Smart Roadside Initiative

Final Report

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16. Abstract This is the Final Report for the Smart Roadside Initiative (SRI) prototype system deployment project. The SRI prototype was implemented at weigh stations in Grass Lake, Michigan and West Friendship, Maryland. The prototype was developed to integrate with existing technologies already available at the weigh stations to provide one common system user interface for law enforcement officers to use. The Final Report summarizes what was deployed at each weigh station, in the commercial vehicle via a smartphone, and the ability to view the SRI user interface at any location using a smartphone. The report provides the results of the unit and acceptance testing and the lessons learned for future deployments.			
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Acronym List

API	Application Programming Interface
ASN	Abstract Syntax Notation
CAN	Controller Area Network
CDL	Commercial Driver's License
CDLIS	Commercial Drivers' License Information System
CMV	Commercial Motor Vehicle
COM	Component Object Model
ConOps	Concept of Operations
CVISN	Commercial Vehicle Information Systems and Networks
CVO	Commercial Vehicle Operations
CVSA	Commercial Vehicle Safety Alliance
DashCon	SRI Enforcement PC User Interface
DB	Database
DMV	(State) Department of Motor Vehicles
DOC	Draft Operational Constraint
DOP	Draft Operational Policy
DSRC	Dedicated Short Range Communications
E-Screening	Electronic Screening
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FMCSR	Federal Motor Carrier Safety Regulations
IEEE	Institute of Electrical and Electronics Engineers
iFrame	Inline Frame Element used in HTML
ISS	Inspection Selection System
ITS	Intelligent Transportation Systems
J2735	SAE Standard DSRC Message Set
LEIN	Law Enforcement Information Network
LPR	License Plate Reader
MICJIN	Michigan Criminal Justice Information Network
NLETS	National Law Enforcement Telecommunications System
OBU	On-board unit
OSADP	USDOT's Open Source Application Development Portal
PC	Personal Computer
RFID	Radio Frequency Identification
RSE	Roadside equipment
RSU	Roadside Unit
R-WS	RESTful Web Services

SAE	Society of Automotive Engineers
SAFER	Safety and Fitness Electronic Records
SDC	SRI Dashcon
SIAS	SRI Information System Aggregation System
SRI	Smart Roadside Initiative
SyRS	System Requirements Specifications
TSPS	Truck Smart Parking Service
UI	SRI User Interface
UID	Universal Identifier
UN	User Need
USDOT	United States Department of Transportation
USDOT-R	USDOT Reader
VIN	Vehicle Identification Number
VWS	Virtual Weigh Station
WIM	Weigh In Motion
WRI	Wireless Roadside Inspection
XML	Extensible Mark-up Language

Chapter 1. Introduction

This report summarizes the development, installation, deployment and testing in the execution of the Smart Roadside Initiative (SRI) prototype project, which was funded by the United States Department of Transportation (USDOT) Intelligent Transportation System (ITS) Joint Program Office (JPO). This report was prepared by Leidos, the prime contractor for the project and known throughout the report as "the development team."

The SRI Vision was for *commercial vehicles, motor carriers, enforcement resources, highway facilities, intermodal facilities, toll facilities, and other nodes on the transportation system to collect data for their own purposes and share the data seamlessly with the relevant parties, in order to improve motor carrier safety, security, operational efficiency, and freight mobility.*

The project goals were to:

- *Build, install, and test prototype of Smart Roadside Application(s).*
- Enable data exchange between vehicle and roadside infrastructures which connect to authoritative databases for information and relevant data.

The keys to successful testing of the SRI prototype were as follows:

- Interoperable technologies.
- Information sharing between vehicle-roadside-freight facility systems.
- Leveraging current technology investments and existing partnerships.

The project began with a multi-phased planning and design approach following the Institute of Electrical and Electronics Engineers (IEEE) standards and processes; the project tasks and key deliverables are outlined below:

- Task 1 - Project and System Engineering Management
  - Project Management Plan
  - System Engineering Management Plan
  - Communications Management Plan
- Task 2 - Application Analysis and Assessment of Deployed Systems
- Task 3 - Application Analysis and Assessment of Research Projects
- Task 4 - Concept of Operations
- Task 5:
  - Design a Prototype of Smart Roadside Applications
    - System Requirements

        - System Architecture
        - Component Level Design
    - Develop, Test and Deploy Prototype(s) of SRI applications
    - Prepare final documentation
- Task 6 - Stakeholder Outreach

When it began in late 2010, the initial concept of the project was to design, build, and deploy a combination of new hardware and software for one test site, i.e., a single interstate weigh station. The research and deliverables provided in tasks 2 and 3 and work done in support of the task 4 Concept of Operations provided strong indications to the development team that a hardware solution was not the right direction for this project. Vendors in the industry were quickly addressing the commercial motor vehicle (CMV) enforcement needs independent of government research, and were providing solutions very rapidly in the market. Despite this development, one problem that became apparent was that there was no integration among any of these vendors products, thereby requiring enforcement officers to have multiple system monitors on their desks in the weigh stations plus having to login separately for each system. It is with this problem in mind that the development team, with the cooperation and support of project sponsors at USDOT, moved forward with the requirements definition and prototype design.

