications with these external information systems that provide information on commercial vehicle safety history and credentials status);
- Access to information at roadside including information that will enable the identification of the driver and vehicle as well as the motor carrier; and
- The deployment of supporting infrastructure at strategic points along commercial vehicle routes to support the exchange of information.

The SRI prototype system requirements focus on the capabilities as described in the Final SRI Concept of Operations (ConOps), which were constructed following a cycle of thorough stakeholder input gathered through facilitated sessions and directed interviews.

The purpose for this document is to communicate a concept for the SRI that bridges the gap between users' needs and visions and developers' technical specifications.

[1] The locations dedicated to truck size and weight enforcement, in addition to vehicle inspections, on highway mainlines are "Weigh Stations"; other locations used temporarily to conduct weight/size and vehicle compliance determinations are "enforcement sites." The term "weigh station" is used throughout this document in reference to *both types of sites* for simplicity since both sites are targeted with the SRI prototype.

System Scope

The "SRI system"[2] is not a discrete system, but rather a prototype which will demonstrate the integration of tools, methods, and standards that together have the potential to transform the way commercial vehicle operators, safety enforcement personnel and other authorized users access, apply, and manage information. Per the final SRI Concept of Operations, the SRI prototype will effectively accomplish the following three things:

- Streamline the methods and mechanisms used to locate and access information, thereby accelerating and improving the accuracy of decisionmaking processes;
- Provide a means to electronically identify commercial vehicles at highway speeds and to manage the exchange of information between vehicles and infrastructure-based systems; and
- Enable the delivery of a broad variety of applications that enhance safety and mobility.

The application of the proposed SRI system within the current operating environment is depicted below in Figure 1.

[2] The term "SRI system" is used throughout this document for simplicity.

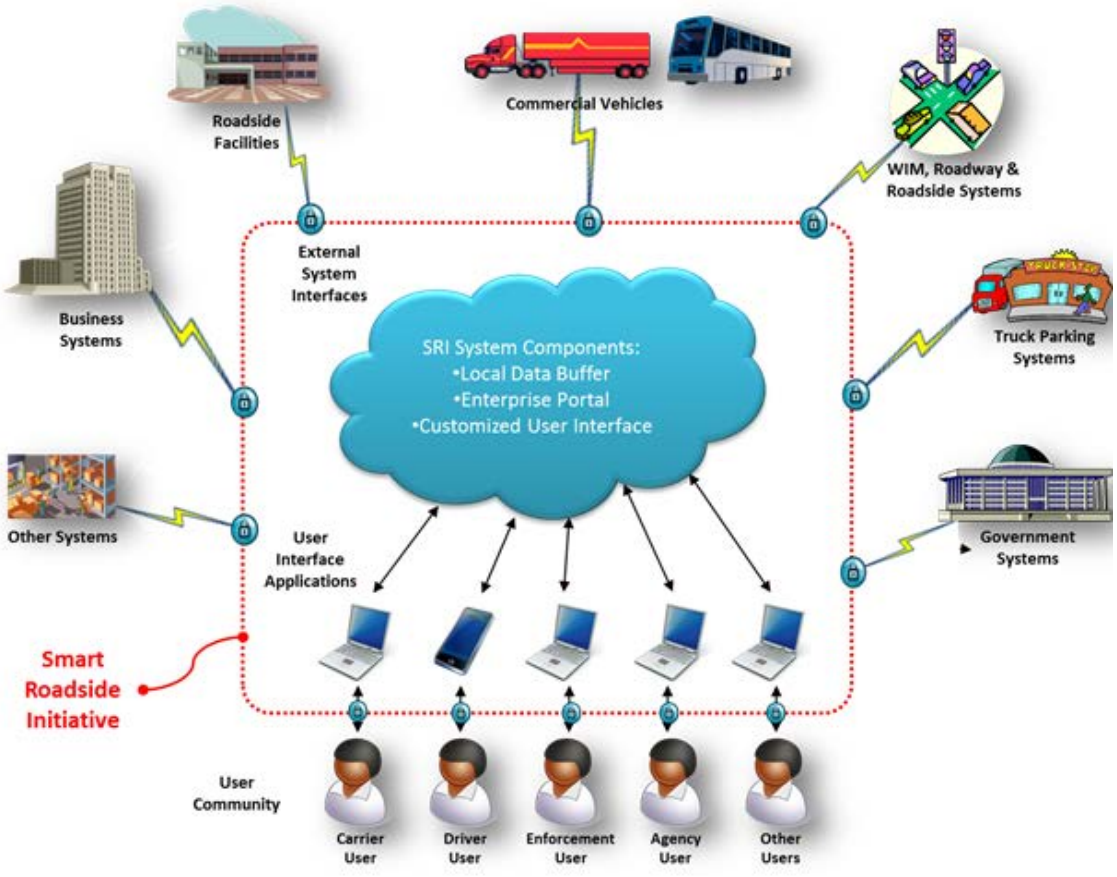

Figure 1. SRI High-Level Perspective Framework

Definitions, Acronyms and Abbreviations

Table 1: Definitions, Acronyms and Abbreviations

Organizations	
CVSA	Commercial Vehicle Safety Alliance
DMV	(State) Department of Motor Vehicles
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
NATSO	National Association of Truck Stop Operators
NHTSA	National Highway Traffic Safety Administration
USDOT	US Department of Transportation
Standards	
CFR	Code of Federal Regulations
CVSP	Commercial Vehicle Safety Plan
CSA	Compliance, Safety, Accountability
FMCSR	Federal Motor Carrier Safety Regulations
IEEE	Institute of Electrical and Electronics Engineers
NIST	National Institute of Standards and Technology
SAE	Society of Automotive Engineers
STAA	Surface Transportation Assistance Act
Industry Terms	
API	Application Programming Interface
CAN	Controller Area Network
CDL	Commercial Driver's License
CMRS	Commercial Mobile Radio Services
CMV	Commercial Motor Vehicle
ConOps	Concept of Operations
CVIEW	Commercial Vehicle Information Exchange Window
DOC	Draft Operational Constraint
DOP	Draft Operational Policy
DSRC	Dedicated Short Range Communications
EOBR	Electronic On-board Recorders
ES	Electronic Screening
HOS	Hours Of Service
IT	Information Technology
MOU	Memorandum of Understanding
OBU	On-board unit
OOS	Out of service
Os/Ow	Oversize/overweight
RFID	Radio Frequency Identification

Industry Terms (cont'd)	
RSU	Roadside equipment
RTM	Requirements Traceability Matrix
SyRS	System Requirements Specifications
TBD	To Be Determined
UID	Universal Identifier
UN	User Need
VIN	Vehicle Identification Number
VMT	Vehicle Miles Traveled
VWS	Virtual Weigh Station
WIM	Weigh-In-Motion
WRI	Wireless Roadside Inspection
Programs	
CVISN	Commercial Vehicle Information Systems and Networks
DRG	Dynamic Route Guidance
FRATIS	Freight Advanced Traveler Information System
MCSAP	Motor Carrier Safety Assistance Program
NASI	North American Standard Inspection Program
SRI	Smart Roadside Initiative
SMS	Safety Measurement System
SRIS	Smart Roadside Inspection System
UCR	Unified Carrier Registration
Technologies	
ASN	Abstract Syntax Notation
DSRC	Dedicated Short Range Communications
OAuth	Open standard for AUTHorization
DRG	Dynamic Route Guidance
FRATIS	Freight Advance Traveler Information System
NASI	North American Standard Inspection Program
SOAP	Simple Object Access Protocol
SRI	Smart Roadside Initiative
SMS	Safety Measurement System
SRIS	Smart Roadside Inspection System
XML	Extensible Mark-up Language
WiFi	Wireless Fidelity
Systems	
A&I	Analysis and Information
CAPRI	Compliance, Analysis and Performance Review Information
CDLIS	Commercial Drivers' License Information System
CVIEW	Commercial Vehicle Information Exchange Window
EMIS	Enforcement Management Information System

Systems (cont'd)	
IFTA	International Fuel Tax Agreement
InfoSys	Federal Motor Carrier Safety Administration Information Systems
ISS	Inspection Selection System
IRP	International Registration Plan
L&I	Licensing and Insurance
MCMIS	Motor Carrier Management Information System
Nlets	National Law Enforcement Telecommunications System
PRISM	Performance and Registration Information Systems Management
SAFER	Safety and Fitness Electronic Records
UFA	Uniform Fine Assessment

References

This section contains a listing of documents referenced during the development of this SyRS.

- IEEE Std. 1233 – IEEE Guide for Developing System Requirements Specifications Document, 17 April 1996 (R1998)
- Military Standard 188 (MIL-STD-188). Telecommunications Standards. U.S. Department of Defense. 2004.
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- Smart Roadside Initiative FINAL Concept of Operations – 22 May 2012.
- Smart Roadside Initiative (SRI) Prioritization of Potential SRI Applications – Tasks 2 and 3: Technical Memorandum 3, SAIC, October, 2011
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- Smart Roadside Initiative (SRI) Application Analysis and Assessment of Deployed Systems and Current Research – Tasks 2 and 3: Documentation Review of Deployed Systems and Documentation Review of Current research/Emerging Systems, SAIC, June, 2011
- USDOT System Requirement Specification "5.9 GHz DSRC Roadside Equipment." Design Specification v. 3.0, USDOT ITS JPO, March 2012

- WSDOT Truck Parking Study – Final Report, Washington State Department of Transportation, December 2005
- I-95 Corridor Coalition Truck Parking Initiative, System Design Version 1.2, FHWA, November 24, 2010
- Statement of Work – Smart Roadside Initiative, USDOT, June 2010

System Overview

The Research Team envisions the basic architecture for the prototype to consist of four major system elements:

- Vehicle systems, which encompass all system elements and devices on a vehicle;
- Roadside systems, which include all system elements deployed locally in both fixed and mobile applications;
    - The roadside systems described in this architecture are deployed at weigh stations, which are defined as the locations dedicated to truck size and weight enforcement and vehicle inspections on highway mainlines; for simplicity in this document (as described in footnote #1), the term also includes locations used temporarily to conduct weight/size and vehicle compliance determinations. It is intended that the SRI prototype applies to both locations.
- Back-Office Systems, including systems currently in existence at Federal, State and local agencies, motor carriers, and service providers as well as those systems that will be implemented among these organizations in the near-term; and
- Communications networks, including the local and wide area public or private networks capable of supporting high-speed data transmission.

Figure 2 illustrates these elements.

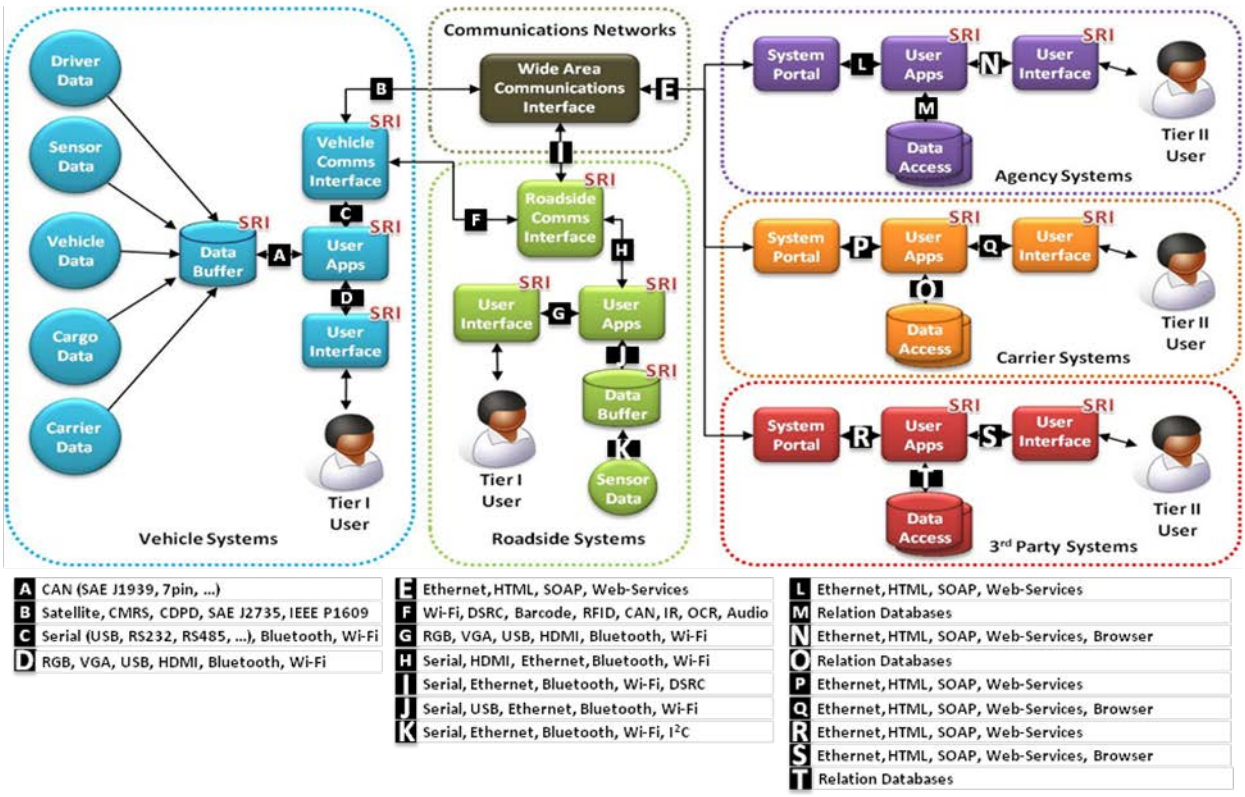

Figure 2. Proposed SRI Functional Architecture

SRI Prototype Capabilities

New Capabilities

New capabilities to be tested through the SRI Prototype Test include:

- Enhanced exchange of information at roadside (via vehicle-to-infrastructure communication) at mainline speeds to support such activities as mobile enforcement compliance checks;
- Assignment of unique identifiers to drivers, vehicles, and motor carriers that can be exchanged at mainline speeds;
    - *The USDOT number was used for the motor carrier's unique identifier, the CDL was used for the driver's unique identifier, and the VIN was used for the vehicle's unique identifier.*
- Common protocols and communications standards for the exchange of information;
- Interoperable applications;
- Temporal targets for measuring the speed of data exchanges occurring between the vehicle and roadside equipment; and
- Supplying information to motor carriers and drivers about motor carrier services in real-time (e.g., truck parking).

Enhanced Capabilities

The integration of multiple systems through the full deployment of SRI enterprise-level application will significantly enhance the exchange of data between the roadside and external systems. *At full deployment of* SRI, the enforcement community will be able to exchange information on motor carrier, driver, and vehicle safety conditions, company and vehicle safety history, and compliance with credentialing requirements with external systems on a near real-time basis.

An additional enhanced capability will be the additional sources of data that can be used to support FMCSA's CSA program, in particular the calculation of a motor carrier's safety rating. The additional data sources will also provide substantially enhanced data on driver and vehicle performance and will significantly expand the total number of data points included in State and Federal motor carrier safety history and credential databases.

Finally, the use of SRI applications on secondary roads and fixed weigh station by-pass routes will enhance size and weight enforcement and reduce damage to road systems.

It is important to articulate that the capabilities of the SRI system at full deployment apply to both the enforcement and motor carrier communities. The previous section articulated providing information to motor carriers and drivers about motor carrier services in real-time (e.g., truck parking) as a new capability. The SRI prototype will also examine truck parking detection and notification systems and pilots currently in development and integrate them if possible into the system design.

Chapter 2. General System Description

System Context

SRI is intended to operate in a range of locations, from weigh stations that are equipped with minimal technology to those that may be equipped with the latest commercially available off-the-shelf solutions in addition to the equipment required to complete minimum manual inspection activities. The SRI prototype is intended to demonstrate flexibility and scalability, allowing for the solution to be deployed easily in other locations regardless of the level of technical sophistication present at the weigh station.

To that end, the Research Team intends to deploy and test the SRI prototype in the Detroit, Michigan metropolitan area with the cooperation of the Michigan State Police and *in West Friendship, Maryland, in cooperation with the Maryland State Police and* the USDOT's *Saxton Transportation Operations Lab (STOL).* The list below indicates the prototype sites that will be included in the test and the physical technology they currently have:

- *Michigan:*
  - *Grass Lake Weigh Station on I-94 Eastbound:*
    - *Fixed WIM on ramp connected to the static scale at the weigh station house software.*
- *Maryland:*
  - *West Friendship Weigh Station on I-70 Westbound*
    - *Fixed WIM on ramp connected to the static scale at the weigh station house*
    - *License plate reader (LPR) on the ramp*

As articulated above, the technology currently in place at these weigh stations mainly relate to WIM and electronic screening. In addition to these fixed locations, the Michigan State Police patrol cars are Internet enabled and can complete mobile inspections, offering an additional test parameter to the Leidos Team. Both fixed and mobile inspection sites offer safe pull-off area(s) for enforcement officers to conduct truck compliance actions.

The selection of the *Maryland* site represents an opportunity to test the SRI Prototype in a current operating environment *DSRC technology in conjunction with the STOL and the USDOT's connected-vehicle commercial vehicle ("Silver").*

The SyRS for the SRI prototype have been developed to be consistent with the parameters present within the two test environments; however, the level of detail is general enough to accommodate future sites. The development is also consistent with National ITS Architecture, and in particular, considers Version 7.0, which brings it into alignment with Commercial Vehicle Information Systems and Networks (CVISN) Version 4.0. The updated logical architectural flows include credential information exchange to support citations and border clearing status. The SRI architecture mirrors the National ITS physical architecture that identifies higher level communications interfaces and interactions between various transportation management organizations.

System Modes and States

As stated in the Final ConOps, the SRI Prototype system will be tested to support commercial motor vehicle roadside operations. The system itself will be an Enterprise Portal application that will be accessible to any authorized user. In the current operational environment, weigh stations operate in one of three different modes: manual, augmented, or automated, with varying levels of technology support.[3] It is important to note that the SRI system will not preclude the use of these modes, yet it will increase the level of automation available to both the enforcement and motor carrier communities and the efficiency with which inspections can be completed. To that end, at full deployment the SRI Prototype system will be reliant on multiple external systems for exchanging information:

- Enforcement systems that are used to calculate truck size and weight;
- Enforcement and credentialing systems that provide information on motor carrier safety history and commercial drivers' license (CDL) status;
- In-vehicle systems that provide information on the driver and commercial motor vehicle (CMV);
- In-vehicle or motor carrier systems that provide unique identifiers for the motor carrier, vehicle, and driver as well as information on driver status (hours-of-service); and
- Systems operated by service providers such as truck rest-stop operators.