In agreement with USDOT, the project team shifted direction from primarily a hardware solution to a software integration system. The system design was changed to accommodate the new approach and discussions began with multiple vendors with hopes of integrating their software into the SRI prototype. The vendor discussions were difficult at best, primarily because the vendors felt their own solution already satisfied the new design of the SRI prototype system and that SRI could hurt their place in the market. The discussions continued for months and some of the key players ultimately refused to participate. Despite this challenge, the development team continued to design and build a SRI framework that would allow for future integration of most any technology deployed at a weigh station. The team was successful in building integrations with a weigh-in-motion (WIM) manufacturer, a license plate reader vendor, the Truck Smart Parking System, smartphone applications, and FMCSA back office systems. These particular integration efforts provided the means to meet the goals of the SRI project. As to the attempt to integrate with external systems, only one was not completed: the integration/incorporation of the mainline WIM located at the West Friendship, Maryland, weigh station. That particular WIM was very old and was not able to connect to multiple systems at the same time. The stakeholders were not in favor of removing the existing communications lines for that mainline WIM to accommodate the SRI prototype test.

Another extensive effort in the SRI project was the identification of the prototype test sites. During the course of the project, the development team worked closely with USDOT to identify candidate locations. This included many weigh stations in multiple States, all of which were researched and visited to identify which sites would benefit from using the SRI system. These States included Michigan, Maryland, Colorado, Kentucky and North Carolina. Site visits and stakeholder interviews with Kentucky and North Carolina indicated that there was little need for a system like SRI, since each State had its own internal version of SRI. Colorado agreed to participate, and offered a unique opportunity to integrate to a State-developed revenue system, but later dropped out due to the timing of a major rewrite of that same revenue system. The final two locations selected for the SRI deployments were the weigh stations at Grass Lake, Michigan, and West Friendship, Maryland.

As planned in the new design approach, SRI successfully leveraged stakeholders' current technology investments in order to augment existing programs while supporting new activities.

The quantitative findings regarding the performance of the SRI Prototype are being developed by an independent contractor and will be published by the USDOT separate from this document. The following are the initial performance metrics that have been identified by the evaluation team:

- Increased Productive Inspections Time
- Increased Inspection Efficiency
- Increased Safety
- User Acceptance
- Increased Revenue

In addition, readers should reference the USDOT's Open Source Application Development Portal (OSADP)[1] which will contain all the source code from the SRI prototype.

The lessons learned and conclusions presented later in this document tie more directly to specific prototype test results. In addition, this document describes the extensive role of the stakeholder community throughout the duration of the project. The remainder of this document is organized as follows:

- Project Background (Section 2)
- Prototype Description and Development Summary (Section 3) provides a high-level overview of the elements of the SRI prototype; this section is high-level as the more detailed architecture and design documents contain the detailed parameters for the overall prototype and each component of the prototype.
- Test Site Description (Section 4) provides specific details regarding the prototype's installation, configuration and integration at the two weigh station locations: Grass Lake, MI and West Friendship, MD.
- Summary of Stakeholder Involvement (Section 5) provides a description of all users and stakeholders involved in the test and how their input and feedback impacted the project.
- Prototype Test Summary (Section 6) describes all aspects of the SRI prototype testing and includes the development team's analysis and findings for the DSRC mobile test.
- Conclusions and Recommendations (Section 7) summarize the lessons learned from the project and provide the development team's recommendations regarding potential enhancements and expansion of the SRI concept and technologies.

[1] http://www.itsforge.net/

Chapter 2. Project Background

The Smart Roadside Initiative began a few years ago when a representative cross-section of the CMV community attended the 2008 Smart Roadside Workshop. The participants at the workshop agreed that CMV safety, security, and mobility systems should be linked into a coordinated and comprehensive roadside program. Smart Roadside is now an approved mode-specific item in the USDOT Intelligent Transportation Systems (ITS) Strategic Research Plan, 2010-2014. While the original scope for the goals of Smart Roadside Initiative (SRI) was broad, aspects of that vision are being advanced through the USDOT's connected vehicle initiative.

The primary focus of the SRI remains constant: improve the effectiveness of traditional enforcement activities conducted at weigh/inspection stations by moving compliance checks to the roadside. In doing so, enforcement is better able to focus limited resources on vehicles requiring more extensive measurements and inspection. Forecasts of truck travel demand made by the American Trucking Association and the Federal Highway Administration (FHWA) point to significant increases in the short and medium term; the importance of removing legally loaded and operating vehicles from enforcement queues cannot be overstated.

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. A key component of the USDOT connected vehicle initiative is to use wireless communications to facilitate the high-speed transfer of data and to support:

- Safety applications that enable a vehicle to have 360 degree awareness and can inform the operator of hazards and situations he or she cannot see;
- Mobility applications that will improve overall transportation system performance by accessing pertinent information from thousands of anonymous vehicles through a connected, data-rich travel environment; and
- Traveler information applications that provide travelers with real-time information, including CMV-specific information, about congestion and travel conditions to enable more informed decisionmaking.

Within the overall connected vehicle initiative, the SRI represents the subset of CMV applications focused on roadside enforcement. Work is also being performed in the USDOT on vehicle-to-vehicle (V2V) active safety applications for CMVs under the Connected Commercial Vehicle Integrated Truck and Retrofit Safety Device projects and an advanced freight traveler information application under the Freight Advanced Traveler Information System (FRATIS) project. The SRI program was planned to operate in a telecommunication-rich environment that facilitates data sharing among these component applications to enable real-time information sharing at the roadside – vehicle to roadside, vehicle to vehicle, and roadside to driver – and be fully interoperable with the other programs within the connected vehicle initiative. The expected benefit of SRI was to expand the sources and types of information available at the roadside to improve CMV safety and enhance mobility.

The current CMV environment consists of numerous Federal, State, regional, and private-sector programs that use a combination of manual, semi-automatic, and advanced technologies to support safety, mobility, and security. The effectiveness of these programs will be greatly improved by the SRI concept as relevant and appropriate data is shared among the current systems and they become integrated in a collaborative fashion. The ideal Smart Roadside "system," when fully deployed, will improve the safety, mobility, and efficiency of truck movement and operations on the roadway by facilitating:

- The integration of external systems that enhance the exchange of information for CMV operations to support roadside operations (i.e., the integration of roadside applications with these external information systems that provide information on CMV 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 CMV routes to support the exchange of information.

Chapter 3. SRI Prototype Description and Development Summary

User Needs

Throughout the project, the development team worked with key stakeholders from the law enforcement and trucking industry communities to identify gaps in user processes and data exchanges that a prototype SRI system might improve. Once identified, the changes were prioritized. The process for prioritizing potential SRI applications was to identify existing technologies and systems that:

- Address core functional objectives of the SRI;
- Have been deployed successfully;
- Are used or are likely to be used in the marketplace;
- Can be integrated to deliver enhanced SRI functionality; and
- Comply with the national Intelligent Transportation System (ITS) architecture.

The objective was to integrate and augment technologies to address both enforcement and industry user needs. With this general prioritization framework in place, the development team sought input from the user community regarding the needs and concerns from which the priorities could be formulated. Identifying, developing, and prioritizing user needs and potential applications involved extensive stakeholder input. This input was developed through a series of meetings, and through focus groups, interviews and surveys of motor carriers, enforcement officials, technologists and others. These efforts are detailed in Section 5 of this document.

For State motor carrier safety enforcement users responsible for ensuring carrier, vehicle, and driver compliance with safety regulations, the needs and concerns identified include operating under limited staff and budget and the desire for user (inspector) friendliness. The general conclusion was that more automation was necessary and that systems should require less user training, have improved human interface(s) and ease-of-use, and provide more accurate and current data to increase utilization and value. In addition to these general needs, enforcement users indicated that the system should:

- Accommodate visual inspections and manual data entry;
- Provide WIM measurements that enable enforcement personnel to identify and flag vehicles for additional weight checks using a static scale;
- Provide dimension measurements that enable enforcement personnel to identify and flag vehicles for additional size measurements;
- Provide parallel feeds of data for both enforcement and carrier systems concurrently and in real-time;
- Provide flexibility to “interrogate” vehicles in both fixed and ad-hoc locations;
- Make inspection results available at locations down-stream;

- Maintain accurate, up-to-date, and reliable data that can support evidentiary needs for use in legal proceedings;
- Provide a means to ensure that data is uncorrupted, verifiable, and secure;
- Be user-friendly, easy to use, understandable, and beneficial to the roadside inspector; and
- Be integrated into existing work flows and work processes.

For potential motor carrier users, which include motor carrier management personnel and drivers who could rely on SRI as a means to convey data essential to conducting screening and inspections and who may use it to access parking data or other services, the needs and concerns include data privacy, security, transparent access, enforcement uniformity, and consideration of cost impacts (especially for smaller carriers). In addition to these general needs, carriers also stipulated that the prototype system should:

- Use transponders for identification purposes only, and that these not be tied to personal information;
- Notify them of “automatic” and any other inspections in real-time, and use these inspections to update their CSA scores;
- Require minimal additional equipment to be installed in vehicles and limit driver distraction;
- Contribute to the minimization of delays;
- Leverage existing technologies whenever possible; and
- Use technology that provides a rapid return on investment (ROI).

Based upon this input, and analysis of pre-defined SRI technical and operational characteristics, the research team formulated a set of user needs which were documented in the SRI Concept of Operations, the most recent update/publication of which is from September 2015.

SRI Prototype Description and Components

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

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

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

When conceptualized in the Concept of Operations, the application of the SRI prototype system was depicted below in Figure 1. By contrast, Figure 2 shows what was actually implemented at both deployed sites. Appendix A contains the SRI prototype traceability matrix, which traces the system design components back to the system requirements and user needs.