Regardless of where it is deployed, the SRI Prototype system will be dependent on the communications infrastructure that is installed to support information exchange. This will include roadside readers and a communications system that can exchange information on a near real-time basis. The near real-time exchange will ensure that compliant CMVs and drivers are not delayed unnecessarily and that they receive the benefit of enhanced mobility as a result of maintaining compliance with safety and credentialing requirements. This near real-time data exchange is critical for ensuring that decisionmaking at the roadside is expedited: that non-compliant CMVs or drivers are identified, and that necessary

[3] The Final SRI ConOps defines manual operations as static scale, with direct officer-driver interaction; augmented operations include some automated devices/processes or means of information access. Automated operations use electronic screening and pre-clearance of vehicles allowing bypass of a fixed weigh station.

enforcement actions are taken. That said, should the existing communications infrastructure not support operation of the SRI Prototype as designed, the Leidos Team will work to augment it appropriately.

Enforcement actions are conducted at fixed facilities, by mobile units, and through execution of the functions performed by certain virtual systems (for example, VWS/ES, WRI). At full deployment, the SRI Prototype system will be able to support the technologies that these applications are embracing as they advance in their development. The system will be available for use at multiple geographic locations. System redundancy requirements will be identified and tested for the prototype test. In addition a maintenance plan will be developed as part of the prototype. A key component of the maintenance plan will be to test alternative times for conducting maintenance operations with minimal disruption to operations. These items are also discussed at a high level within the maintenance and reliability subsections in section 3 of this document.

As feasible, the components discussed in the preceding paragraphs will be tested in support of a 24/7 operational test.

Major System Capabilities

The Smart Roadside Initiative represents an opportunity to enhance significantly both the performance and the inherent value of activities related to improving efficiency and productivity within the freight sector, protecting infrastructure assets, and improving commercial vehicle safety compliance. By providing a framework for robust interfaces among commercial vehicles, roadside systems, and the broad array of users, the SRI system has the potential to address many of the gaps in the current roadside operating environment and significantly expanding the exchange of information to support roadside operations. A high-level overview of how these will be addressed is summarized in Table 3 below.[4]

[4] Note: an earlier version of this table was contained in the Final SRI ConOps. Some language has been simplified for clarity in the version presented in the SyRS. The ConOps will be updated accordingly to be consistent.

Table 2. SRI Prototype Applications and Gap Resolutions

Constraints	SRI Application	Current System	SRI Prototype Solution
Lack of unique identifier for all motor carriers	Universal Truck Identification	USDOT number for interstate motor carrier can be read by roadside reader although accuracy decreases as travel speed increases. States are now requiring Intrastate DOT numbers that include number and unique identifier for base state but this is not a standard practice across all States.	Unique identifier for motor carrier, driver, and vehicle accessed electronically. Will be used by both inter- and intra- state motor carriers.
Inability at present to identify driver and vehicle	Universal Truck Identification	Identification of driver requires manual inspection by enforcement personnel. Vehicle can be identified by license plate readers or manual inspection.	Unique identifier for motor carrier, driver, and vehicle accessed electronically. Will be used by intra and interstate motor carriers.
Limited Coverage on National and State highways	Virtual Weigh Station Wireless Roadside Inspection	Fixed facilities tend to be on interstate system. States use mobile patrols and "plug and play" facilities to conduct size and weight and safety enforcement.	Expand coverage of VWS and WRI
Limited communications to support roadside operations – vehicle to roadside	SRI communications infrastructure	Pre-clearance programs issue "green light/red light" through a transponder. Information exchange between enforcement personnel at fixed facilities or between states done using radio, hand-held communication devices, or electronic mail.	SRI communications infrastructure will support expanded information exchange to support roadside operations. SRI communications infrastructure will support exchange of information between enforcement personnel within a state and between states and with motor carriers.

Constraints	SRI Application	Current System	SRI Prototype Solution
Lack of common protocols and standards to support roadside operations	SRI Communications Infrastructure SAE J2735 Standard	The National ITS Architecture and associated CVISN processes provide general baseline functional specifications and data flows, but no specific implementation guidelines for a full solution. For example, the ITS architecture does not define terminator functionality, but only describe the general functionality of systems that they interface. Equipment and service package performance specifications for SRI are undefined.	The adoption of the SAE J2735 Standard will help establish a common format for message sets.
Lack of physical infrastructure to support roadside communications	SRI Physical Infrastructure	As noted in section 3, a number of vendors are deploying roadside applications that support SRI functionality. However, these applications are relatively new and do not have a widespread deployment. Resource constraints have also limited States' ability to deploy these applications.	The results of the prototype may provide states with information on what types of equipment work best and equipment specifications.
Lack of Operational Truck Parking Program	Truck Parking	Two operational tests are underway along the I-5 Corridor in California and along the I-95 Corridor. Other projects are also being developed.	Through the prototype an additional test of a potential truck parking system will be conducted to provide space availability information to the driver

The foundational element of the SRI system is the establishment of open standards-based connectivity to the variety of systems that are currently in place at the Federal, State, and Local levels within government and current and future commercial systems. This connectivity is essential to the timely and ubiquitous information exchange that underpins the SRI system. One of the key reasons for this is to enable system users the flexibility to implement components/modules of the system suited to the needs of the user and to enable previous automated tools to be integrated into the SRI system.

The second major element is the mechanism by which users will access information. This information, which will be used to facilitate a broad range of operational and policy decisions, must be presented to all users in a concise, consolidated fashion. For example, Tier 1 users will use information from an operational standpoint to complete screening, enforcement and clearance activities (enforcement officers) and to receive the outcomes of these decisions (carriers). Meanwhile, most Tier 2 users will access and review this information from a policy

perspective to formulate and access safety rankings and to evaluate and analyze current CMV safety policy regarding size and weight, permitting, compliance, and credentialing.[5] The SRI prototype user interfaces are intended to be single points of access. These interfaces will use standardized information access mechanisms, but the presentation formats will be user-customizable.

The third major element is the communications link between the moving commercial vehicle and the rest of the SRI network. The ultimate goal is to provide for electronic identification of the vehicle, carrier, and driver and to allow for the information exchanges necessary to support a variety of location-based services. The system must be "technology agnostic," meaning that it must accommodate any communications channel that provides the requisite performance, reliability, and information security.

The common characteristic for all three major elements is a focus on enhancing the user experience by streamlining access to information, improving decision making, and providing a means for delivering new capabilities. An overarching element of this vision is that SRI must fit into and support an information exchange environment that allows for the rapid movement of what are potentially very large data sets. This is essential not only to meet the performance requirements inherent in the delivery of the capabilities envisioned for commercial vehicle operations, but also to ensure that it leverages technology that may also be used for vehicle-to-vehicle (V2V) safety applications. This extends beyond the simple ability to utilize any such technologies to promote the development and adoption of methods and mechanisms that ensure SRI functions do not compromise the low-latency data exchanges necessary to support those safety functions.

It is essential to understand that the SRI system is intended to enable the delivery of specific applications and data. Each of those applications—ES/VWS, WRI, and truck parking—represent an initial set of individual applications that will be integrated and tested using this conceptual framework. The SRI system will also test the use of a universal truck ID (UID); that is, a set of unique identifiers for the motor carrier, driver, and vehicle. The UID will be the key for identifying the individual motor carrier, driver, and vehicle for testing the SRI linkages described in the preceding paragraph.

Major System Conditions

Operational Policies

Existing Operational Policies

The FMCSA and the FHWA have promulgated extensive regulations governing motor carrier safety and size and weight enforcement, as summarized in Table 4 below. The majority of

[5] Tier 1 and Tier 2 users are described in detail within this document in section 2.6.1.

operational policies currently in place at the State level are designed to implement and comply with Federal regulatory requirements.

Table 3. : Existing Operational Policies

Policy	Current System
North American Standard (NAS) Inspection Program	Motor carrier inspections are done using the seven levels of inspection established in the North American Standard Inspection Program, described in section 3.3.1.1.
NAS Inspector Certification and Training	The program requires that all inspectors be trained and certified and specifies that inspectors must conduct a certain number of inspections annually to maintain their certification.
Size and weight Enforcement	The United States Code of Federal Regulations (CFR) Title 23 (Highways), Part 658.17 (Weight) specifies maximum gross vehicle and axle weight limits on the National System of Interstate and Defense Highways. The Surface Transportation Assistance Act (STAA), also specified in 23 CFR 658, requires states to allow truck sizes defined as 'conventional combinations' of tractor-trailers on the National Network to support interstate commerce. As described in section 3.3.1, FHWA require that States prepare and submit an annual truck size and weight enforcement plan. States may tailor its plans and corresponding enforcement to meet specific requirements.
USDOT Numbers	Interstate motor carriers are required to obtain a USDOT number. This number is used as the unique identifier for the motor carrier.
Compliance, Safety, Accountability (CSA)	CSA is FMCSA's new safety and enforcement program. Under this program the methodology used to assess motor carrier safety ratings has been expanded to include performance data not included in the former SafeStat methodology.

Draft Operational Policies

At this point that the SRI system represents a framework within which specific capabilities will be delivered by individual applications as part of the SRI prototype, and these applications (e.g., WRI, ES/VWS, etc.) will be governed by policies crafted specifically for them. Following are the draft operational policies (DOP) for the SRI system.

DOP01 – The SRI Prototype System shall test the technical viability of 24/7 operations, which will require some level of system monitoring by potential first-tier end users.

DOP02 – The SRI Prototype System, to the extent technically feasible, shall use existing computer hardware and communications infrastructure to demonstrate economies of scale that can be achieved in a long-term SRI deployment. The SRI prototype system shall not preclude the continued use of existing systems for retrieving and processing data.

DOP03 – The SRI Prototype System shall be deployed and tested at a fixed facility on the National Highway System and shall *at some point in the future also* be deployed and tested in a mobile environment on selected secondary routes near the fixed facility.

DOP04 – The SRI *Prototype System will test the use of* unique motor carrier, vehicle, and driver identifiers that have legal standing or can be uniquely associated with identifiers established by Federal or State statute or regulation. These identifiers must be usable in any jurisdiction within which a vehicle may operate. This is

necessary to establish a clear link to data stored at an authoritative source and to minimize the likelihood confusion or inefficiency due to the duplication or ambiguity of terms. For the purpose of the SRI *Prototype System Test*, the unique identifiers for CMVs, drivers, and motor carriers shall be the VIN, the CDL number, and the USDOT number, respectively.

DOP05 – For the purposes of the SRI prototype, any data upon which a *vehicle weight* action is based must be verifiable as being sourced from an authoritative system or system of record. This includes: identity of vehicle, driver, and carrier. *Future screening actions conducted as part of SRI shall include verification of* current safety status of any individual vehicle system; current safety status of the driver; and current safety status of the carrier (or vehicle owner). Any future application executed to complete a screening action must be verifiable as being sourced from an authoritative system or system of record.

DOP06 – For the purposes of the SRI prototype, the prototype applications shall utilize technologies that are consistent with nationwide interoperability standards currently used for the USDOT V2X Program - SAE STD J2735, IEEE Standard 1609 and IEEE Standard 802.11p.

DOP07 – To ensure consistency and reduce complexity during the SRI prototype test, SRI user community members should define and implement a common framework to define and test user access provisions and use restrictions while allowing for *future* flexibility to govern access at the level of each SRI support application.

DOP08 – The SRI prototype shall test how information capture and management procedures permit authorized users to have transparent access to data captured for identification and *weight check* purposes and all results of these activities. Authorized users are considered to be those who are a party to such transactions. Authorized users' access to data will be based on their specific responsibilities and job requirements. Authorized users will not have unlimited access to all data captured.

DOP09 – The SRI prototype will test how to present information to users so that users have access to data but are not able to modify data captured by SRI prototype applications.

DOP10 – For the purposes of the SRI prototype, the vehicle-to-roadside information exchanges and system-to-system information exchanges shall minimize the quantity of data necessary to facilitate the delivery of capabilities.

DOP11 – The SRI prototype shall ensure that motor carrier-provided data used for screening and inspection activities is authenticated and has not been replaced or corrupted during its transmission from motor carrier data sources.

Major System Constraints

Existing Operational Constraints

Table 4. Existing Operational Constraints

Constraint	Current System
Lack of unique identifier for all motor carriers	The USDOT number for interstate motor carrier can be read by roadside reader. States are now requiring intrastate DOT numbers that include a number and unique identifier, but this is not a standard practice across all States
Inability at present to identify driver	Drivers are identified manually through an enforcement action or inspection. No electronic means is currently deployed that enables the identification of a driver.
Lack of consensus on unique Identifiers	There is no agreement on what should constitute a unique identifier for the motor carrier, the driver, or the vehicle
Limited coverage on National and State highways	Fixed facilities tend to be on the Interstate system. States use mobile patrols and "plug and play" facilities to conduct size, weight, and safety enforcement, but States do not have the resources for coverage of all highways used by CMVs, and as truck use on non-Interstate facilities increase and State resources continue to decline, the gap between the necessary human resources and those that are available continues to widen.
Limited communications to support roadside operations—vehicle-to-vehicle or vehicle-to-roadside	Pre-clearance programs issue "green light/red light" through a transponder. Information exchange between enforcement personnel at fixed facilities or between States using hand-held communication devices or electronic mail.
Lack of common protocols and standards to support roadside operations	At present, CMV roadside operations lack common communication protocols and common standards. The National ITS Architecture and associated CVISN processes provide general baseline functional specifications and data flows, but do not specific implementation guidelines for a full solution.
Lack of interoperability	States frequently use vendor systems to support CMV credentialing and roadside safety associations. These systems are technically interoperable but institutional issues limit the exchange of data among vendor systems.
Lack of physical infrastructure to support roadside communications	As noted in section 3, a number of vendors are deploying roadside applications that support SRI functionality. However, these applications are relatively new and do not have a widespread deployment. Resource constraints have also limited States' ability to deploy these applications.

Draft Operational Constraints

The following high-level draft operational constraints (DOC) are offered regarding the SRI system. They are categorized in the same manner as the operational policies.

DOC01 – Driver distraction is a significant concern to USDOT and has been shown to compromise highway safety. The SRI *Prototype System* test must ensure that no component or method deployed within the SRI framework will promote the implementation of any system, device, or practice that will result in unsafe operation of a CMV by distracting the driver.

DOC02 – Motor carrier participation is reliant on systems, staffs, and procedures not compromising business-sensitive information, so encryption tools and standards must be applied to meet the appropriate legal and business requirements. The *SRI Prototype System* must test security applications to ensure that proprietary data on motor carrier operation meets legal and business requirements.

DOC03 – The component carrier, vehicle, and driver universal identifiers for use by SRI for both interstate and intrastate operators are not at present established in statute or regulation. The SRI *Prototype System* test must identify a suitable set of unique identifiers for intrastate carriers included in the test that enables the identification of the motor carrier, driver, and vehicle. These may include, in part or in whole, current identifiers that are established by statute and regulation (e.g., license plates, VINs, etc.).

DOC04 – Prior to *future* testing of SRI applications on secondary roads, State DOT and Public Safety officials *must* identify locations that are considered safe locations for conducting roadside enforcement. CVSA Operational Policy #5 contains guidelines on how to select a safe location for enforcement and should be used as a reference.

User Characteristics

User Classes

There are two categories of users of current enforcement systems: those that use them to conduct operations on a daily basis and those that use them to track performance, set or analyze policy, and/or analyze data in the aggregate. It is useful to assign informal designations for these categories (no specific formal designations exist) for the purposes of this system. Users who access and utilize systems for daily operations will be referred to herein as Tier I users, and those who use them principally for after-the-fact policymaking and assessment actions will be referred to as Tier II users. With those designations in place, current users are categorized as follows:

Table 5. Users and Categories

User Designation	Description
Tier I Users	
CMV Enforcement Officer	Enforcement personnel (typically at the State level) tasked with screening vehicles, drivers, and carriers for inspection, conducting CMV inspections, and operations and maintenance of weigh stations.
CMV Driver	Individuals who operate trucks or buses on public roadways.
Motor Carrier[6]	Companies (including owner/operators) that maintain responsibility for registration and operation of CMVs.
CMV Enforcement Supervisor	Enforcement personnel tasked with directing the activities of CMV enforcement officers.
Third Party Providers	Independent providers of electronic screening, electronic tolling, periodic inspection, fleet management telematics, and traveler information services.
Tier II Users	
Motor Carrier Safety Assistance Program (MCSAP) Lead Agency Manager	Individual within the lead agency responsible for implementation and management of the MCSAP within a given State jurisdiction.
FMCSA Personnel	Federal staff responsible for formulating and coordinating CMV safety policy and analyzing results of implementation.
FHWA Size & Weight Personnel	Federal staff responsible for formulating and coordinating CMV size and weight policy and analyzing results of implementation.
NHTSA Personnel	Federal staff responsible for setting and enforcing safety performance standards.
Other State Agency Personnel	State staff responsible for issuing credentials and permits, and monitoring compliance with regulatory requirements (e.g., departments of transportation, bureaus of motor vehicles, departments of revenue or commerce, departments of public safety, public utility commissions, and State police agencies).
CMV and Equipment Manufacturers	Manufacturing entities whose products must conform with safety and regulatory compliance requirements.

Interactions among User Classes

The implementation of SRI will in all likelihood significantly increase the number of users of the current system; that is, individuals that promote and provide for save CMV operations. Table 7 summarizes the expected interaction of these users, broken out by user group, with the system.

[6] Motor carriers are referred to generically as business entities that operate CMVs.