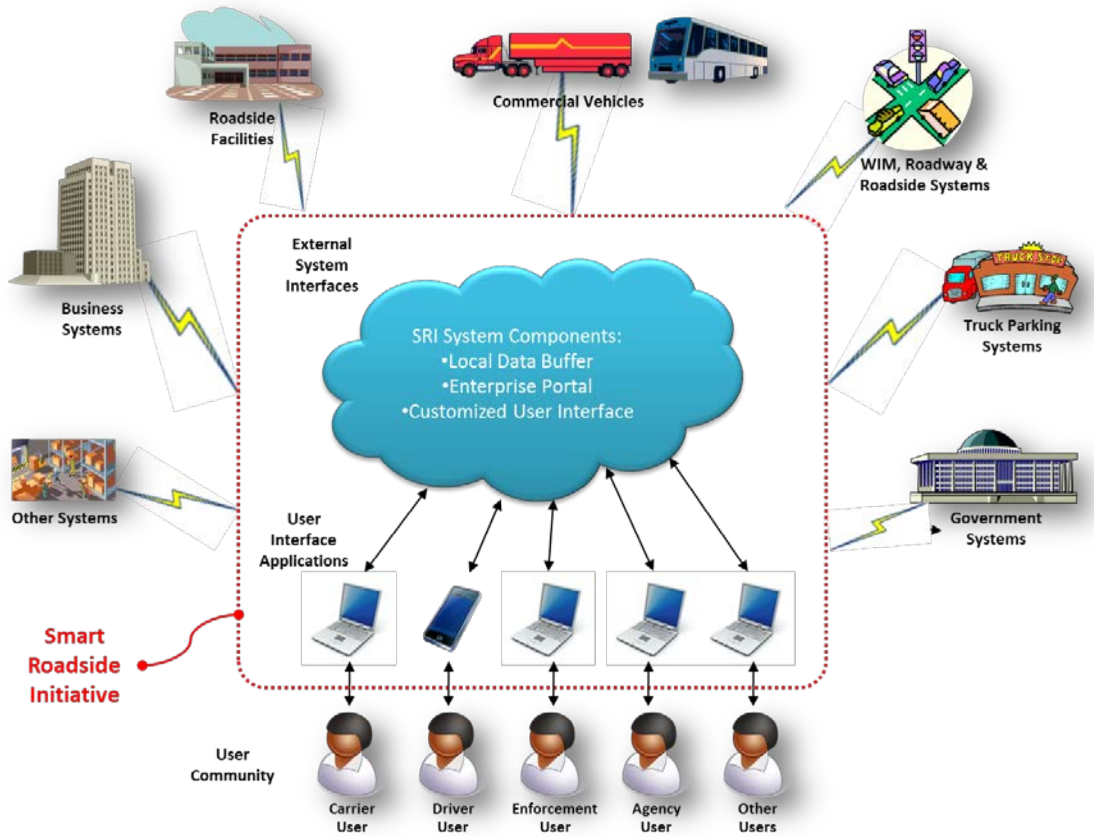


Figure 1. SRI High-Level Perspective Framework

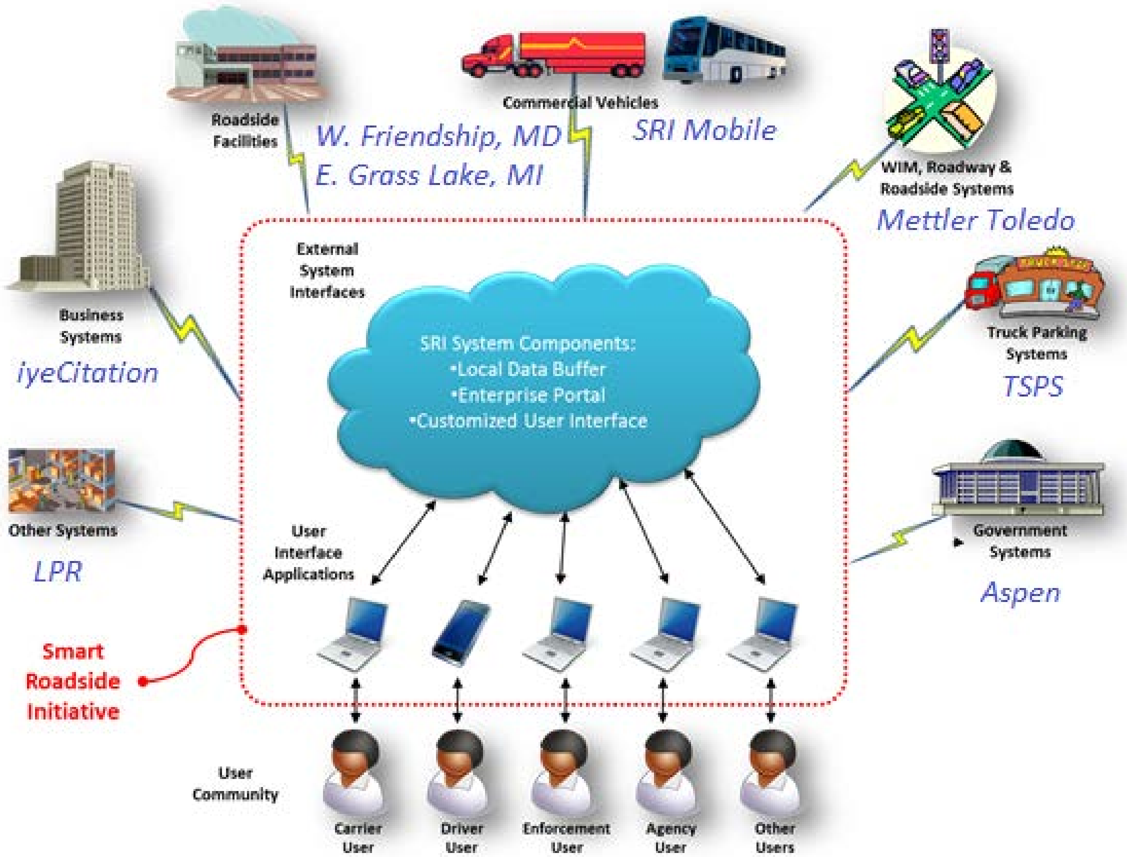


Figure 2. SRI High-Level Perspective Framework (Updated)

Design Rationale

Since multiple systems (Federal, State, and commercial) have to be accessed for CMV screening, a cloud computing approach was chosen. Cloud computing is the use of computing resources (hardware and software) that are delivered as a service over a network. The name comes from the use of a cloud-shaped symbol as an abstraction for the complex infrastructure it contains in system diagrams. Cloud computing allows for a central location of services that can be offered for multiple clients at multiple locations. RESTful (Representational State Transfer) Web Services are used to provide access to the SRI System's Cloud computing platform.

REST-style architectures consist of clients and servers. Clients initiate requests to servers; servers process requests and return appropriate responses, usually in the form of an extensible markup language (XML) document. Requests and responses are built around the transfer of representations of resources. A resource can be essentially any coherent and meaningful concept that may be addressed. A representation of a r esource is typically an XML or a Javascript Object Notation (JSON) document that captures the current or intended state of a resource. The SRI cloud computing is depicted below in Figure 3.