Table 6. Users Interactions with SRI System

User Designation	Description
Tier I Users	
CMV Enforcement Officer	SRI will significantly increase the quantity and quality of data available to a CMV enforcement officer and will improve his or her ability to identify non-compliant carriers and drivers. The Research Team expects that enforcement personnel will have regular interaction with the system as part of their daily enforcement activities.
CMV Driver	Drivers will need to be diligent in ensuring that hours on duty and hours driving remain compliant with hours-of-service regulations to avoid non-compliance. Drivers will also need to react to SRI messages on vehicle performance. The Research Team expects that direct driver interaction with the proposed system will be limited to responding to vehicle performance issues, although the potential exists for direct interaction with third party service providers. The Research Team expects that the most significant impact on drivers will be the increased ability of enforcement personnel to verify hours of service. This is not a direct interaction, but potentially will have a significant impact on how a driver performs his or her duties.
Motor Carrier	The Research Team anticipates that motor carrier interaction with the system will be through responding to system outputs such as notices of enforcement actions, notices of yellow lights requiring equipment maintenance, and monitoring driver hours to ensure compliance with HOS requirements.
CMV Enforcement Supervisor	CMV enforcement personnel will have extensive interaction with the system. They are often frequently involved in direct enforcement actions and will also use the system for quality control purposes to monitor officer performance.
Third Party Providers	Third party providers will potentially have extensive interaction with the system if the market for their services develops.
Tier II Users	
MCSAP Lead Agency Manager	There is an expectation that management will have periodic interaction with the system. The manager will make use of system outputs, in particular the analysis of data that can be used to support planning and resource allocation.
Motor Carrier Safety Program Personnel	There is an expectation that other State personnel involved with motor carrier safety programs will interact routinely with the system. The State personnel involved with programs such as CVISN and driver licensing will be involved in providing and authenticating data.
FMCSA Personnel	There is an expectation that FMCSA personnel at the Division level will have extensive interaction with the system as part of their daily activities. Also, the Service Center and Headquarters personnel will have more limited interaction in the same way as a MCSAP Lead Agency Manager.
FHWA Size & Weight Personnel	There is an expectation that FHWA Program Coordinators at the Division level will have limited interaction with the system as part of their daily activities. Interaction might consist of reviews of compliance statistics for use in compliance campaigns. Also, the Headquarters personnel will have even less interaction than Division Office personnel.
NHTSA Personnel	There is little expectation that NHTSA personnel will have extensive direct interaction with the system. Also, NHTSA personnel will have more limited interaction in the same way as a MCSAP Lead Agency Manager utilizing system outputs and reports based on data collected by the system.

User Designation	Description
Other State Agency Personnel	Procurement of SRI infrastructure and installation and deployment of SRI software will involve State agency IT. State procurement personnel will also be involved through the procurement process. If a State has a centralized IT office that establishes State policies and procedures, this office will be involved in developing technical specifications for SRI procurement and ensuring compatibility with existing State IT infrastructure and systems. Finally, if a State has a Chief Information Officer, this individual will be involved both in ensuring that all SRI hardware and software applications are compliant with State requirements and in approving the procurement. However, once the system is procured, installed, and being operated, the agency IT personnel responsible for system operation and maintenance will be the primary State personnel with interaction on a regular basis.
CMV and Equipment Manufacturers	The potential exists for these users to develop and manufacture system software and hardware components. To some extent, this is already happening with companies providing roadside infrastructure (readers, WIM) and other companies providing SRI and ES/VWS software applications.

Assumptions and Dependencies

A number of assumptions are necessary to deliver the desired functionality as envisioned by the full deployment and development SRI system described in the concept of operations. These are defined at a high level in this section, with more explicit details as they relate to the specific elements of the proposed system provided in section 3.

The SRI Prototype System test did not include functionality related to assumptions J through M and U and V.

The high-level assumptions include:

A. A common and universally accepted character string that can be uniquely tied to a registration record will serve as the basis for the unique identification of a specific tractor;
B. A common and universally accepted character string that can be uniquely tied to a registration record will serve as the basis for the unique identification of a specific piece of trailing equipment;
C. An identifier, which may or may not be identical to the aforementioned vehicle and trailing equipment character string(s) in format and specific characters, will be stored in an on-board system on the vehicle or in a manner that makes it visible and legible for detection by a roadside device;
D. A common and universally accepted character string that can be uniquely tied to a driver record will serve as the basis for the unique identification of individual CV drivers;
E. Every universal truck identification event request results in the formulation of an event identifier that is associated with the date and time, the trigger location, the

requesting user, and any other important information necessary to track the specific characteristics of each request;

F. Systems deployed at the roadside will have access to an authoritative State or other database that associates the vehicle and trailing equipment character string to the electronic identifier and to the appropriate vehicle ownership and registration records;
G. The UID application will provide for the unique identification of a specific truck, trailer, and driver for all other SRI-related functions where such identification is necessary to deliver the desired capabilities;
H. The identification of the vehicle can be completed simultaneously with or within a very short time period of the other SRI processes depicted herein in order to ensure information is available for rapid decisionmaking;
I. Roadside devices for collecting and processing data to calculate size and weight (e.g., WIMs, height sensors, etc.) will be controlled from and data will be passed directly to the roadside system components;
J. If an FMCSA-compliant on-board electronic device that records driver HOS (e.g., automatic on-board recording device (AOBRD) or EOBR) is installed on the vehicle, this device will be the source of driver HOS compliance data.
K. If an FMCSA-compliant on-board electronic device that records driver HOS (e.g., AOBRD or EOBR) is not installed on the vehicle, the system will be configured to link to information contained within a carrier system, provided that system contains up-to-date information.
L. Carrier credential verification will be performed where credentials data is stored (i.e., within systems that contain records considered by enforcement agencies as being authoritative);
M. The carrier system will be notified upon the completion of any SRI event;
N. If electronic truck parking systems are available, these will return information about availability of spaces;
O. A motor carrier dispatcher or a vehicle owner or operator will be making requests for parking availability information;
P. The truck may be moving when the driver receives notification regarding availability;
Q. An individual carrier and/or driver will have the option of selecting the types of information desired;
R. Notifications and alerts sent to a vehicle operator must be delivered in compliance with USDOT requirements regarding driver distraction;
S. Information security methods and protocols that safeguard information and enable the delivery of needed data and information will be tested as part of the prototype test;
T. The “common and universally accepted character string” that can be tied directly to a tractor or a piece of trailing equipment has not yet been defined; however, one option would be to use all or part of the vehicle identification number (VIN) in

conjunction with the license plate number. (The use of the VIN and license plate number implies that some mechanism has to be defined to enable SRI systems and other connected systems to associate these numbers to appropriate records.)

U. The use of a State motor vehicle registration number, which is viable as long as each number is uniquely associated with a single tractor or trailer, is also an option for the "common and universally accepted character string." (In either case, the character string should contain information regarding where the associated information can be located (i.e., which system contains the authoritative data).)

V. Capabilities of the various systems deployed under SRI will vary based upon technical limitations imposed by communications service availability, as well as deployment cost. Care will need to be exercised by deploying entities to ensure that critical functionality is available to meet operational needs for each deployment.

Operational Scenarios

The scenarios developed for the SRI Prototype System test are substantially revised from the scenarios proposed in 2012. As previously noted, these revisions are based on the system components and applications included in the Prototype System test.

A CMV travels on a "control segment" of roadway—along the mainline or on a weigh and inspection station entrance (or "sorter" ramp)—instrumented with technologies employed by the SRI Prototype System. The scenarios that follow reference the "weigh/inspection station" as the location where enforcement personnel come into direct contact with the driver, vehicle, and load. It should be understood that the use of the term "weigh/inspection station" as used in the scenarios that follow includes both safe pull-off areas (like rest areas located along roadways) that are used by enforcement personnel as temporary inspection stations as well as fixed weigh/inspection facilities.

The SRI system equipment deployment is required along the roadway in advance of such sites so that necessary compliance checks can occur, data exchanges between the roadside and the vehicle can occur, and roadside equipment can access off-site data systems to verify driver, vehicle, and carrier compliance with relevant data maintained by CMV safety program personnel, including public licensing and credentialing agencies, tax agencies, safety program agencies, and over-size/over-weight permit offices.

Scenario 1: Compliant CMV – Internet and Cellular Communications "Green Light"

Prior to departure the CMV driver downloads the SRI mobile application to a Smartphone and then enters the unique identifier information (CDL number, USDOT number, power unit license plate number, and Vehicle Identification Number (VIN)). The CMV driver may also take a picture of the CMV using the Smartphone and then stores the picture in the SRI

mobile application. The CMV then enters the SRI system "control segment." The entry of the CMV into a defined GPS-based geo-fence launches an automated check and verification of the vehicle and motor carrier unique identifiers. The unique identifier check and verification is exchanged using the mobile SRI application on the CMV driver's Smartphone. The CMV will then proceed to the weigh/inspection station and enter a second GPS-based geo-fence around a WIM scale. The CMV's weight will be captured and validated by the third party service provider via the Internet. The third party service provider will then notify the SRI Prototype System of the results of the validation (pass) and the SRI Prototype System will generate a "green light" message that will be provided to the CMV driver's Smartphone's mobile SRI application indicating that the CMV requires no further weight check and may return to the mainline. The message will be provided to law enforcement personnel via the SRI Prototype System. Elements of SRI Prototype System that will be tested include:

- *Exchange and verification of unique identifiers for the motor carrier and vehicle;*
- *Testing of Internet and cellular communications;*
- *Data exchange between the CMV driver, law enforcement personnel and third-party service providers using the SRI Prototype System ;*
- *Verification that all data is captured and accurately displayed on the SRI User Interface (UI);*
- *If a Power unit license plate Reader (LPR) is used to capture the CMV's license plate number and/or USDOT number, the information will be checked against SAFER and the results will be displayed on the SRI UI;*
- *Verification that the vehicle is operating within legal weight limits.*

Scenario 2: Non-Compliant CMV – Internet and Cellular Communications "Red Light"

Prior to departure the CMV driver downloads the SRI mobile application to a Smartphone and then enters the unique identifier information (CDL number, USDOT number, power unit license plate number, and Vehicle Identification Number (VIN)). The CMV driver may also take a picture of the CMV using the Smartphone and then stores the picture in the SRI mobile application. The CMV then enters the SRI system "control segment." The entry of the CMV into a defined GPS-based geo-fence launches an automated check and verification of the vehicle and motor carrier unique identifiers. The unique identifier check and verification is exchanged using the mobile SRI application on the CMV driver's Smartphone. The CMV will then proceed to the weigh/inspection station and enter a second GPS-based geo-fence around a WIM scale. The CMV's weight will be captured and

validated by the third party service provider via the Internet. The third party service provider will then notify the SRI Prototype System of the results of the validation (fail) and the SRI Prototype System will generate a "red light" message that will be provided to the CMV driver's Smartphone's mobile SRI application indicating that the CMV exceeded WIM weight thresholds. The CMV will then proceed to the static scale for an additional weight check and possible enforcement action. The WIM and static scale weights will be provided to law enforcement personnel via the SRI Prototype System. Elements of SRI Prototype System that will be tested include:

- *Exchange and verification of unique identifiers for the motor carrier and vehicle;*
- *Testing of Internet and cellular communications;*
- *Data exchange between the CMV driver, law enforcement personnel and third-party service providers using the SRI Prototype System ;*
- *Verification that all data is captured and accurately displayed on the SRI User Interface (UI);*
- *If a Power unit license plate Reader (LPR) is used to capture the CMV's license plate number and/or USDOT number, the information will be checked against SAFER and the results will be displayed on the SRI UI;*
- *Verification that the vehicle is operating within legal weight limits.*

Scenario 3: Non-Compliant CMV – Internet and Cellular Communications "Red Light" and Illegal Bypass

Prior to departure the CMV driver downloads the SRI mobile application to a Smartphone and then enters the unique identifier information (CDL number, USDOT number, power unit license plate number, and Vehicle Identification Number (VIN)). The CMV driver may also take a picture of the CMV using the Smartphone and then stores the picture in the SRI mobile application. The CMV then enters the SRI system "control segment." The entry of the CMV into a defined GPS-based geo-fence launches an automated check and verification of the vehicle and motor carrier unique identifiers. The unique identifier check and verification is exchanged using the mobile SRI application on the CMV driver's Smartphone. The CMV will then proceed to the weigh/inspection station and enter a second GPS-based geo-fence around a mainline WIM scale. The CMV's weight will be captured and validated by the third party service provider via the Internet. The third party service provider will then notify the SRI Prototype System of the results of the validation (fail) and the SRI Prototype System will generate a "red light" message that will be provided to the CMV driver's Smartphone's mobile SRI application indicating that the CMV exceeded WIM weight thresholds. The CMV does not proceed to the static scale as required when issued a

"red light" and instead returns to the mainline. The mainline WIM weights will be provided to law enforcement personnel via the SRI Prototype System who will then determine if the CMV will be pulled over for additional enforcement action. Elements of SRI Prototype System that will be tested include:

- *Exchange and verification of unique identifiers for the motor carrier and vehicle;*
- *Testing of Internet and cellular communications;*
- *Data exchange between the CMV driver, law enforcement personnel and third-party service providers using the SRI Prototype System ;*
- *Verification that all data is captured and accurately displayed on the SRI User Interface (UI);*
- *If a Power unit license plate Reader (LPR) is used to capture the CMV's license plate number and/or USDOT number, the information will be checked against SAFER and the results will be displayed on the SRI UI;*
- *Verification that the vehicle is operating within legal weight limits.*

Scenario 4: Compliant CMV – DSRC "Green Light"

Prior to departure the CMV driver downloads the SRI mobile application to a Smartphone and then enters the unique identifier information (CDL number, USDOT number, power unit license plate number, and Vehicle Identification Number (VIN)). The CMV driver may also take a picture of the CMV using the Smartphone and then stores the picture in the SRI mobile application. The CMV driver ensures that the CMV is equipped with a DSRC-enabled On-Board Unit (OBU).

The CMV then enters the SRI system "control segment" established by DSRC line-of-sight. On entry a Roadside Unit (RSU) identifies the OBU and initiates an automated check and verification of the driver, vehicle and motor carrier unique identifiers. The OBU pulls the unique identifier information from the mobile SRI application on the CMV driver's Smartphone via Bluetooth. The OBU then pushes the information to the RSU using DSRC. The information is then pushed to a server and uploaded to the SRI Prototype System where the unique identifiers are verified. The results are then pushed back to the CMV OBU via the RSU using DSRC and from the OBU to the mobile SRI application via Bluetooth. The CMV will then proceed to the weigh/inspection station and pass over a WIM scale. The CMV's weight will be captured and validated by the third party service provider via the Internet. The third party service provider will then notify the SRI Prototype System of the results of the validation (pass) and the SRI Prototype System will generate a "green light" message that will be provided to the OBU via DSRC and then to the CMV driver's

Smartphone's mobile SRI application via Bluetooth. On receiving the message that no further weight check is required the CMV may return to the mainline. The WIM weight check results will be provided to law enforcement personnel via the SRI Prototype UI. Elements of SRI Prototype System that will be tested include:

- *Exchange and verification of unique identifiers for the motor carrier and vehicle;*
- *Testing of Internet and cellular communications;*
- *Testing of DSRC;*
- *Data exchange between the CMV driver, law enforcement personnel and third-party service provider using the SRI Prototype Systems;*
- *Verification that all data is captured and accurately displayed on the SRI User Interface (UI);*
- *Verification that the vehicle is operating within legal weight limits.*

Scenario 5: Non-Compliant CMV – DSRC "Red Light"

Prior to departure the CMV driver downloads the SRI mobile application to a Smartphone and then enters the unique identifier information (CDL number, USDOT number, power unit license plate number, and Vehicle Identification Number (VIN)). The CMV driver may also take a picture of the CMV using the Smartphone and then stores the picture in the SRI mobile application. The CMV driver ensures that the CMV is equipped with a DSRC-enabled On-Board Unit (OBU).

The CMV then enters the SRI system "control segment" established by DSRC line-of-sight. On entry a Roadside Unit (RSU) identifies the OBU and initiates an automated check and verification of the driver, vehicle and motor carrier unique identifiers. The OBU pulls the unique identifier information from the mobile SRI application on the CMV driver's Smartphone via Bluetooth. The OBU then pushes the information to the RSU using DSRC. The information is then pushed to a server and uploaded to the SRI Prototype System where the unique identifiers are verified. The results are then pushed back to the CMV OBU via the RSU using DSRC and from the OBU to the mobile SRI application via Bluetooth. The CMV will then proceed to the weigh/inspection station and pass over a WIM scale. The CMV's weight will be captured and validated by the third party service provider via the Internet. The third party service provider will then notify the SRI Prototype System of the results of the validation (fail) and the SRI Prototype System will generate a "red light" message indicating that the WIM weight thresholds have been exceeded. This message will be provided to the OBU via DSRC and then to the CMV driver's Smartphone's mobile SRI application via Bluetooth. CMV exceeded WIM weight thresholds. On receiving the "red

light" message the CMV proceeds to the static scale for further weight verification. The WIM and static scale weight check results will be provided to law enforcement personnel via the SRI Prototype System via the SRI UI who will then determine if additional enforcement action is required. Elements of SRI Prototype System that will be tested include:

- *Exchange and verification of unique identifiers for the motor carrier and vehicle;*
- *Testing of Internet and cellular communications;*
- *Testing of DSRC;*
- *Data exchange between the CMV driver, law enforcement personnel and third-party service providers using the SRI Prototype System;*
- *Verification that all data is captured and accurately displayed on the SRI User Interface (UI);*
- *Verification that the vehicle is operating within legal weight limits.*

Scenario 6: Non-Compliant CMV – DSRC "Red Light" and Illegal Bypass

Prior to departure the CMV driver downloads the SRI mobile application to a Smartphone and then enters the unique identifier information (CDL number, USDOT number, power unit license plate number, and Vehicle Identification Number (VIN)). The CMV driver may also take a picture of the CMV using the Smartphone and then stores the picture in the SRI mobile application. The CMV driver ensures that the CMV is equipped with a DSRC-enabled On-Board Unit (OBU).

The CMV then enters the SRI system "control segment" established by DSRC line-of-sight. On entry a Roadside Unit (RSU) identifies the OBU and initiates an automated check and verification of the driver, vehicle and motor carrier unique identifiers. The OBU pulls the unique identifier information from the mobile SRI application on the CMV driver's Smartphone via Bluetooth. The OBU then pushes the information to the RSU using DSRC. The information is then pushed to a server and uploaded to the SRI Prototype System where the unique identifiers are verified. The results are then pushed back to the CMV OBU via the RSU using DSRC and from the OBU to the mobile SRI application via Bluetooth. The CMV will then proceed to the weigh/inspection station and pass over a WIM scale. The CMV's weight will be captured and validated by the third party service provider via the Internet. The third party service provider will then notify the SRI Prototype System of the results of the validation (fail) and the SRI Prototype System will generate a "red light" message that will be provided to the OBU via DSRC and then to the CMV driver's Smartphone's mobile SRI application via Bluetooth. CMV exceeded WIM weight thresholds.