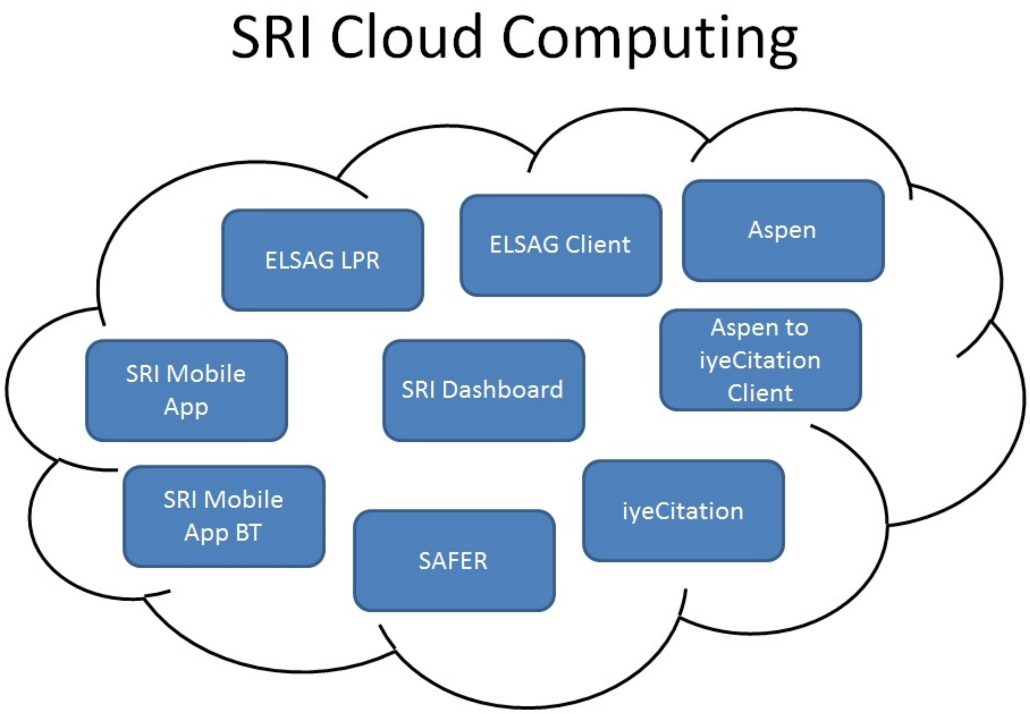


Figure 3. SRI Cloud Computing (Updated)

A web application for this prototype was chosen instead of a thick client approach. Due to the number of systems accessed and the proprietary nature of the applications, a thick client was deemed to be too costly and too restrictive. To alleviate the complexity, multiple thin clients were written to access local data from the systems and were transmitted using the web service framework provided by SRI. In the Mettler-Toledo scale application, the vendor was able to write to the web services themselves. The data provided to the web services was then viewable via a web browser and logon credentials. A collection of Comet servlets were used to provide real time data pushes to the browser when new data was received.

Since SRI was changed from being a thick client to a web application, the goal of having the system available on multiple platforms was still accomplished. The end user just needed to have a system with a modern browser (i.e. Chrome or Firefox) and Internet connectivity.

The foundational element of the SRI system is the establishment of open standards-based connectivity through the use of RESTful web services to the variety of systems that are currently in place at the Federal, State, and local levels, referenced as R-WS in Figure 4, which is discussed below in the As-built SRI Prototype Design section. This connectivity is essential to the timely 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.

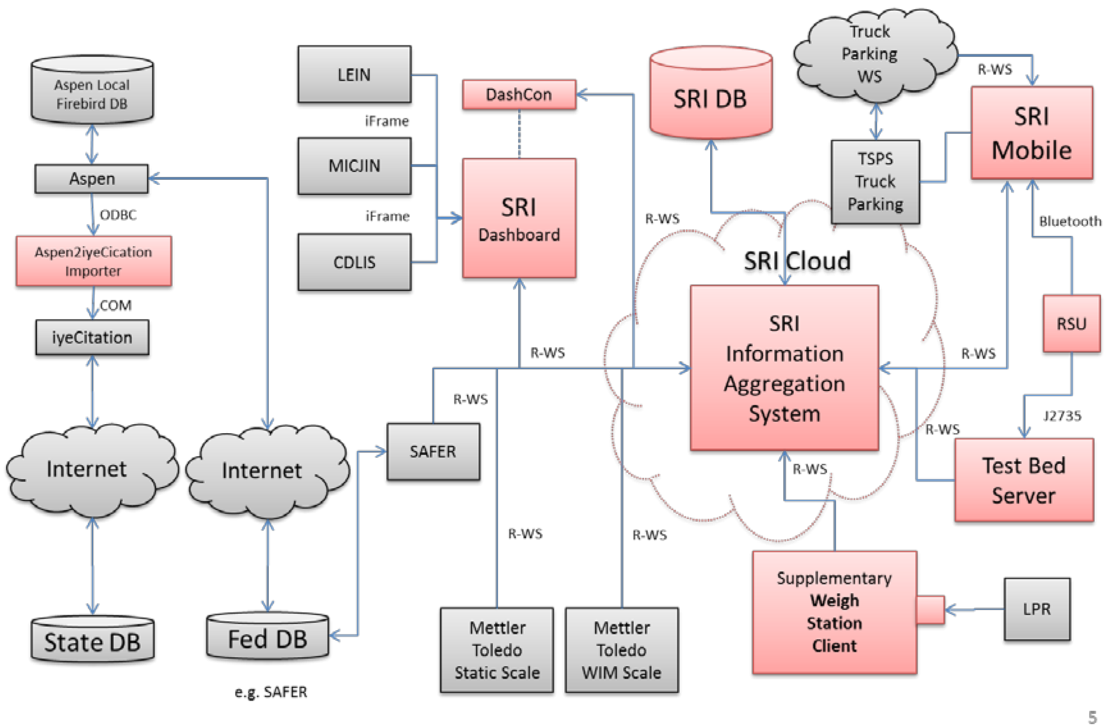


Figure 4. Interconnectivity of the SRI Information Aggregation System

The second major element is the mechanism by which users access information. This information, which is used to facilitate a broad range of operational and policy decisions, must be presented to users in a concise, consolidated fashion. These user interfaces are intended to be single points of access that use standardized information access mechanisms, although presentation formats are user-customizable.