On receiving the message that the CMV exceeded WIM weight thresholds, the CMV does not proceed to the static scale as required and instead returns to the mainline. The WIM and static scale weight check results will be provided to law enforcement personnel via the SRI Prototype System via the SRI UI who will then determine if the CMV should be pulled over for additional enforcement action. Elements of SRI Prototype System that will be tested include:

- *Exchange and verification of unique identifiers for the motor carrier and vehicle;*
- *Testing of Internet and cellular communications;*
- *Testing of DSRC;*
- *Data exchange between the CMV driver, law enforcement personnel and third-party service providers using the SRI Prototype System;*
- *Verification that all data is captured and accurately displayed on the SRI User Interface (UI);*
- *Verification that the vehicle is operating within legal weight limits.*

Scenario 7: SRI UI Access using a mobile device

A law enforcement officer off-site from a weigh/inspection station accesses the Internet using a Smartphone. The officer will enter the SRI URL into his Web browser to access a UI designed specifically for a Smartphone. On accessing the UI the officer will then receive real-time information on CMV weight check status results generated by the SRI Prototype System. The officer will then be able to identify non-compliant CMVs and determine if further enforcement action is required.

Elements of SRI Prototype System that will be tested include:

- *Testing of Internet and cellular communications;*
- *Data exchange between the CMV driver, law enforcement personnel and third-party service providers using the SRI Prototype System;*
- *Verification that all data is captured and accurately displayed on the SRI User Interface (UI);*
- *Verification that the vehicle is operating within legal weight limits.*

Scenario 8: Data Exchange between ASPEN and iyeCitation

A CMV directed to a weight check on static scale is found to be in violation of weight limits, either per-axle or GVW. Enforcement personnel prepare a report on the violation using ASPEN and save the report to an ASPEN local data base. Enforcement personnel then determine that the CMV driver will be issued a citation for operating in excess of weight limits

Enforcement personnel will then access the SRI UI and select the ASPEN look-up feature on the UI. The user will then enter the ASPEN report number to identify the correct record in the local database. If the report number is not available, the ASPEN look-up default the latest report from the local database. The ASPEN report will be pulled from the local database and sent to directly to iyeCitation.

All information will be exchanged using a .net ODBC to the ASPEN Firebird database. The user will validate that the correct information has been pushed from ASPEN to iyeCitation.

Elements of the SRI Prototype System that will be tested include:

- *Data exchange between law enforcement personnel and third-party service providers; and*
- *Use of the SRI User Interface (UI) to initiate data exchange.*

Scenario 9: Real-Time Truck Parking Information System

Prior to departure the CMV driver downloads the SRI mobile application to a Smartphone and then enters the unique identifier information (CDL number, USDOT number, power unit license plate number, and Vehicle Identification Number (VIN)). Once downloaded and accessed the application will automatically display any open truck parking spots open in the upcoming truck stop locations en route for the driver. If the CMV driver decides he wants to select a truck spot he must first pull over and stop the truck whereas the app will not allow for touch screen selection while the truck is in motion. Once the driver has stopped they can then select the specific truck stop location by touching the truck stop name/icon on their smartphone. Once the truck facility has been selected the driver will need to login to a separate application for Truck Smart Parking to specifically reserve a parking spot.

The SRI Mobile application pulls GPS coordinates from the Smartphone and generates a Webservice request that includes the geo-coding data (latitude, longitude, and bearing). The request is sent to a third party service provider's Webservice and a response indicating truck parking facility location and available spaces is generated and sent to the SRI mobile application. The mobile application then calculates the estimated distance to each identified facility and displays this information along with location and available spaces.

Elements of the SRI Prototype System that will be tested include:

- *Testing of Webservice communications;*

- *Data exchange between CMV drivers and third-party service providers using the SRI mobile application;*
- *Verification that all data is captured and accurately displayed on the SRI mobile application;*
- *Verification that the mobile application is correctly calculating estimated travel distances.*

Chapter 3. System Requirements

This section provides the system-level capabilities, conditions, and constraints for SRI. To the extent possible, the Research Team has sought to include the region-specific items for the Michigan test site. However, these items may require addition and/or revision should a second demonstration site be selected.

A naming convention has been established for requirements listed in this section and section 4 (Interfaces) as follows:

<letter><primary identifier><secondary identifier>

- Letter represents the classification of each requirement:
  - e = system
  - a = application
  - p = performance
  - s = security
  - i = interface
- Primary identifier represents the highest level, or parent, identification number within the requirement classification
- Secondary identifier represents the detail, or child, identification number within the requirement class. Child requirements further refine their parent requirements

Within the sub-sections, the requirements are summarized in tables according to the classification. In the tables, child requirements appear indented and italicized to distinguish them from their parent requirements.

Physical Requirements

The physical components of the SRI system will include existing systems accessed through networks and standard interfaces, user's systems such as weigh-in-motion as well as smart phones, laptop and desktop computers, and SRI servers – system servers are likely to include some that are dedicated for the existing weigh stations and others that may be hosted by the connected vehicle test bed for the RSUs associated with those locations. The Research Team expects that the smart phones, laptops, and desktops will serve as the primary delivery mechanism for the user interface to access SRI-enabled functions. The physical components of existing systems *are not* covered by this SyRS document.

It is likely that the primary physical components will be the RSUs and servers that will host the basic SRI capabilities as well as the OBUs, EOBRs, and, potentially, smart phones on the CMVs. To the extent possible, we have tried to provide specific details related to the RSUs and existing servers.

It is expected that the interfaces to the solutions and existing systems in place at the Michigan and Maryland weigh stations should be defined as standard web services to maximize the flexibility in implementing and accessing them. Section 4 details these interfaces specifically.

Physical aspects of the SRI system are described below.

Construction

The Research Team seeks to deploy the SRI system in an environment where no physical construction will be required for installation as the processes for completing these activities will likely be detrimental to the demonstration schedule and could result in delays.

Durability

Both SRI prototype software and hardware shall identify an upgrade path so future enhancements can be made to reflect future requirements and to protect the system against deterioration over time. In addition, hardware concerns should be carefully documented and continually revisited to ensure that the services and applications within the SRI system can operate both on current hardware and on new hardware as it becomes available and appropriate to do so. In the short-term, the SRI system design must be capable with integrating with existing public and private components. In the long-term, the SRI system should also apply common interface definition and other standards to ensure it will endure as current systems evolve.

Adaptability

The Research Team plans to develop the SRI system using an open architecture, with standard defined interfaces and well-defined implementation tools. The SRI system must be structured to allow future applications and information requirements to be easily integrated without requiring substantial changes to the system backbone, including hardware, software and data storage. This will include a prototype that contains:

- Open source components
- Standard defined interfaces
- Common interface definition

As introduced in section 3.2.2, these elements will be crucial in facilitating the integration of future applications and information requirements in a manner that minimizes changes to SRI system hardware and software. It will also facilitate the system's scalability to other locations, simplifying the installation and set-up for future SRI system users.

Environmental Conditions

The SRI system will be deployed within an existing environment of weigh stations and connected vehicle RSUs. As such, the physical components of these locations have already been installed and withstand the environmental conditions as required by their designs. The new components of SRI will include the software and associated components to integrate existing hardware and software at each test location. The Research Team must ensure that both the existing and new prototype components are sufficient to support the maintainability and reliability that will be prescribed in the future system design regarding:

- Power supply
- Cooling and venting
- Precipitation protection
- Spectral noise interference

These items will be documented for the existing WIM equipment present at the weigh stations. The Environmental Requirements discussed in this document include:

- Operating voltage
- Operating frequency
- Electrical emissions
- Temperature and humidity
- Rain
- Salt fog protection
- Shock and vibration
- Electrostatic discharge

The Research Team expects that most equipment installed at the weigh stations will be software-related and therefore not subject to seasonal environmental impacts. The team expects this to be the case at additional locations, should one or more be selected for demonstration. Should environmental impact to SRI system components be identified during the architecture or design phase, these will be documented and addressed at that time.

Functional Requirements

System Requirements

Table 7. System-Level Requirements

e.001	SRI shall be designed to operate in conjunction with and not interfere with existing systems.
e.002	SRI shall monitor roadside equipment.
e.003	SRI shall monitor external system availability.
e.004	SRI shall provide continuous system health availability information.[7]
e.005	The SRI Prototype System shall be deployed and tested at a fixed facility on the Interstate System.
e.006	The SRI Prototype System shall be deployed and tested in a mobile environment on selected secondary routes.
e.007	The SRI prototype shall use the USDOT number as the unique identifier for the carrier.
e.008	The SRI prototype shall use the VIN number as the unique identifier for the CMV.
e.009	The SRI prototype shall use the CDL number as the unique identifier for the CMV driver.
e.009.1	*The SRI prototype shall use the drivers' license number or appropriate identifier for drivers operating CMVs that do not require a CDL.*
e.010	The SRI prototype shall verify that all information originates from an authoritative source.
e.011	Both interstate and intrastate vehicles/carriers shall be able to use the SRI prototype.
e.012	SRI shall collect, store, ~~maintain~~ and provide real-time on-line interactive access to historical vehicle, driver and carrier safety data at the weigh station. [8]
e.013	SRI shall provide capability to securely log the passing of each vehicle, the information passed to the roadside system, and the information passed back to the vehicle from the roadside system.
e.014	SRI shall provide an interface to all commercial drivers that is compliant with existing safety regulations.

Relationship to Existing Systems

Requirement **e.001** indicates a parallel implementation of the SRI system with existing systems. This requirement implies that the Research Team intends to avoid modifications to existing systems as part of the SRI system demonstration.

Reliability

The system monitoring described in requirement **e.003** may require sub-systems that lie outside of the core SRI system architecture and operate independently to complete these functions.

Network Connectivity

Requirement **e.012** specifies "real-time" data collection and access. For the SRI system to be effective, data related to screening actions should be current to the extent that it is feasible with respect to frequency of updates to/from the source system and within the

[7] SRI prototype will provide continuous availability when the weigh station is open and internet connectivity is available.
[8] This data will be stored for 23 hours and 59 minutes and discarded after that for security reasons.

financial constraints of the prototype demonstration. That is, network connectivity at the demonstration sites must provide sufficient bandwidth and reliability to deliver the "real-time" information required.

Similarly, some roadside facilities may have little or no access to on-line connections, or the connection latency may impede "real-time" access.

The SRI system design will specifically define "real-time" and/or "near real-time" in a quantitative manner to support an engineering level design for the specific demonstration locations.

Policy and Jurisdictional Impacts

Requirements **e.009** and **e.010** relate to draft operational policies contained in the Final SRI ConOps and imply the key system impact that will integrate disparate systems. However, it should be noted that while this is a critical goal of SRI, the credentials needed to access systems and verify source authenticity may not be available across some jurisdictional boundaries. Likewise, the available connectivity or authorizations across jurisdictional boundaries may impede access amongst interstate systems where updated information may reside. This touches on policy issues and interstate jurisdictional matters that SRI may have no control over.

At this point, we have verified the authoritative source for driver, carrier and vehicle credentials that *should be* accessed to gain the required information. The piece of information is listed, along with the source (in parentheses).

- Driver credentials:
  - License status (CDLIS)
  - Driver qualification/medical card (CDLIS)
  - Driver-related violation history (MCMIS)
  - CSA basic score (MCMIS)
  - Past inspection information (SAFER)
- Carrier credentials:
  - IFTA
  - UCR (SAFER)
  - Insurance (L&I)
  - Operating Authority (L&I)
  - Out-of-service orders (MCMIS)
  - USDOT number (MCMIS)
  - Carrier-related violation history (MCMIS)
  - ISS score/CSA basic (MCMIS)
  - Past inspection information (SAFER)
- Vehicle credentials:
  - Registration (State DMV/CVIEW)
  - USDOT Number (MCMIS)

- Prism (SAFER)
- IFTA
- CSA basic (MCMIS)
- Past inspection information (SAFER)

Application Requirements

Table 8. Application Requirements

a.001	SRI shall be consistent with the ITS National Architecture and associated standards such as the CVISN National Architecture.
a.002	SRI shall provide an interface and processing modules for truck parking applications.
a.002.1	*SRI shall provide information about the availability of truck parking spaces.*
a.002.2	*SRI shall provide current parking availability information at a specific facility.*
a.002.3	*SRI shall provide predicted future parking availability information at a specific facility.*
a.002.4	*SRI shall provide 24x7 access to truck parking information.*[9]
a.002.5	*SRI shall provide a graphical interface to stationary (i.e., dispatcher/operator/driver/traffic analyst/other) users.*
a.002.6	*SRI shall provide a user interfaces to non-stationary drivers when integrated in-vehicle display systems exist.*
a.002.7	*SRI shall allow a stationary user to submit requests for automated truck parking information.*
a.002.8	*SRI shall allow a user to receive the results of an automated request for truck parking information.*
a.003	SRI shall provide an interface and processing modules for enforcement screening applications.
a.003.1	*SRI shall provide the ability for roadside systems to integrate roadside systems data and make it available to Roadside System SRI user applications.*
a.004	SRI shall provide a processing capability that automates the roadside inspection tasks.
a.004.1	*The SRI system shall determine if a CMV complies with jurisdictional licensing requirements.*
a.004.2	*The SRI system shall determine if a driver complies with jurisdictional licensing requirements.*
a.004.3	*The SRI system shall determine if a driver complies with HOS requirements.*
a.004.4	*The SRI system shall determine if a CMV complies with jurisdictional size requirements.*
a.004.5	*The SRI system shall determine if a CMV complies with designated safety requirements.*
a.004.6	*The SRI system shall determine if a CMV complies with weight requirements.*
a.004.7	*The SRI system shall determine if a CMV has a legally issued permit to exceed the legal limits for size and/or weight at the current location of the CMV.*
a.004.8	*SRI shall provide the data necessary to document inspection events and outcomes.*
a.004.9	*SRI shall formulate alarms for user notification via the user interface(s).*
a.004.10	*SRI shall automatically identify to the enforcement personnel approaching vehicles that have been flagged as potentially needing maintenance or to be put out of service due to violation of designated vehicle, driver and/or carrier safety regulations.*
a.004.11	*The SRI prototype shall obtain vehicle-based maintenance data from the vehicle CAN BUS where available.*
a.004.12	*SRI shall provide vehicle-based maintenance data obtained from the vehicle to the carrier.*
a.004.13	*SRI shall provide driver-based safety information obtained from the vehicle to the carrier.*
a.005	SRI shall provide an interface for Tier 1 users.

[9] Dependent on availability of external truck parking application.

a.005.1	*SRI shall provide an interface for CMV Enforcement Officers and supervisors to enter data.*
a.005.2	*SRI shall provide an interface for CMV Enforcement Officers and supervisors to execute processes.*
a.005.3	*SRI shall provide an interface for CMV Enforcement Officers and supervisors to receive information and alerts.*
a.005.4	*SRI shall provide an interface for CMV drivers to receive information and alerts.*
a.005.5	*SRI shall provide an interface for motor carriers to view information and receive alerts.*
a.006	SRI shall conduct the analytical and data fusion functions necessary to evaluate CMV, carrier, and driver compliance.
a.007	SRI shall comply with nationwide interoperability standards currently used for the USDOT V2X Program.
a.007.1	*SRI shall comply with SAE STD J2735.*
a.007.2	*SRI shall comply with the relevant sections of IEEE 1609 (including Architecture, Resource Manager, Security Services, Networking Services, Multi-Channel Operations, over-the-air data exchange protocol for ITS) and the version updates available at the time of design.*
a.007.3	*SRI shall comply with SAE J1929.*
a.007.4	*SRI shall comply with IEEE Standard 802.11p.*
a.008	SRI shall provide vehicle system information that is used by SRI to users.
a.008.1	*SRI shall provide designated vehicle system information to the driver through the driver application.*
a.008.2	*SRI shall provide applicable vehicle system information to the carrier through the carrier application.*

Flexibility

While the Research Team sought specificity in documenting the SRI system requirements, in the instance of defining the flexibility of the system to integrate future information sources, applications, and equipment, it was sometimes difficult to achieve. The SRI system architecture and design will specify all equipment to be used, at which point some requirements will be further clarified with examples, or, if necessary, new child requirements. Likewise, the Research Team predicts changes within the USDOT policy making process to impact future demonstrations of the prototype; again, these are impossible for the Research Team to predict and document with the SyRS. A summary of requirements that may be further defined include:

- Sub-requirement **a.002.6**: MAP-21 provides HOS exemptions in some cases, for example, for drivers transporting agricultural commodities. The SRI system, to the extent known, will accommodate such exceptions and future possible exemptions with each new policy-making cycle.
- Requirement **a.003**: To the extent that hand-held devices such as RFID and barcode readers support this activity, the SRI design will support them through this requirement/interface. This includes SAE J1939 hand-held analyzers that can either plug into the vehicle CAN bus, or communicate with it via a cordless (e.g. Bluetooth) interface; several smart phone apps already support this.
- Sub-requirement **a.004.10**: The identification of the automatic identification technology selected will determine its reliability. The Research Team also recognizes

that regardless of the technology reliability, equipment may malfunction or fail to operate as specified for external reasons. For example, some USDOT numbers and license plates may be optically occluded by damage, fading, dirt, etc.; similarly, some transponders may be defective or on low battery.

- Requirement **a.006**: this requirement will need additional information to define *what* data elements the algorithm applies to and what or how much SRI will implement. The Research Team expects this to occur as we work with administrators of the weigh stations in Michigan and the Connected Vehicle Test Bed[10] to flush out specific communications and storage parameters.
- Requirement **a.007** and its sub-requirements: The Research Team recognizes the battery of standards relevant to connected vehicles.[11] The SRI system architecture and design process will review these standards and identify and document those specifically applicable to the prototype.
- The capability described in requirement **a.008** must also buffer data for transmission due to the unreliable nature of wireless interfaces, particularly during hand-off/roaming between base stations or access points. The application must track the extent of data transmission completed successfully and remaining data to be transmitted when connection is re-established. Again, the Research Team will clarify and add these sub-requirements during the design phase.

Data Requirements

This purpose of this section is to identify the data and formats for each of the system-to-system interfaces within SRI *at full deployment*. The most complete item at this stage in the system requirements is the data registry, which provides detail regarding the exchanges to and from the key components of the SRI system: the UID, ES/VWS, WRI, and truck parking.

System Data Registry

It is necessary to examine each data and information exchanges more closely in order to fully grasp how an SRI system would function. This section dissects these exchanges and offers additional detail. It is important to note that this information stops short of specifying individual data elements, since such data elements might imply the use of a specific technology or device which is premature in the requirements stage. The information is presented in tabular form in Tables 9 through 12, with references to which functional capability or capabilities use the various exchanges. It is recognized that individual requests and responses, though similarly named, might undergo some transformation of format and the content might evolve as it passes from one element to the next, which is reflected in the tables. Though the information is presented in rough chronological order, it is not arranged in direct sequential order.

Table 9 contains the data registry for the UID functional depiction.

[10] The connected vehicle test bed is currently undergoing an operational upgrade (August 2012).

Table 9. Universal Electronic Identification Functional Data Registry

Exchange Name	Source	Destination	Description
Interrogation Request	Roadside User	Roadside User Interface	• Username • Password • Interrogation trigger request NOTE: The SRI system as depicted here offers the roadside user the ability either to establish a standing request to conduct interrogations according to pre-defined criteria or to conduct individual, ad-hoc interrogations (i.e., a mobile application).
Interrogation Request	Roadside User Interface	Roadside User Application	• Roadside communications interface activation request • Event ID assignment NOTE: It is presumed that the principal authoritative vehicle (truck and trailer) ID number will be its VIN or a State registration number, and the driver ID will be his/her CDL. In this instance, the interrogator is instructed by the user interface application to look within its read range for a device containing an alphanumeric string (the UID), which may be the specific vehicle VIN/registration number and/or CDL, or some other character string that is related to a VIN/registration number and/or CDL in a separate database. The user interface application would also assign an event ID string containing date, time, location, and a sequential number that incorporates information about the requesting party. Alternatively, this SRI system can also accommodate the use of a more traditional vehicle ID mechanism, such as a license plate read by an automated license plate recognition (ALPR) system.
Interrogation Request	Roadside User Application	Roadside Communications Interface	• Vehicle system UID poll request • Event ID NOTE: Using the same event ID string applied above, the user application would forward a request to the roadside communications interface to poll detected vehicle systems for information related to the UID.
Interrogation Request	Roadside Communications Interface	Vehicle Communications Interface	• UID request • Event ID NOTE: The roadside communications interface executes a scan within the prescribed geographic area for a vehicle communications interface device with the proper communications and security protocols, and having executed a handshake, relays the request for the properly formatted UID string.

[11] http://www.standards.its.dot.gov/fact_sheet.asp?f=71

Exchange Name	Source	Destination	Description
Interrogation Request	Vehicle Communications Interface	Vehicle User Application	• UID request • Event ID NOTE: The vehicle communications interface relays the request for the properly formatted UID string to the vehicle user application.
Interrogation Request	Vehicle User Application	Vehicle Data Buffer	• UID request • Event ID NOTE: The vehicle user application is the gateway application to all of the various existing and potential future on-vehicle systems. As such, it relies on an open source/open standard interface. Here, it would simply distribute the request to the vehicle data buffer.
ID Data	Vehicle Data Systems	Vehicle Data Buffer	The various systems on the vehicle would periodically report data for storage in the vehicle data buffer, including: • Truck VIN or other registration character string • Trailer VIN or other registration character string • Driver CDL • USDOT Number NOTE: The source of this information is yet to be determined.
Interrogation Response	Vehicle Data Buffer	Vehicle User Application	• UID string • Event ID
Interrogation Response	Vehicle User Application	Vehicle Communications Interface	• UID string • Event ID
Interrogation Response	Vehicle Communications Interface	Roadside Communications Interface	• UID string • Event ID
Interrogation Response	Roadside Communications Interface	Roadside User Application	• UID string • Event ID
Interrogation Response	Roadside User Application	Roadside Data Buffer	• UID string • Event ID
Interrogation Request	Roadside Communications Interface	Wide Area Communications Interface	• UID string • VIN/CDL information request • Event ID NOTE: Using the same event ID string applied above and the UID received from the vehicle, the user application would forward a request to the roadside communications interface to poll connected agency registration systems for information related to the UID (which will presumably include information as to the State system where registration data resides) that will be provided back from the vehicle.

Exchange Name	Source	Destination	Description
Interrogation Request	Wide Area Communications Interface	Agency System Portal	• UID string • VIN/CDL information request • Event ID NOTE: Having received the request for an agency response, the wide area communications interface passes the request on to the agency system portal.
Interrogation Request	Agency System Portal	Agency System Application	• UID string • VIN/CDL information request • Event ID NOTE: The agency portal evaluates the request and routes it to the appropriate system application for UID activity.
Interrogation Request	Agency System Application	Agency Database	• UID string • VIN/CDL information request • Event ID NOTE: The agency system application receives the request, assesses the appropriate action, and seeks out information from the requisite database(s).
ID Response	Agency Database	Agency System Application	• Vehicle and driver information • Event ID NOTE: The vehicle and driver information returned could include an expanded data set containing items of interest, perhaps including a history of UIDs for each component (truck, trailer, driver), since each combination of equipment and driver would constitute a unique UID. This would allow for enhanced screening and inspection selectivity by giving the roadside user the option of setting different thresholds based upon whether the vehicle, driver, and carrier have been recently inspected together.
ID Response	Agency System Application	Agency Portal	• Vehicle and driver information • Event ID • UID string NOTE: The roadside user is presented with the combined information set incorporating the elements initially requested at the start of the process.
ID Response	Agency Portal	Wide Area Communications Interface	
ID Response	Wide Area Communications Interface	Roadside Communications Interface	
ID Response	Roadside Communications Interface	Roadside User Application	
ID Response	Roadside User Application	Roadside Data Buffer	
ID Response	Roadside User Application	Roadside User Interface	

Exchange Name	Source	Destination	Description
Event Notification	Roadside User Application	Roadside Communications Interface	• Event ID • UID string • Notification of Result The notification of result would include an information exchange history, including any decisions made or actions taken during the process.
Event Notification	Roadside Communications Interface	Vehicle Communications Interface	
Event Notification	Vehicle Communications Interface	Vehicle User Application	
Event Notification	Vehicle User Application	Vehicle User Interface	
Event Notification	Vehicle User Interface	Vehicle User	
Event Notification	Roadside Communications Interface	Wide Area Communications Interface	
Event Notification	Wide Area Communications Interface	Agency System Portal	
Event Notification	Agency System Portal	Agency System Application	
Event Notification	Agency System Application	Agency Database	
Event Notification	Wide Area Communications Interface	Carrier Portal	
Event Notification	Agency System Portal	Carrier System Application	
Event Notification	Agency System Application	Carrier Database	

*This process presumes that the vehicle and driver information is requested from the agency system after a UID has been retrieved from the vehicle. Alternately, this information may be retrieved periodically and stored in the roadside data buffer.

Table 10 contains the data registry for the ES/VWS function. As with the graphic depictions in the previous section, it is understood that the universal truck ID process would be conducted concurrently, and that the request to initiate it would likely be incorporated into the vehicle screening request that represents the start of the ES/VWS process. That process is omitted from this data registry table for simplicity of presentation.

Table 10. Electronic Screening/Virtual Weight Station Data Registry Table

Exchange Name	Source	Destination	Description
Screening Request	Roadside User	Roadside User Interface	• Username • Password • Event ID* • UID* • Vehicle weight request (from in-road sensors) • Vehicle measurement request (from roadside sensors) • Vehicle screening preferences NOTE: Screening preferences may include roadside user request for screening only a certain class or type of vehicle, or for examination of a subset of screening items. The SRI system as depicted here offers the roadside user the ability either to establish a standing request to conduct screening according to pre-defined criteria, or conduct individual, ad-hoc screening events (i.e., a mobile application).
Screening Request	Roadside User Interface	Roadside User Application	• Event ID* • UID* • Vehicle screening information requirements NOTE: The information requirements would likely include pre-determined parameters that are a function of the screening preferences defined by the roadside user.
Screening Request	Roadside User Application	Roadside Communications Interface	• Event ID* • UID* • Vehicle screening information requirements NOTE: Using the same event ID string applied above, the user application would forward a request to the roadside communications interface to poll detected vehicle systems for information related to the screening event.
Screening Request	Roadside Communications Interface	Vehicle Communications Interface	• UID • Event ID • Vehicle screening information requirements NOTE: The roadside communications interface executes a scan within the prescribed geographic area for a vehicle communications interface device reporting the appropriate UID string received from the UID process.
Screening Request	Vehicle Communications Interface	Vehicle User Application	• UID • Event ID • Vehicle screening information requirements NOTE: The vehicle communications interface relays the request for the properly formatted screening information to the vehicle user application.
Screening Request	Vehicle User Application	Vehicle Data Buffer	• UID • Event ID • Vehicle screening information requirements NOTE: The vehicle user application is the gateway application to all of the various data and information related to screening which would be stored on the vehicle.

Exchange Name	Source	Destination	Description
ID Data	Vehicle Data Systems	Vehicle Data Buffer	The various systems on the vehicle would periodically report data for storage in the vehicle data buffer, including: • Sensor Data • Permit Data • HOS Data NOTE: The source of this information and the means by which it is transferred to the vehicle data buffer is yet to be determined.
Screening Response	Vehicle Data Buffer	Vehicle User Application	• UID • Event ID • Vehicle screening data/information NOTE: The screening data/information would include the sensor, permit and HOS data, and any other data that the carrier has agreed to provide for screening, and the roadside system is prepared to receive and process.
Screening Response	Vehicle User Application	Vehicle Communications Interface	• UID • Event ID • Vehicle screening data/information
Screening Response	Vehicle Communications Interface	Roadside Communications Interface	
Screening Response	Roadside Communications Interface	Roadside User Application	
Screening Response	Roadside User Application	Roadside Data Buffer	
Screening Request	Roadside User Application	Roadside Communications Interface	• Event ID • UID • Vehicle screening information requirements NOTE: Using the same event ID string applied above, the user application would forward a request to the roadside communications interface to query appropriate back-office agency or 3rd party systems for the execution of screening algorithms.**
Screening Request	Roadside Communications Interface	Wide Area Communications Interface	• UID • Event ID • Vehicle screening information requirements
Screening Request	Wide Area Communications Interface	Agency System Portal	
Screening Request	Agency System Portal	Agency System Application	
Screening Request	Agency System Application	Agency Database	• UID • Event ID • Vehicle screening information requirements NOTE: The agency system application receives the request, assesses the appropriate action, and seeks out information from the requisite database(s) to complete the screening.

Exchange Name	Source	Destination	Description
Screening Response	Agency Database	Agency System Application	• UID • Event ID • Vehicle screening results NOTE: The screening algorithm would produce a result in accordance with the parameters specified by the roadside user and the prevailing policies within the agency conducting the screening, and would store the results in the database in addition to passing them back.
Screening Response	Agency System Application	Agency Portal	• UID • Event ID • Vehicle screening results
Screening Response	Agency Portal	Wide Area Communications Interface	
Screening Response	Wide Area Communications Interface	Roadside Communications Interface	
Screening Response	Roadside Communications Interface	Roadside User Application	
Screening Response	Roadside User Application	Roadside Data Buffer	• UID • Event ID • Vehicle screening results NOTE: Copies of all screening actions and results would be retained in the roadside data buffer for a period deemed appropriate by the roadside user based upon historical knowledge of the screening frequency for each UID. This could eliminate many of the preceding steps, reducing the overall communications traffic load and improving responsiveness.
Screening Response	Roadside User Application	Roadside User Interface	• UID • Event ID • Vehicle screening results • Recommended actions NOTE: The roadside user is presented with the combined information set incorporating the elements initially requested at the start of the process, plus a set of recommended actions based on standing agency policy.
Event Notification	Roadside User Application	Roadside Communications Interface	• UID • Event ID • Vehicle screening results • Directed actions NOTE: The roadside user would define and forward actions to the vehicle, which could be the default response or some modified response based upon the judgment of the roadside user. These directed actions could, for example include instructions to pull in to the next available authorized weigh station.
Event Notification	Roadside Communications Interface	Vehicle Communications Interface	• UID • Event ID • Vehicle screening results • Directed actions
Event Notification	Vehicle Communications Interface	Vehicle User Application	

Exchange Name	Source	Destination	Description
Event Notification	Vehicle User Application	Vehicle User Interface	
Event Notification	Vehicle User Interface	Vehicle User***	• Directed actions NOTE: It is presumed that the method of notification and the content delivered would vary based upon the type of user interface in the vehicle, and that safety concerns would preclude the presentation of comprehensive information if the vehicle is moving. The notification would be tailored to ensure that the information content and delivery format do not present a level of driver distraction that would create a safety hazard.
Event Notification	Roadside Communications Interface	Wide Area Communications Interface	• UID • Event ID • Vehicle screening results • Directed actions NOTE: The notification of result would include an information exchange history, including any decisions made or actions taken during the process. This would be retained as long as necessary to verify that results have been received by authorized recipients.
Event Notification	Wide Area Communications Interface	Agency System Portal	
Event Notification	Agency System Portal	Agency System Application	
Event Notification	Agency System Application	Agency Database	
Event Notification	Wide Area Communications Interface	Carrier Portal	
Event Notification	Agency System Portal	Carrier System Application	
Event Notification	Agency System Application	Carrier Database	

*From the universal truck ID process.
**For this example, a State agency is conducting the screening function. It could be provided by a 3rd party, as well.
***In this example, it is presumed that the carrier would be able to access or receive from the appropriate agency screening entities a record of all screening activities conducted over a prescribed period. Alternately, the SRI system could be defined to incorporate a direct notification function, which is described in the data registry for WRI provided below.

Table 12 contains the data registry for the WRI function. As with the graphic depictions in the previous section, it is understood that the universal truck ID process would be conducted concurrently and that the request to initiate it would likely be incorporated into the vehicle/driver inspection request that represents the start of the WRI process. That process is omitted from this data registry table for simplicity of presentation.

Table 11. Wireless Roadside Inspection Data Registry Table

Exchange Name	Source	Destination	Description
Inspection Request	Roadside User	Roadside User Interface	• Username • Password • Event ID* • UID* • Vehicle weight request (from in-road sensors) • Vehicle measurement request (from roadside sensors) • Vehicle Inspection preferences NOTE: Inspection preferences may include roadside user request for Inspection only a certain class or type of vehicle, or for examination of a subset of Inspection items.
Inspection Request	Roadside User Interface	Roadside User Application	• Event ID* • UID* • Vehicle Inspection information requirements NOTE: The information requirements would likely include pre-determined parameters that are a function of the Inspection preferences defined by the roadside user.
Inspection Request	Roadside User Application	Roadside Communications Interface	• Event ID* • UID* • Vehicle Inspection information requirements NOTE: Using the same event ID string applied above, the user application would forward a request to the roadside communications interface to poll detected vehicle systems for information related to the Inspection event.
Inspection Request	Roadside Communications Interface	Vehicle Communications Interface	• UID • Event ID • Vehicle Inspection information requirements NOTE: The roadside communications interface executes a scan within the prescribed geographic area for a vehicle communications interface device reporting the appropriate UID string received from the UID process.
Inspection Request	Vehicle Communications Interface	Vehicle User Application	• UID • Event ID • Vehicle Inspection information requirements NOTE: The vehicle communications interface relays the request for the properly formatted Inspection information to the vehicle user application.
Inspection Request	Vehicle User Application	Vehicle Data Buffer	• UID • Event ID • Vehicle Inspection information requirements NOTE: The vehicle user application is the gateway application to all of the various data and information related to Inspection which would be stored on the vehicle.
ID Data	Vehicle Data Systems	Vehicle Data Buffer	The various systems on the vehicle would periodically report data for storage in the vehicle data buffer, including: • Sensor Data • Permit Data • HOS Data NOTE: The source of this information and the means by which it is transferred to the vehicle data buffer is yet to be determined.

Exchange Name	Source	Destination	Description
Inspection Response	Vehicle Data Buffer	Vehicle User Application	• UID • Event ID • Vehicle Inspection data/information NOTE: The Inspection data/information would include the sensor, permit and HOS data, and any other data that the carrier has agreed to provide for Inspection, and the roadside system is prepared to receive and process.
Inspection Response	Vehicle User Application	Vehicle Communications Interface	• UID • Event ID • Vehicle Inspection data/information
Inspection Response	Vehicle Communications Interface	Roadside Communications Interface	
Inspection Response	Roadside Communications Interface	Roadside User Application	
Inspection Response	Roadside User Application	Roadside Data Buffer	
Inspection Request	Roadside User Application	Roadside Communications Interface	• Event ID • UID • Vehicle Inspection information requirements NOTE: Using the same event ID string applied above, the user application would forward a request to the roadside communications interface to pass the request to appropriate back-office agency systems for the execution of Inspection algorithms.
Inspection Request	Roadside Communications Interface	Wide Area Communications Interface	• UID • Event ID • Vehicle Inspection information requirements
Inspection Request	Wide Area Communications Interface	Agency System Portal	
Inspection Request	Agency System Portal	Agency System Application	
Inspection Request	Agency System Application	Agency Database	• UID • Event ID • Vehicle Inspection information requirements NOTE: The agency system application receives the request, assesses the appropriate action, and seeks out information from the requisite database(s) to complete the Inspection.
Inspection Response	Agency Database	Agency System Application	• UID • Event ID • Vehicle Inspection results NOTE: The Inspection algorithm would produce a result in accordance with the parameters specified by the roadside user and the prevailing policies within the agency conducting the Inspection, and would store the results in the database in addition to passing them back.
Inspection Response	Agency System Application	Agency Portal	• UID • Event ID • Vehicle Inspection results
Inspection Response	Agency Portal	Wide Area Communications Interface	

Exchange Name	Source	Destination	Description
Inspection Response	Wide Area Communications Interface	Roadside Communications Interface	
Inspection Response	Roadside Communications Interface	Roadside User Application	
Inspection Response	Roadside User Application	Roadside Data Buffer	• UID • Event ID • Vehicle Inspection results NOTE: Copies of all Inspection actions and results would be retained in the roadside data buffer for a period deemed appropriate by the roadside user based upon historical knowledge of the Inspection frequency for each UID. This could eliminate many of the preceding steps, reducing the overall communications traffic load and improving responsiveness.
Inspection Response	Roadside User Application	Roadside User Interface	• UID • Event ID • Vehicle Inspection results • Recommended actions NOTE: The roadside user is presented with the combined information set incorporating the elements initially requested at the start of the process, plus a set of recommended actions based on standing agency policy.
Event Notification	Roadside User Application	Roadside Communications Interface	• UID • Event ID • Vehicle Inspection results • Directed actions NOTE: The roadside user would define and forward actions to the vehicle, which could be the default response or some modified response based upon the judgment of the roadside user. These directed actions could, for example include instructions to pull in to the next available authorized weigh station.
Event Notification	Roadside Communications Interface	Vehicle Communications Interface	• UID • Event ID • Vehicle Inspection results • Directed actions
Event Notification	Vehicle Communications Interface	Vehicle User Application	
Event Notification	Vehicle User Application	Vehicle User Interface	
Event Notification	Vehicle User Interface	Vehicle User**	• Directed actions NOTE: It is presumed that the method of notification and the content delivered would vary based upon the type of user interface in the vehicle, and that safety concerns would preclude the presentation of comprehensive information if the vehicle is moving. The notification would be tailored to ensure that the information content and delivery format do not present a level of driver distraction that would create a safety hazard.
Event Notification	Roadside Communications Interface	Wide Area Communications Interface	• UID • Event ID • Vehicle Inspection results

Exchange Name	Source	Destination	Description
Event Notification	Wide Area Communications Interface	Agency System Portal	• Directed actions NOTE: The notification of result would include an information exchange history, including any decisions made or actions taken during the process. This would be retained as long as necessary to verify that results have been received by authorized recipients.
Event Notification	Agency System Portal	Agency System Application	
Event Notification	Agency System Application	Agency Database	
Event Notification	Wide Area Communications Interface	Carrier Portal	
Event Notification	Agency System Portal	Carrier System Application	
Event Notification	Agency System Application	Carrier Database	

*From the universal truck ID process.
**In this example, it is presumed that the carrier would be able to access or receive from the appropriate agency screening entities a record of all screening activities conducted over a prescribed period. Alternately, the SRI system could be defined to incorporate a direct notification function, which is described in the data registry for WRI provided below.