The third major element is the communications link between the moving CMV 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 m eans for delivering new capabilities. An overarching element of this vision is that SRI fit into and supports 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 CMV operations, but also to ensure that it leverages technology that may also be used for V2V safety applications. This extends beyond the simple ability to use any such technologies to promote the development and adoption of methods and mechanisms that ensure SRI functions do no t compromise the low-latency data exchanges necessary to support those safety functions.

SRI Prototype Capabilities

New Capabilities

New capabilities tested through the SRI Prototype Test include the following:

- Enhanced exchange of information at roadside (via vehicle-to-infrastructure, V2I, communication) at mainline speeds to support credential reporting;
- Utilization of unique identifiers for drivers, vehicles, and motor carriers who participate in the system that can be exchanged at mainline speeds (for the purposes of the SRI prototype, these identifiers were the drivers' license number (driver), vehicle identification number, VIN (vehicle), and USDOT number (motor carrier));
- 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 SRI enterprise-level application significantly enhances the exchange of data between the roadside and external systems. As a result of this integration through SRI, the law enforcement community is able to exchange information regarding 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.

The additional data sources also provide substantially enhanced visibility into driver and vehicle performance and 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 facility by-pass routes can enhance size and weight enforcement and reduce damage to road systems. By-pass route instrumentation is an effective deterrent to trucks exiting mainline facilities in order to bypass weigh stations. Not only does instrumentation on by-pass routes reduce damage, but it also assists in enforcing weight limits on these routes. Therefore, where appropriate at future prototype sites, data from these devices can be integrated into SRI.

It is important to articulate that the new and enhanced capabilities of the SRI system benefit 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 examined truck parking detection and notification systems and pilots currently in development and integrated them into the system design where deemed feasible based on the maturity of these developments.

The Smart Roadside Initiative System Requirements Specifications (October 16, 2012 and updated September 2015) and the Smart Roadside Initiative System Design Document (March 2013 and updated September 2015) detail the SRI System Context, System Modes and States, Major System Capabilities, Major System Conditions (Operational Policies), Major System Constraints, User Classes and their interactions, assumptions and dependencies, and the operational scenarios for the prototype system. The following provides an overview of the SRI prototype components, information exchanges, and test scenarios.

As-built SRI Prototype Design

At the heart of the SRI prototype is the SRI Information Aggregation System (SIAS). This component contains the web services and other communications interfaces which integrates to external sensors and systems to collect, verify and present the gathered information such as license plate, truck weight, USDOT number, and driver information to the relevant information users including law enforcement officers and truck drivers.

Figure 4 depicts its relationship to the other SRI prototype components.[3] Note that the red items are the components developed by Leidos under contract to USDOT; gray items are existing systems and connections.

Service-Oriented Architecture

A service-oriented architecture (SOA) is the architectural pattern in which application components provide services to other components via a communications protocol, typically over a network, in this case; the Internet. The principles of service-orientation are independent of any vendor, product, or technology. For example, the web service protocol for the reporting of CMV weight is ambiguous enough for WIM provider, Mettler Toledo, to use for both static scale reporting and weigh in motion reporting. It is also generic enough for other vendors to use if they chose to be a part of the Smart Roadside Initiative. The sign-up process would expose the weight reporting web service protocol, structure, and assignment of credentials to send the web service data.

Core Functionality

SIAS functionality includes:

- Dynamic web interface that displays CMV information to officers in real time,
- The collection of CMV weight information from Mettler Toledo WIM and static scales,
- The storage of CMV weight information on the SRI database for 24 hours,
- The collection of license plate images and data from ELSAG (vendor),
- The storage of license plate data on the SRI database for 24 hours,
- The storage of license plate images on the SRI App Server for 24 hours,
- The collection of CMV credential information from SRI Mobile,
- The storage of CMV credential information on the SRI database for 24 hours,
- The exchange of Aspen data to iyeCitation for reduction in data entry,
- The automatic retrieval of SAFER information via SRI Mobile credentials,
- The manual retrieval process for SAFER data,
- The development of a mobile application for storing and providing CMV and Driver related credentials automatically to weigh station,

[3] SRI Prototype System Integration and Test Plan, Leidos, May 2015.

- The notification of Pass/Fail weight status from weigh station to mobile application,
- The development of a mobile website to allow officers to view SRI on either a tablet or smartphone wherever Internet connectivity is available.