Table 13 contains the data registry for the Truck Parking function. For this process, it is assumed that the universal truck ID would be provided at the time the driver makes a request for parking information and that the request would trigger the generation of an event ID. It is possible that the universal truck ID application could be used to verify arrival of a truck with a reservation at a parking facility and to facilitate access control and payment systems, as well. This would require the implementation of functionality within an infrastructure systems hub that deploys those capabilities for the parking facility.

Table 12. Truck Parking Data Registry Table

Exchange Name	Source	Destination	Description
Parking Request	Vehicle User	Vehicle User Interface	• Username • Password • Parking needs • Parking preferences NOTE: Parking needs relate to driver-stipulated requirements such as space length, location, fuel availability, etc. Parking preferences relate to desirable features, such as other site amenities, fuel price, etc.
Parking Request	Vehicle User Interface	Vehicle User Application	• UID* • Event ID • Parking needs • Parking preferences
Parking Request	Vehicle User Application	Vehicle Communications Interface	
Parking Request	Vehicle Communications Interface	Wide Are Communications Interface	
Parking Request	Wide Are Communications Interface	System Portal**	
Parking Request	System Portal	System Application	
Parking Request	System Application	System Database	
Parking Response	System Application	System Portal	• Event ID • Parking space availability • Parking space location • Available amenities NOTE: It is presumed that the method of notification and the content delivered would vary based upon the type of user interface in the vehicle and that safety concerns would preclude the presentation of comprehensive information if the vehicle is moving.
Parking Response	System Portal	Wide Are Communications Interface	
Parking Response	Wide Are Communications Interface	Vehicle Communications Interface	
Parking Response	Vehicle Communications Interface	Vehicle User Application	
Parking Response	Vehicle User Application	Vehicle User Interface	
Parking Response	Vehicle User Interface	Vehicle User	

*From the universal truck ID process.
**It is recognized that truck parking services could be provided by an agency or a 3rd party provider. Both are depicted in the figure, but no distinction is provided in this table regarding which entity provides the service.

Data Exchange Requirements

The data that will be gathered in support of documenting data exchange requirements will include:

- Input and output capacity and limits for each SRI system component, for example:
  - Package size

  - Throughput rate
- Data exchange standards between SRI system components; for example:
  - Data interfaces
  - Minimum bandwidth
  - Exchange duration
  - Exchange speed
- Data element definition and storage requirements; for example:
  - Data elements to be exchanged with FMCSA systems
  - Data elements to be exchanged with carrier systems
  - Data elements to be exchanged with 3rd party systems
  - Data elements to be stored/not/stored
  - Data elements to be buffered for processing
- Data volatility: for example, for data to be buffered, how long will the data be stored before being discarded.

Performance Requirements

Table 13. Performance Requirements

p.001	SRI shall provide current information in a timely fashion, or as available from integrated data sources, to meet SRI prototype application requirements.
p.001.1	*SRI shall be able to exchange data with external systems within 2 seconds, 99% of the time.*
p.001.2	*SRI shall be able to exchange data with Roadside Equipment within 2 seconds, 99% of the time.*
p.001.3	*SRI shall be able to exchange data with CMV within 2 seconds, 99% of the time.*
p.001.4	*SRI data exchanges shall be time stamped with the GMT of when the exchange was completed.*
p.002	SRI shall provide the capability to establish two-way communications with each properly equipped vehicle approaching the weigh station.
p.002.1	*SRI shall maintain two-way communications with each properly equipped vehicle as it passes through the weigh station.*
p.002.2	*SRI shall maintain two-way communications with each properly equipped vehicle as it exits the weigh station.*
p.003	The SRI system shall be able to maintain an overall 99% in a 24- hour period system availability.
p.003.1	*The SRI Prototype will log each system outage with the date, GMT, length (in minutes), and cause of the outage.*
p.003.2	*The SRI Prototype will identify the user responsible for system outages that occur as a result of system breach or tampering.*
p.004	SRI shall be able to communicate "Pass/Need to stop" instructions to a driver in time for compliance with the instruction.
p.005	SRI shall be designed to accommodate multiple users with different user needs and requirements.
p.006	SRI shall provide sanitized data to external systems for public use.[12]
p.07	SRI shall provide an initial automated inspection capability that will expedite and supplement the existing visual and manual inspection processes.

[12] Sanitized data refers to data that has had proprietary or sensitive information removed.

p.007.1	*SRI shall make a decision as to whether to allow each vehicle to pass or require them to stop for a check.*
p.007.2	*SRI shall include a manual override function for the automatically generated decision for vehicles to pull in for safety inspection.*
p.007.3	*SRI shall issue Randomly generated pull-in for safety inspection signals.*
p.007.4	*SRI shall issue Manually generated pull-in for safety inspection signals.*
p.007.5	*SRI shall issue Automatically generated pull-in for safety inspection signals.*
p.007.6	*SRI shall perform checks on Vehicle/Carrier/Driver Safety Information when making the "Pass/Need To Stop" determination.*
p.007.7	*SRI shall perform checks on Vehicle Credentials when making the "Pass/Need To Stop" determination.*
p.007.8	*SRI shall perform checks on Driver and Carrier Credentials/Status when making the "Pass/Need To Stop" determination.*
p.007.9	*SRI shall perform checks on Vehicle Size and Weight Information when making the "Pass/Need To Stop" determination.*

System Latency and Reliability

The network reliability will be specific to each installation—each weigh station and RSU—of the SRI system. At the weigh stations, as stated earlier, network access varies and is not consistent. SRI system installation may include network upgrades to ensure consistency across all sites within the Michigan demonstration environment; however, this will be unknown until system design is completed.

That said, with respect to this topic, the Research Team recognizes that we will have to define/quantify the associated network latency and reliability required to completely articulate the performance requirements in **p.001** and its sub-requirements as well as **p.003** (to achieve the stated level of availability). Likewise, the requirements related to data request/response time (sub-requirements **p.007.3** through **p.007.9**) should also define the minimum latency/reliability of the transaction, particularly when accessing systems remote from the weigh station. Again, the network connection available at the weigh station will be evaluated to determine whether it can support the required latency/reliability/data-rate for a particular vehicle speed from the detection point and upgrades specified in system design as required.

Additional Definition

Certain requirements will be further defined during the system design process. In particular:

- **p.002**: this requirement was written assuming use of the connected vehicle truck built under a separate FHWA task order. This assumes the CMV will be able to participate in two-way communications. However, the Research Team recognizes that not all vehicles necessarily support "two-way" communications. Therefore, the system design will specifically define the vehicle components with which the SRI system will communicate; for example, the CAN bus, EOBR, OBU, smart phone, etc.

- With respect to parent requirement **p.007**, the Research Team will further define the specific functions included in an "initial automated inspection" within the SRI system design to provide specific detail regarding what actions and data exchanges constitute this activity.

System Security Requirements

Security will be extremely important in the SRI prototype system since it involves integrating data across public and private sector participants. Sanitizing the data such that any proprietary or private elements are removed will be paramount to the system's success. At this stage in the development, however, it is difficult to define specific requirements related to exact system protections and sub-requirements related to system interfaces and data exchange authentications. Items related to application and network security will be defined in detail during the development of the architecture and design. It is expected that the SRI system design will define minimum "protection" mechanisms to avoid ambiguity within the specific security requirements. For example, these might range from simple passwords to security badges and biometrics.

Table 14. Security Requirements

s.001	SRI shall protect personal data from unauthorized access.
s.002	SRI shall protect proprietary information from unauthorized access.
s.003	SRI shall protect proprietary systems from unauthorized access.
s.004	SRI shall provide read access and read/write access to authorized users.
s.005	SRI shall provide read access and read/write access to authenticated users.

While not included as a specific requirement, since the prototype may make use of connected vehicle applications and/or data feeds, it is important to note that any SRI applications that will run on DSRC must meet applicable Federal security technical implementation guidelines, per the National Institute of Standards and Technology (NIST). Applications security will still need to be defined for demonstrations not taking place within the Connected Vehicle Test Bed.

With regard to network security, the team recognizes that DSRC security in this area is still under development. We expect that, within the Connected Vehicle Test Bed environment, we will have access to the Security Credential Management System and therefore will use 1609.2 security certificates. These elements will protect the communications using DSRC, but will not protect end-to-end communications or any communications that do not require the connected vehicle platform (i.e., those at a test site other than the Test Bed). Thus, protections for additional communications will also need to be defined.

The RSU within the Connected Vehicle Test Bed (both fixed and mobile) are network devices running a thin client of Linux. The RSU will be configured and protected by the to-be-defined local security policy that will govern the overall prototype, including requirements pertaining to local firewalls, minimum password length, logging requirements, and intrusion detection and prevention.

Information Management

As with the data exchange requirements in section 3.3, the Research Team will further flush out specific requirements related to the data exchanges between the physical components of SRI. Many of these specific parameters are unknown at this time but will quickly become apparent as we continue the systems engineering process and identify and evaluate equipment options.[13] It is preliminary during the requirements stage to make these determinations, but as equipment solutions are identified, their operating parameters will be incorporated.

The Research Team will document the information management requirements for the physical components of the SRI system, including:

- EOBR:
  - Device operating system, such as iOS, Android, Etc.
  - Features/requirements for the SRI application for the CMV driver, including:
    - Device capacity
    - Data backup
    - Configuration and customization
    - Access log-in
- Existing and 3rd party RSU features:
  - Equipment capacity
  - Data backup
  - Configuration
  - Access log-in
- SRI server (to connect to RSUs)
  - Server capacity
  - Data backup
  - Configuration
  - Access log-in
- SRI user application (enforcement officer laptop/desktop):
  - Computer capacity
  - Data backup
  - Configuration
  - Access log-in

[13] As documented earlier in this document, the connected vehicle test bed is currently undergoing and upgrade. Therefore RSE operational features are unknown at this point.

Processing

This system is intended to identify potential information exchange and processing opportunities that will enable better decision making by enforcement personnel, carriers, drivers, and other authorized users. The development of the specific decision support applications will require substantial input from end users; however, this concept outlines what type of processing might take place at various points and the intended outcomes of that processing. These changes might include, but not be limited to:

- The execution of logic designed to offer enhanced recommendations to enforcement personnel regarding whether to inspect a given vehicle or driver more closely;
- The processing of inspection history data to more comprehensively determine whether screening functions are appropriate or in need of change to increase or decrease the relative frequency of inspection of individual vehicles or drivers;
- The implementation of requests and responses that enable users to conduct both pre-defined and ad hoc queries to gain information through a single interface; and
- The formulation of output that is accessible via an assortment of fixed and mobile system user access points that fully leverages the range of the potential SRI function set.

Figures 3 through 6 depict the possible approaches for information exchange and processing activities for the key components of the SRI system: the UID, ES/VWS, WRI, and truck parking. As the team continues the systems engineering processes, these diagrams will be updated to reflect findings and decisions regarding each component.

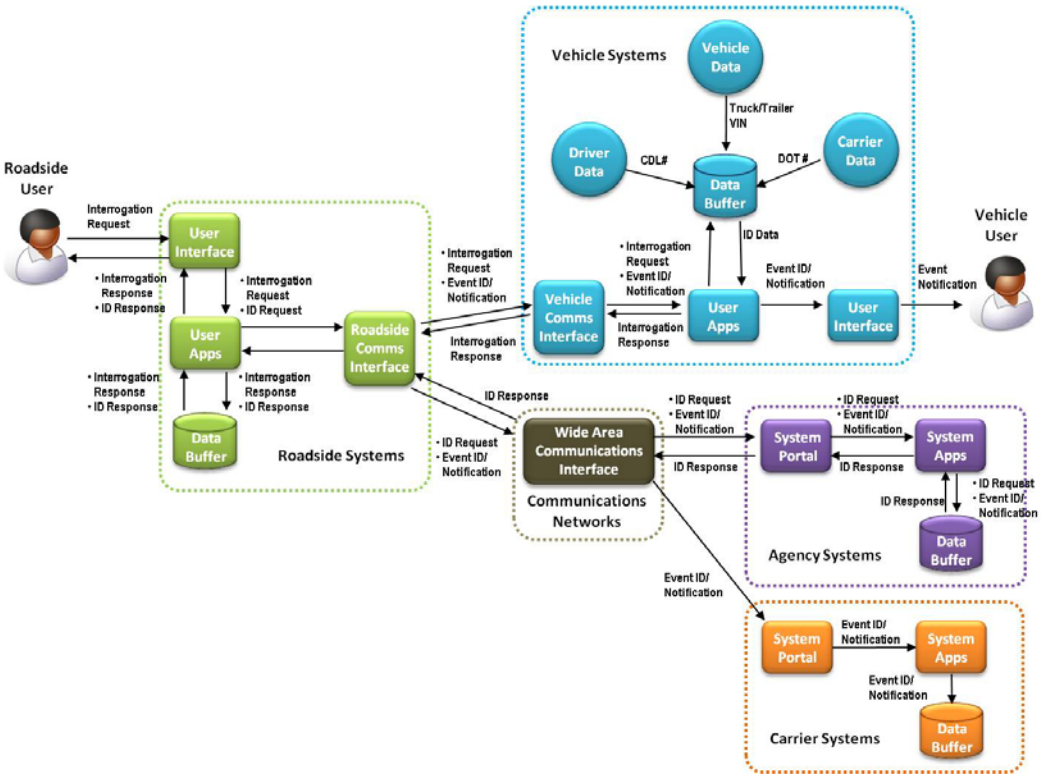

Figure 3. Sample Universal Electronic ID Functional Depiction

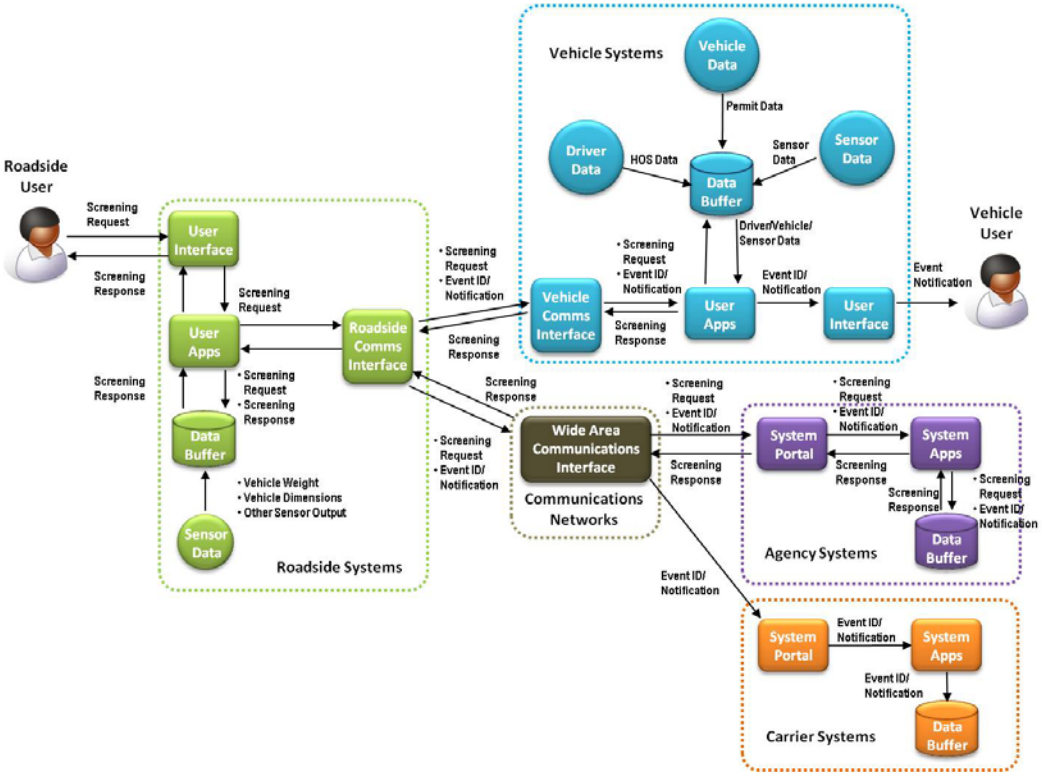

Figure 4. Sample Electronic Screening/Virtual Weigh Station Functional Depiction

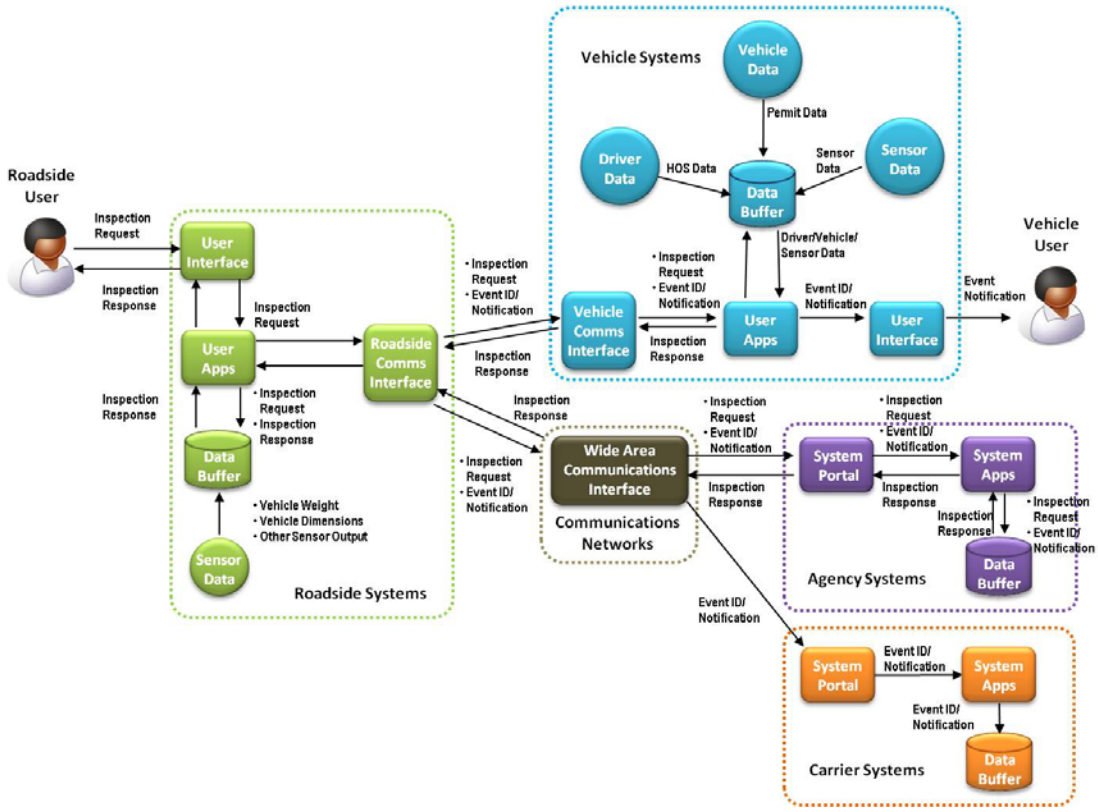

Figure 5. Sample Wireless Roadside Inspection Functional Depiction

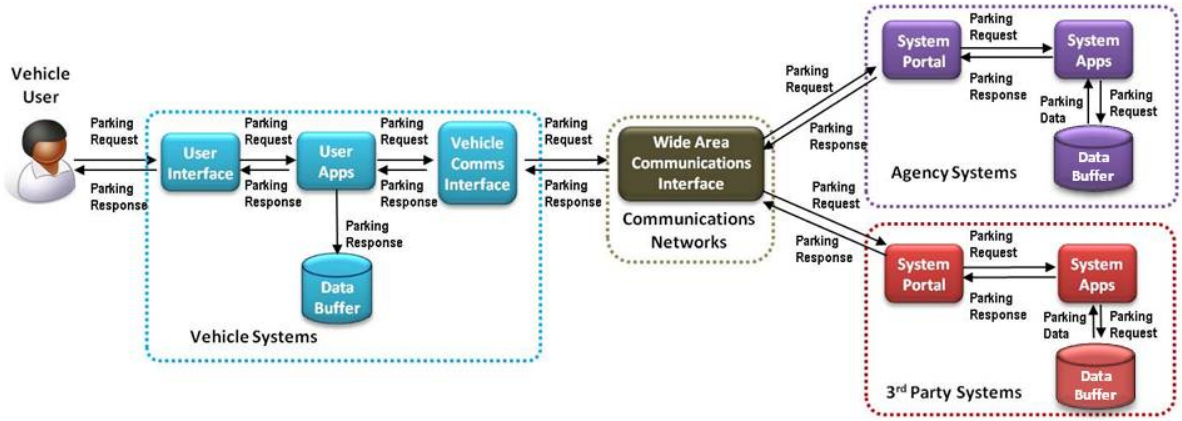

Figure 6. Sample Truck Parking Functional Depiction

System Operations

System Human Factors

The SRI system will contain several pieces of equipment that will require concentrated human engineering attention. Of most critical attention is needed for the EOBR, OBU and, potentially, the smart phone that will be installed on the CMVs. In particular:

- The on-board devices should provide audible and visual alerts and instructions to drivers, eliminating driver interaction with the device(s) and limiting driver distraction.
- In those cases where SRI provides data directly to a vehicle operator, SRI shall do so in a safe manner which minimizes driver distraction and eliminates the need for driver interaction with the device.

These are the highest priority items to meet, as an instance of human error in the case of CMV operations is extremely serious. To ensure compliance with these requirements and with overarching FMCSA policy, the Research Team will be extremely careful in defining appropriate verification criteria for them.

While these are the highest priority requirements with respect to the SRI system human factors, the SRI system user interface for the enforcement officers (in the weigh station and in the patrol car laptops) and the motor carrier back office personnel. A well-designed, well-tested user interface can make or break a system and will therefore be a critical item within the SRI system architecture and design process.

System Maintainability

This section includes the expected requirements for supporting and maintaining the SRI system, once operational. Since the SRI system will be installed in an existing operating environment, many of these items will be determined by the network availability, back office system communication, and uptime. Within the Connected Vehicle Test Bed, the back office infrastructure is currently being upgraded and no current metrics have been identified. Within the weigh stations, the Research Team may be able to upgrade network access to support SRI as needed. Any necessary upgrades will be determined during the design process. All acquisitions and procedures will reference the baseline Federal standard for telecommunication terms (FED-STD-1037B), and the series of US military standards (MIL-STD-188) that specify telecommunication parameters for achieving maintainability, reliability, and supportability in equipment lifecycle configuration management.

Measures and actions specifically related to this topic will be determined near the end of the system design process, as the system structure, complexity, and number of components (and whether they are off-the-shelf or developed in-house) will all impact the type, frequency, and cost of both preventative and reactive maintenance. Initial targets may be included in the system design and further refined in the development and test plans.

System Reliability

Reliability in any system is important; it will be especially so with respect to the SRI system, as the weigh stations in Michigan currently operate 24/7. System reliability helps set targets to minimize system downtime and failures. As with maintenance, it will be somewhat dependent on the system design and components that are deployed. Specific requirements related to reliability metrics will be documented initially within the system design, and will likely be further refined in the development and test plans for the prototype. All reliability measures will reference MIL-STD-188 where appropriate. In particular, they will incorporate best practices from the MIL-STD-188-100 series that specify interoperability and performance standards for digital interfaces, timing, and synchronization.

Policy and Regulation

Current and proposed operational policies governing the SRI system are documented in the final ConOps and re-stated within section 2.4 of this document. The requirements traceability matrix in section 5 maps all of the requirements to these stated policies as well as to user needs and other source items.

That said, the commercial vehicle operating environment is one that is constantly changing, with many potential policies and regulations on the horizon to govern future operations and technologies. A few examples include policies related to:

- Logging driver HOS
- Using EOBRs
- Implementing a Unified Registration System

The SRI SyRS do not include any specific requirements related to changes in current policy, nor have any requirements been included to propose new policy or regulation. Requirements on this topic are outside the scope of SRI, as they can take years to identify, document, and finalize. Similarly, the responsibility and authority to propose and execute these changes lie outside the leadership of the SRI team.

System Life Cycle Sustainment

The SRI system will be designed to include adequate quality assurance activities. Many of these—error checking and reporting, operations review, and data collection to support system evaluation and analysis—will be tested and included during the prototype demonstration phase. The Research Team will be begin to define these specific activities in the development and test plans for the SRI system and will also include quality assurance components within the system design.

Chapter 4. System Interfaces

Because the objective of this concept is to add capabilities using a combination of existing systems and new systems, interface changes are anticipated at several levels. These changes will come in two forms: system-to-system interfaces designed to connect new systems to existing systems and user interfaces to allow for interaction between users and various system elements. Interface changes affected by the SRI system will include:

- A "universal" interface that provides for the exchange of information between the new SRI system elements (e.g., enhanced electronic screening, WRI, etc.) and the existing systems at the immediate roadside (via a local area network, for example) and existing government, carrier, and third party systems (via a wide area network);
- Local user interfaces through which individual users can access information, interact with the SRI system elements and other systems, and receive notifications; and
- Any interfaces necessary for the elements of the SRI system to communicate with each other, including roadside equipment and on-vehicle devices.

Physical

The SRI system will include numerous physical interfaces *at full deployment*. These include:

- Truck engine status module to EOBR and/or OBU and, potentially, a smart phone
- Truck driver to EOBR and/or OBU and, potentially, a smart phone
- EOBR and/or OBU and, potentially, a smart phone to roadside equipment
- Roadside equipment to weigh station operator's computer
- Weigh station operator's desktop and/or laptop to human operator
- Roadside equipment to truck parking system
- Roadside equipment to law enforcement officer

Software

More importantly, the SRI system will integrate disparate systems in use at fixed and mobile weigh stations. As weigh station sites were evaluated for selection in the prototype demonstration, each site administrator completed a checklist of existing systems. Michigan *and Maryland's* use of current systems includes:

- FMCSA systems:
    - Aspen

    - QueryCentral/ISS
    - SAFER
    - Also available but not used regularly: A&I, DataQs, the FMCSA Portal, InfoSys, L&I, EMIS, and MCMIS
    - Also available, but typically only used by enforcement officers completing safety audits or compliance reviews: Sentri, CAPRI, CaseRite, and UFA
- State systems:
    - Nlets
    - IRP
    - IFTA
    - Os/Ow permitting
    - Crash reporting
- Other systems:
    - CDLIS
- Third party systems – unknown at this point
- Carrier systems – unknown at this point

Interface Requirements

The backbone to support the specific physical and software interfaces will become increasingly defined during the SRI system design process. To start, the Research Team has defined certain basic capabilities and standards below.

Table 15. Interface Requirements

i.001	SRI shall be designed to receive vehicle, and operator information ~~from~~ through vehicle OBU.[14]
i.001.1	*SRI shall exchange vehicle, owner and operator information with appropriate state and federal systems (i.e., Aspen to ~~Query Central~~ iyeCitation).*
i.002	SRI shall receive vehicle safety performance data and designated vehicle, carrier and driver information from SRI-capable Roadside ~~Equipment (RSE~~) unit (RSU).
i.002.1	*Vehicle safety performance data and vehicle, carrier and driver information should be conformant to standards SAE J2735 and IEEE P1609.*
i.003	SRI shall receive size and weight information from SRI-capable Roadside Unit (RSU) ~~Equipment (RSE).~~
i.003.1	*Telemetry and sensor output data shall comply with SAE J2735.*
i.004	SRI shall send information received from external back office systems to SRI-capable Roadside Unit (RSU)~~Equipment (RSE).~~
i.004.1	*SRI data exchanges between external back office systems and ~~RSEs~~ RSUs shall be formatted for compliance with these systems.*
i.005	SRI shall access external, authoritative information sources in a manner that ensures all relevant information is reliable, secure, and up-to-date.
i.005.1	*SRI shall access and provide current information in real-time or as available from integrated data sources.*

[14] OBU bluetooth to mobile app

i.005.2	*SRI shall access from authoritative data sources the information necessary to validate vehicle size and weight information.*
i.006	SRI shall interface with truck parking systems.
i.007	SRI shall provide designated collected data to back office external systems (~~systems TBD~~ Aspen,iyeCitation).
i.008	SRI shall receive designated data from back office external systems (~~systems TBD~~ SAFER).
i.008.1	*SRI shall send data from sensors and the CAN BUS in SAE J2735 compliant format.*
i.009	SRI shall provide a driver interface that is compliant with driver safety regulations.
i.010	SRI shall include trailing equipment identification pulled by uniquely identifiable CMV power units.
i.010.1	*SRI shall conform to SAE J1939 to support communications to/from CAN for tractor/trailer combinations.*
i.011	SRI information exchanges shall be compliant with appropriate communications protocols, such as SAE J2735, P1609 for ~~Wi-Fi and~~ DSRC, Cellular Digital Packet Data for CMRS, RESTful Web Services for cellular ~~XML/SOAP~~ and Abstract Syntax Notation (ASN.1) for DSRC ~~Ethernet connections~~.
i.012	SRI shall facilitate the real-time exchange of truck parking information.
i.012.1	*SRI shall exchange data with parking systems to support truck parking functionality.*

Chapter 5. Requirements Traceability Matrix

Table 18 on the following page contains the SRI Requirement Traceability Matrix which maps the SRI SyRS to their corresponding source. Most cases the source is a user need, operational policy or constraint from the ConOps. In some cases, it relates to a stated capability from the ConOps – these capabilities are defined below:

Table 16. Conceptual SRI System Top-Level Capabilities and Performance Metrics

Identifier	Description
Top Level Capabilities of Conceptual SRI system	
T001	The ability to capture detailed information about a vehicle, its owner, and its operator while the vehicle travels at-speed on a mainline roadway
T002	The ability to access rapidly and without manual intervention additional information about the vehicle, carrier, and driver regarding operating credentials status and key safety performance data
T003	The ability to execute certain automated inspection actions without requiring the vehicle to come to a stop
T004	The ability to access authoritative information sources to ensure that all relevant information necessary to take action is reliable and up-to-date
T005	The ability to exchange information between the vehicle and roadside systems
T006	The ability to ensure that CMVs are compliant with size and weight requirements
T007	The ability to locate and use information related to the availability of facilities adequate to ensure a driver can obtain needed rest.
Performance Metrics for Conceptual SRI System	
P001	High-volume information exchange – the system will need to be able to identify and exchange information with multiple CMVs, particularly in high-traffic areas or at facilities (fixed or mobile) where CMVs enter a queue for inspections and/or size and weight checks.
P002	Speed – information exchange will need to be performed at a near real-time speed to ensure prompt decision making at roadside. This will be particularly important for decisions on whether or not a CMV is permitted to by-pass a weigh station or is selected for additional enforcement checks.
P003	Reliability – the system must provide reliable, irrefutable and secure information exchange with the ability to authenticate sources of data in near real-time. This is necessary to ensure: 1) enforcement personnel are able to ascertain the status of a motor carrier, vehicle, and driver; 2) to provide all parties with a tracking of the exchange; and 3) to maintain the security of the information exchanged.
P004	Scalability – the prototype applications will demonstrate the technical feasibility of SRI; however, these are only a small component of the multitude of applications that could be developed for and supported by SRI, such as electronic payments, weather information, real-time information on accidents and congestions, etc.
P005	Flexibility – the system will be designed to accommodate multiple users with different user needs and requirements.

In addition, Table 18 contains a column which specifies whether the requirement applies to the currently identified prototype locations in Michigan (indicated by an 'MI') and/or Maryland (indicated by a 'MD') or whether the Research Team has determined that the requirement could only be met by a future demonstration of SRI (as indicated by an 'F'). During the design phase the Research Team may update this table based on new information obtained.

Lastly, Table 18 includes a column indicating the verification method that will be used to determine whether the system design satisfies the requirement. In traditional systems engineering, one of four methods are typically selected: test, demonstration, analysis or inspection, defined as follows:[15]

- Test: the application of scientific principles and procedures to determine the properties or functional capabilities of items.
- Demonstration: the actual operation of an item to provide evidence that it accomplishes the required functions under specific scenarios.
- Analysis: the use of established technical or mathematical models or simulations, algorithms, or other scientific principles and procedures to provide evidence that the item meets its stated requirements.
- Inspection: observation using one or more of the five senses, simple physical manipulation, and mechanical and electrical gauging and measurement to verify that the item conforms to its specified requirements.