Data Exchanges

SIAS communications includes:

- HTTP(S) protocol for accessing of SRI Web Services.
- HTTP(S) protocol for accessing TSPS (Truck Smart Parking System) Web Services
- HTTP protocol for accessing SAFER Web Servlet
- FireBird ODBC protocol for accessing Aspen DB.
- DLL for accessing iyeCitation COM objects
- Directory watcher for ELSAG LPR software. When new data files are deposited, the application sends the information to SRI via the SRI Web Services
- Bluetooth protocol for sending CMV and Driver related credentials to an On Board Unit (OBU) (see Figure 5)
- Bluetooth protocol for receiving weight status from OBU
- Digital Short Range Communication (DSRC) protocol for exchange of data between OBU and Road Side Unit (RSU)

Figure 5. Arada OBU Unit

In essence, the SIAS collects, synthesizes, and formats information from site, State, Federal, and carrier systems to facilitate jurisdiction-dependent enforcement decisions that improve inspection efficiency and lowers false positives.

Data Management

SRI is dependent on outside systems and services to operate at full capacity. External system access is key for maximum web application functionality. However, all of the external systems are not reliant upon each other. If one of the systems goes down, the others will still continue to function. The SRI system is capable of functioning even if one of the external systems becomes unavailable, although with a more limited feature set.

Data is stored from external systems on the SRI system for a maximum of 24 hours. An hourly script wipes data sensitive information from tables for any data older than 24 hours. This will keep from data tracking as well as limit the exposure to PI data.

Security

The SIAS controls user accounts with login and password credentials for customizable business rules, notification filters, and other configuration settings that are relevant to enforcement sites and their jurisdictions. The implementation utilizes standard security measures such as a secure socket layer (SSL) for encryption, which is the defacto industry standard for secure internet communications. The access system was implemented with different privileges, including one for system administrators.

SRI Mobile Website

The SRI prototype has a dynamic web user interface that utilizes a web responsive framework. This framework allows for the presentation layer to respond differently for different types of clients based upon the resolution of the display device making the request. So the web application will look and behave differently based upon the device viewing it.

On a personal computer (PC) with a high resolution monitor, SRI is full featured with all of the components viewable on one screen. An example of the desktop website, as deployed in the West Friendship, MD weigh station is depicted in Figure 6.

Figure 6. SRI Website on PC/Monitor

On a tablet or a smartphone that same uniform resource locator (URL) will be scaled back to utilize the smaller real estate that lower resolution provides. With a responsive framework, the UI adapts for many different resolutions and screen sizes.With the Mobile Website, officers can utilize Smart Roadside from any mobile device of their choosing. As long as Internet connectivity is available on the mobile device, Smart Roadside can be used. This frees up commanding officers to view the goings on of the weigh station without having to be present at the weigh station. Log in and subsequent screens are presented in Figure 7:

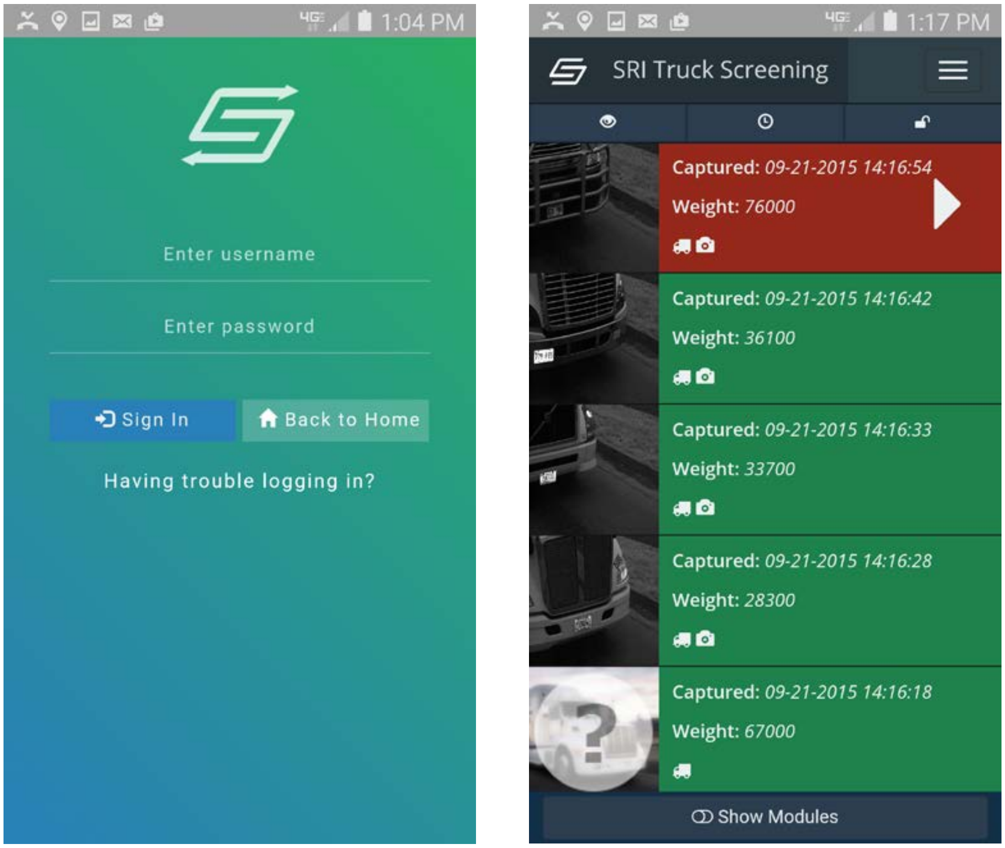


Figure 7. SRI Mobile Website

SRI Mobile Application (Mobile App)

The SRI prototype includes a mobile application for truck drivers that provides audio and visual cues notifying the driver to either pull into the weigh station for further inspection or to bypass the static scale. While stationary the driver can also access the Truck Smart Parking System to locate available truck parking spaces. This application provides a mechanism for drivers to enter their license number, VIN, USDOT number, and license plate number, as well as a photo of their specific vehicle. In addition, this application provides the communication back to the driver regarding their weigh station instructions. The mobile application interfaces with the SRI core services. The mobile application for the truck driver includes:

- Fields for the driver to enter their relevant information (when opening the mobile application for the first time).
- Provides the result of the Mettler-Toledo weight assessment (pass or fail) to the driver via a visual red light/green light screen plus audio via cellular communication.
- Provides truck parking information (using the Truck Smart Parking Service, TSPS), which is automatically pulled up for the driver when leaving a geofence around the weigh station. This geofence is defined by the SRI prototype.