[15] http://www.personal.psu.edu/mhl100/2007/11/classical-requirements-verification.html

Matrix

Table 17. SRI Requirements Traceability Matrix

Req ID	Requirement	Source	Verification Method	Michigan and/or Maryland or Future Demonstration
e.001	SRI shall be designed to operate in conjunction with and not interfere with existing systems.	UN14	Inspect	MI, MD
e.002	SRI shall monitor roadside equipment.	DOP01	Inspect	MI, MD
e.003	SRI shall monitor external system availability.	DOP01	Inspect	MI, MD
e.004	SRI shall provide continuous system health availability information.[2]	DOP01	Inspect	MI, MD
e.005	The SRI Prototype System shall be deployed and tested at a fixed facility on the Interstate System.	DOP03	Demonstrate	MI, MD
e.006	The SRI Prototype System shall be deployed and tested in a mobile environment on selected secondary routes.	DOP03	Demonstrate	F
e.007	The SRI prototype shall use the USDOT number as the unique identifier for the carrier.	DOP04	Inspect	MI, MD
e.008	The SRI prototype shall use the VIN number as the unique identifier for the CMV.	DOP04	Inspect	MI, MD
e.009	The SRI prototype shall use the CDL number as the unique identifier for the CMV driver.	DOP04 UN12	Inspect	MI, MD
e.009.1	*The SRI prototype shall use the drivers' license number or appropriate identifier for drivers operating CMVs that do not require a CDL.*	DOP04 UN12	Inspect	F
e.010	The SRI prototype shall verify that all information originates from an authoritative source.	DOP05	Inspect	F
e.011	Both interstate and intrastate vehicles/carriers shall be able to use the SRI prototype.	UN 08	Demonstrate	F
e.012	SRI shall collect, store~~, maintain~~ and provide real-time on-line interactive access to historical vehicle, driver and carrier safety data at the weigh station.[3]	UN 08	Demonstrate	MI, MD
e.013	SRI shall provide capability to securely log the passing of each vehicle, the information passed to the roadside system, and the information passed back to the vehicle from the roadside system.	UN 08	Inspect	MI, MD
e.014	SRI shall provide an interface to all commercial drivers that is compliant with existing safety regulations.	DOC01	Demonstrate	MI, MD
Application Requirements (a)				
a.001	SRI shall be consistent with the ITS National Architecture and associated standards such as the CVISN National Architecture.	UN08	Analyze	MI, MD
a.002	SRI shall provide an interface and processing modules for truck parking applications.	UN10	Demonstrate	MI

Req ID	Requirement	Source	Verification Method	Michigan and/or Maryland or Future Demonstration
a.002.1	*SRI shall provide information about the availability of truck parking spaces.*	UN10	Demonstrate	MI
a.002.2	*SRI shall provide current parking availability information at a specific facility.*	UN10	Demonstrate	MI
a.002.3	*SRI shall provide predicted future parking availability information at a specific facility.*	UN10	Demonstrate	F
a.002.4	*SRI shall provide 24x7 access to truck parking information.*[4]	UN10	Demonstrate	MI
a.002.5	*SRI shall provide a graphical interface to stationary (i.e., dispatcher/operator/driver/traffic analyst/other) users.*	UN05	Demonstrate	MI
a.002.6	*SRI shall provide a user interfaces to non-stationary drivers when integrated in-vehicle display systems exist.*	UN07	Demonstrate	F
a.002.7	*SRI shall allow a stationary user to submit requests for automated truck parking information.*	UN05	Demonstrate	MI
a.002.8	*SRI shall allow a user to receive the results of an automated request for truck parking information.*	UN05	Demonstrate	MI
a.003	SRI shall provide an interface and processing modules for enforcement screening applications.	UN10	Demonstrate	MI, MD
a.003.1	*SRI shall provide the ability for roadside systems to integrate roadside systems data and make it available to Roadside System SRI user applications.*	UN09	Analyze	MI, MD
a.004	SRI shall provide a processing capability that automates the roadside inspection tasks.	T007	Analyze	F
a.004.1	*The SRI system shall determine if a CMV complies with jurisdictional licensing requirements.*	T002	Test	F
a.004.2	*The SRI system shall determine if a driver complies with jurisdictional licensing requirements.*	T002	Test	F
a.004.3	*The SRI system shall determine if a driver complies with HOS requirements.*	T007	Test	F
a.004.4	*The SRI system shall determine if a CMV complies with jurisdictional size requirements.*	T006	Test	F
a.004.5	*The SRI system shall determine if a CMV complies with designated safety requirements.*	T002	Test	F
a.004.6	*The SRI system shall determine if a CMV complies with weight requirements.*	T006	Test	F
a.004.7	*The SRI system shall determine if a CMV has a legally issued permit to exceed the legal limits for size and/or weight at the current location of the CMV.*	T002	Test	F
a.004.8	*SRI shall provide the data necessary to document inspection events and outcomes.*	UN10	Analyze	MI, MD

Req ID	Requirement	Source	Verification Method	Michigan and/or Maryland or Future Demonstration
a.004.9	*SRI shall formulate alarms for user notification via the user interface(s).*	UN05	Test	F
a.004.10	*SRI shall automatically identify to the enforcement personnel approaching vehicles that have been flagged as potentially needing maintenance or to be put out of service due to violation of designated vehicle, driver and/or carrier safety regulations.*	UN11	Demonstrate	F
a.004.11	*The SRI prototype shall obtain vehicle-based maintenance data from the vehicle CAN BUS where available.*	UN04	Demonstrate	F
a.004.12	*SRI shall provide vehicle-based maintenance data obtained from the vehicle to the carrier.*	UN05	Demonstrate	F
a.004.13	*SRI shall provide driver-based safety information obtained from the vehicle to the carrier.*	UN05	Demonstrate	F
a.005	SRI shall provide an interface for Tier 1 users.	UN10	Demonstrate	MI, MD
a.005.1	*SRI shall provide an interface for CMV Enforcement Officers and supervisors to enter data.*	UN10	Demonstrate	MI, MD
a.005.2	*SRI shall provide an interface for CMV Enforcement Officers and supervisors to execute processes.*	UN10	Demonstrate	MI, MD
a.005.3	*SRI shall provide an interface for CMV Enforcement Officers and supervisors to receive information and alerts.*	UN10	Demonstrate	MI, MD
a.005.4	*SRI shall provide an interface for CMV drivers to receive information. ~~and alerts~~.*	UN10	Demonstrate	MI, MD
a.005.5	*SRI shall provide an interface for motor carriers to view information and receive alerts.*	UN10	Demonstrate	F
a.006	SRI shall conduct the analytical and data fusion functions necessary to evaluate CMV, carrier, and driver compliance.	UN09	Analyze	F
a.007	SRI shall comply with nationwide interoperability standards currently used for the USDOT V2X Program.	DOP06 UN014	Inspect	MD
a.007.1	*SRI shall comply with SAE STD J2735.*	DOP06 UN014	Inspect	MD
a.007.2	*SRI shall comply with the relevant sections of IEEE 1609 (including Architecture, Resource Manager, Security Services, Networking Services, Multi-Channel Operations, over-the-air data exchange protocol for ITS) and the version updates available at the time of design.*	DOP06 UN014	Inspect	MD
a.007.3	*SRI shall comply with SAE J1929.*	DOP06 UN014	Inspect	F
a.007.4	*SRI shall comply with IEEE Standard 802.11p.*	DOP06 UN014	Inspect	MD

Req ID	Requirement	Source	Verification Method	Michigan and/or Maryland or Future Demonstration
a.008	SRI shall provide vehicle system information that is used by SRI to users.	UN09 UN14	Demonstrate	F
a.008.1	*SRI shall provide designated vehicle system information to the driver through the driver application.*	UN09	Demonstrate	F
a.008.2	*SRI shall provide applicable vehicle system information to the carrier through the carrier application.*	UN09	Demonstrate	F
Performance Requirements (p)				
p.001	SRI shall provide current information in a timely fashion, or as available from integrated data sources, to meet SRI prototype application requirements.	P001	Test	MI, MD
p.001.1	*SRI shall be able to exchange data with external systems within 2 seconds, 99% of the time.*	P002 UN05 UN11	Test	MI, MD
p.001.2	*SRI shall be able to exchange data with Roadside Equipment within 2 seconds, 99% of the time.*	P002 UN05 UN11	Test	MI, MD
p.001.3	*SRI shall be able to exchange data with CMV within 2 seconds, 99% of the time.*	P002 UN05 UN11	Test	MI, MD
p.001.4	*SRI data exchanges shall be time stamped when the exchange was completed.*	P002	Test	MI, MD
p.002	SRI shall provide the capability to establish two-way communications with each properly equipped vehicle approaching the weigh station.	UN08	Demonstrate	MI, MD
p.002.1	*SRI shall maintain two-way communications with each properly equipped vehicle as it passes through the weigh station.*	UN08	Demonstrate	MI, MD
p.002.2	*SRI shall maintain two-way communications with each properly equipped vehicle as it exits the weigh station.*	UN08	Demonstrate	F
p.003	The SRI system shall be able to maintain an overall 99% in a 24 hour period system availability.	UN05	Inspect	MI, MD
p.003.1	*The SRI Prototype will log each system outage with the date, ~~GMT~~time, length (in minutes), and cause of the outage.*	P003	Inspect	MI, MD
p.003.2	*The SRI Prototype will identify the user responsible for system outages that occur as a result of system breach or tampering.*	P003	Test	F
p.004	SRI shall be able to communicate "Pass/Need to stop" instructions to a driver in time for compliance with the instruction.	UN07	Test	MI, MD

Req ID	Requirement	Source	Verification Method	Michigan and/or Maryland or Future Demonstration
p.005	SRI shall be designed to accommodate multiple users with different user needs and requirements.	P005	Demonstrate	MI,MD
p.006	SRI shall provide sanitized data to external systems for public use.[5]	UN03	Inspect	F
p.007	SRI shall provide an initial automated inspection capability that will expedite and supplement the existing visual and manual inspection processes.	UN010	Analyze	F
p.007.1	*SRI shall make a decision as to whether to allow each vehicle to pass or require them to stop for a check.*	UN010	Test	MI, MD
p.007.2	*SRI shall include a manual override function for the automatically generated decision for vehicles to pull in for safety inspection.*	UN11	Demonstrate	F
p.007.3	*SRI shall issue Randomly generated pull-in for safety inspection signals.*	UN10	Test	F
p.007.4	*SRI shall issue Manually generated pull-in for safety inspection signals.*	UN10	Test	F
p.007.5	*SRI shall issue Automatically generated pull-in for safety inspection signals.*	UN10	Test	F
p.007.6	*SRI shall perform checks on Vehicle/Carrier/Driver Safety Information when making the "Pass/Need To Stop" determination.*	T002	Analyze	~~F~~
p.007.7	*SRI shall perform checks on Vehicle Credentials when making the "Pass/Need To Stop" determination.*	T002	Analyze	~~F~~
p.007.8	*SRI shall perform checks on Driver and Carrier Credentials/Status when making the "Pass/Need To Stop" determination.*	T002	Analyze	F
p.007.9	*SRI shall perform checks on Vehicle ~~Size and~~ Weight Information when making the "Pass/Need To Stop" determination.*[6]	T006	Analyze	MI, MD
Security (s)				
s.001	SRI shall protect personal data from unauthorized access.	UN06	Inspect	MI, MD
s.002	SRI shall protect proprietary information from unauthorized access.	UN06	Inspect	MI, MD
s.003	SRI shall protect proprietary systems from unauthorized access.	UN06	Inspect	MI, MD
s.004	SRI shall provide read access and read/write access to authorized users.	DOP09	Test	MI, MD
s.005	SRI shall provide read access and read/write access to authenticated users.	DOP09	Test	MI, MD

Req ID	Requirement	Source	Verification Method	Michigan and/or Maryland or Future Demonstration
Interface (i)				
i.001	SRI shall be designed to receive vehicle, and operator information ~~from~~ through vehicle OBU.[7]	T001 UN01 UN02	Demonstrate	MD
i.001.1	*SRI shall exchange vehicle, owner and operator information ~~with appropriate state and federal systems~~ (i.e., from Aspen ~~and Query Central~~to iyeCitation).*	DOP 02	Analyze	MI, MD
i.002	SRI shall receive vehicle safety performance data and designated vehicle~~, carrier~~ and driver information from SRI-capable Roadside Unit (RSU) ~~Equipment (RSE).~~	T002 UN02	Inspect	F
i.002.1	*Vehicle ~~safety performance data and vehicle, carrier and driver~~ information should be conformant to standards SAE J2735 and IEEE P1609.*	DOP 02	Inspect	MD
i.003	SRI shall receive ~~size and~~ weight information from SRI-capable Roadside Unit ~~Equipment (RSE~~RSU).	T003 UN02	Demonstrate	MD
i.003.1	*Telemetry and sensor output data shall comply with SAE J2735.*	DOP 02	Inspect	F
i.004	SRI shall send information received from external back office systems to SRI-capable Roadside Unit ~~Equipment (RSE~~ RSU).	T003 UN02	Demonstrate	F
i.004.1	*SRI data exchanges between external back office systems and RSEs shall be formatted for compliance with these systems.*	DOP 02	Inspect	F
i.005	SRI shall access external, authoritative information sources in a manner that ensures all relevant information is reliable, secure, and up-to-date.	T004	Analyze	MI, MD
i.005.1	*SRI shall access and provide current information in real-time or as available from integrated data sources.*	T004	Analyze	MI, MD
i.005.2	*SRI shall access from authoritative data sources the information necessary to validate vehicle ~~size and~~ weight information.*	T004	Inspect	MI, MD
i.006	SRI shall interface with truck parking systems.	T007	Demonstrate	MI
i.007	SRI shall provide designated collected data to back office external systems (~~systems TBD~~ Aspen,iyeCitation).	UN03	Demonstrate	MI, MD
i.008	SRI shall receive designated data from back office external systems (~~systems TBD~~ SAFER).	UN04	Demonstrate	MI, MD
i.008.1	*SRI shall send data from sensors ~~and the CAN BUS in~~ SAE J2735 compliant format.*	UN04	Inspect	F
i.009	SRI shall provide a driver interface that is compliant with driver safety regulations.	UN07	Demonstrate	MI, MD

Req ID	Requirement	Source	Verification Method	Michigan and/or Maryland or Future Demonstration
i.010	SRI shall include trailing equipment identification pulled by uniquely identifiable CMV power units.	UN13	Inspect	F
i.010.1	*SRI shall conform to SAE J1939 to support communications to/from CAN for tractor/trailer combinations.*	DOP02	Demonstrate	F
i.011	SRI information exchanges shall be compliant with appropriate communications protocols, such as SAE J2735, P1609 for DSRC, Cellular Digital Packet Data for CMRS, and ~~XML/SOAP~~ RESTful web services for cellular and Abstract Syntax Notation (ASN.1) for DSRC ~~Ethernet connections~~.	DOP10	Inspect	MD
i.012	SRI shall facilitate the real-time exchange of truck parking information.	UN011	Analyze	MI
i.012.1	*SRI shall ~~exchange~~ receive data with parking systems to support truck parking functionality.*	UN04	Analyze	MI

[1] Colorado replaced by Maryland (MD).

[2] Dependent on weigh station hours of operation. SRI prototype system will provide continuous availability when station is open.

[3] Historical data from SAFER; information collected by SRI prototype stored for 23h, 59m.

[4] Depending on availability of TSPS application.

[5] Sanitized data refers to data that has had proprietary or sensitive information removed.

[6] SRI prototype only performed checks on vehicle weights (checks meaning data collected was verified by a decision engine – in this case, Mettler-Toledo.

[7] OBU bluetooth to mobile app.

Appendix A – User Needs

This Appendix provides the SRI System user needs, as they were captured in the Final SRI ConOps.

UN01 – The system must be able to identify CMV power units uniquely.

The underlying operational premise for delivering future SRI functionality is that every individual vehicle can be uniquely identified and separated from all surrounding vehicles. Furthermore, each vehicle must be able to be tied to a carrier. This user need must be met in order to deliver any functionality related to the inspection or screening of any vehicle.

UN02 – The system must support the exchange of data between the CMV and the roadside without requiring the vehicle to stop.

The ability to exchange data at high speed is fundamental to the execution of CMV electronic screening and virtual weighing activities (WIM and VWS) without expanding existing weigh and inspection facilities or inspection workforces, or requiring compliant vehicles to stop. It is also useful for the delivery of truck parking information as well as a variety of other safety and operations data to vehicles. This capability is essential to minimize travel delays for safe, legal CMVs.

UN03 – The system able must provide the ability to pass data collected from CMV to external systems.

An extensive array of off-site support system providers (Federal, State, carrier, and third party) exist that store and process safety-related data and information, including several systems of record that are used to establish safety ratings and deliver additional value-added information to the CMV and its driver. Conveying data to these systems is essential for SRI to support the future execution of capabilities in each of the four functional areas and to facilitate other value-added functionality.

UN04 – The system must provide the ability to receive data from external systems.

Data and information stored in the aforementioned Federal, State, carrier, and third-party service provider systems—particularly enforcement systems of record—represent authoritative systems for both performing electronic screening and roadside inspections as well as delivering information related to the location and reservation of parking. Receiving data from these systems is essential for SRI to support the future execution of capabilities in each of the four functional areas and to facilitate other value-added functionality.

UN05 – The system must provide the ability to efficiently and effectively exchange data between external systems and local users at the roadside or in the CMV.

The vehicle user (i.e., the driver and other motor carrier personnel) and roadside user (i.e., a CMV safety enforcement officer) are the first-line users of the SRI applications and must have the ability to interact with the various SRI applications in a manner that allows for timely, efficient, well-informed decisions. These decisions will be driven by user-defined operational requirements associated with each of the four functions included in this concept and will balance safety, efficiency, and mobility enhancements.

UN06 – The system must provide protection against unauthorized access to and use of data.

Some of the information exchanged through the various elements of the system can be considered sensitive, particularly information that pertains to individual persons and their movements. Given that the system cannot be deployed successfully without the existence of a broad array of interconnected systems, the risk exists for data and information to be accessed and compromised by outside parties. This risk must be minimized to the greatest extent possible.

UN07 – The system must allow a vehicle operator to interact with it in a safe manner during vehicle operation.

The SRI system is first and foremost an enabler for safety enhancement. Distracting a driver during vehicle operation runs counter to the central purpose of the SRI program, and every effort must be made to ensure that the level of attention required for the driver to access functionality is kept to a minimum. Additionally, information provided to the vehicle operator must be prioritized in accordance with the SAE J2735 Message Prioritization Standard.

UN08 – The system must be consistent with the ITS National Architecture and associated standards.

As a program that is under the ITS Program, SRI and supporting core systems must conform to the National ITS Architecture which includes the CVISN architecture, or clearly specify where architecture modifications are necessary to deliver desired capabilities. It must also support interoperability with other existing and emerging systems whenever possible.

UN09 – The system must facilitate the integration of data from multiple sources into one or more cohesive, reusable datasets.

Where UN03, UN04, and UN05 specify the need to accommodate data and information exchange, this need speaks specifically to the need for SRI to provide the ability to integrate data received from roadside devices with data received from in-vehicle systems and make that data available to the external systems described in UN03 and UN04 while distributing

data to roadside and in-vehicle systems. Information from multiple sources will need to be accessed and analyzed simultaneously in order to deliver the specified capabilities.

UN010 – The system must include information capture and processing functionality that meets specific CMV operation needs (e.g., truck parking and weight check applications).

The SRI is an enabling system, meaning that it must support the data collection, information formulation and dissemination, and decision-support systems that will be developed to conduct specific functional operations using an open architecture.

UN011 – The system must provide applications data in sufficient time to support decision making at the roadside.

The very nature of future capabilities such as WRI and ES/VWS make it essential that data be captured, processed, and communicated quickly enough to allow for timely decisions on the part of roadside enforcement personnel. This is particularly true when the results of these activities indicate that a vehicle should be stopped for additional inspection, per-axle and GVW verifications, or potential enforcement action.

UN012 – The system must be able to identify, uniquely and reliably, which CMV driver is actually operating a CMV.

Many roadside safety screening activities include the assessment of driver qualifications and fitness for duty. The underlying operational premise for delivering future demonstrations of SRI functionality is that every individual driver can be specifically identified. Furthermore, each driver must be able to be tied to the vehicle being operated. This user need must be met in order to deliver any functionality related to the inspection or screening of any driver.

UN013 – The system must be able to support the identification of trailing equipment pulled by uniquely identifiable CMV power units.

The underlying operational premise for delivering SRI functionality is that every individual piece of trailing equipment can be specifically identified. Furthermore, each piece of trailing equipment must be able to be associated with the vehicle power unit being operated.

UN014 – The system must operate in a V2X cooperative systems environment.

SRI is being developed simultaneously with other telecommunication-based systems that will enhance highway safety, mobility, and environmental stewardship. Applications being developed to serve these other systems will be in operation in the same roadside environment as that of SRI. By providing for a broad set of potential uses and focusing on implementation of interoperable technologies, SRI establishes greater value and more

attractiveness to potential users, which should help to offset costs incurred during deployment and use.

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