Figure 8 presents images for the drivers' entry of information and truck parking. Figure 9 presents the instructions and results of the weight assessment; all instructions and results were also verbally communicated to the driver in accordance with FMCSA safety requirements.

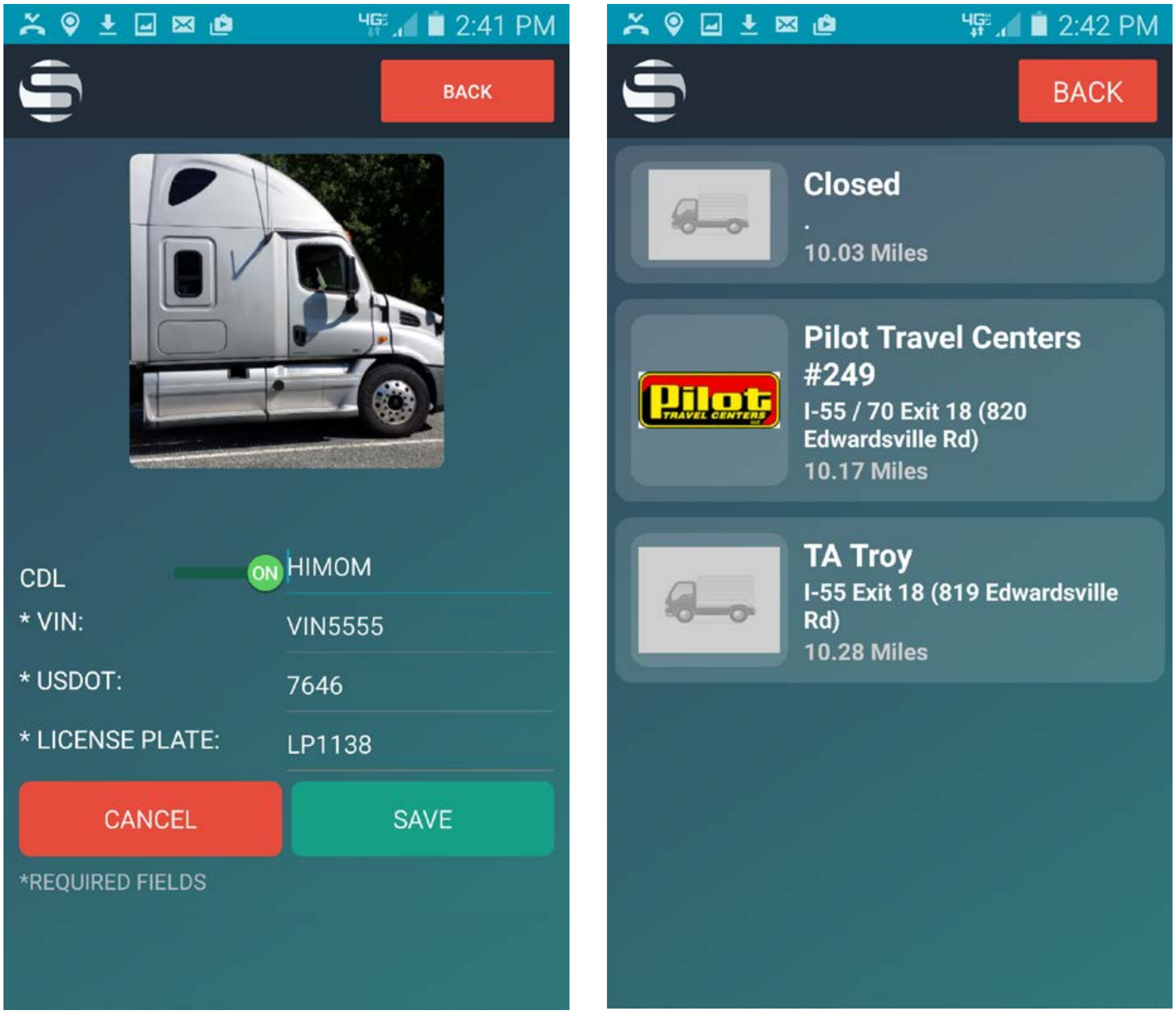


Figure 8. SRI Mobile Application

Figure 9. SRI Mobile App Instructions and Results

A DSRC version of the mobile application was also tested in the Maryland pilot. In that scenario there is a backend server that received the data from a roadside unit (RSU) and request Mettler-Toledo weight assessment from the SRI Web Services. The response was processed by the backend server, converted into a J2735 compliant message using SAE J2735-Nov 2009 (J2735_200911) and sent to the RSU. The RSU then broadcasts that message to the on-board unit (OBU) via dedicated short-range communication (DSRC), and the OBU sends the message to the mobile application via Bluetooth. The RSU used is one of the mobile trailer units from the USDOT's Saxton Transportation Operations Laboratory (STOL). For future implementations a similar RSU can be used at any location and still provide the same communications back to the OBU. Figure 10 depicts the antenna and unit, as installed at the West Friendship weigh station.

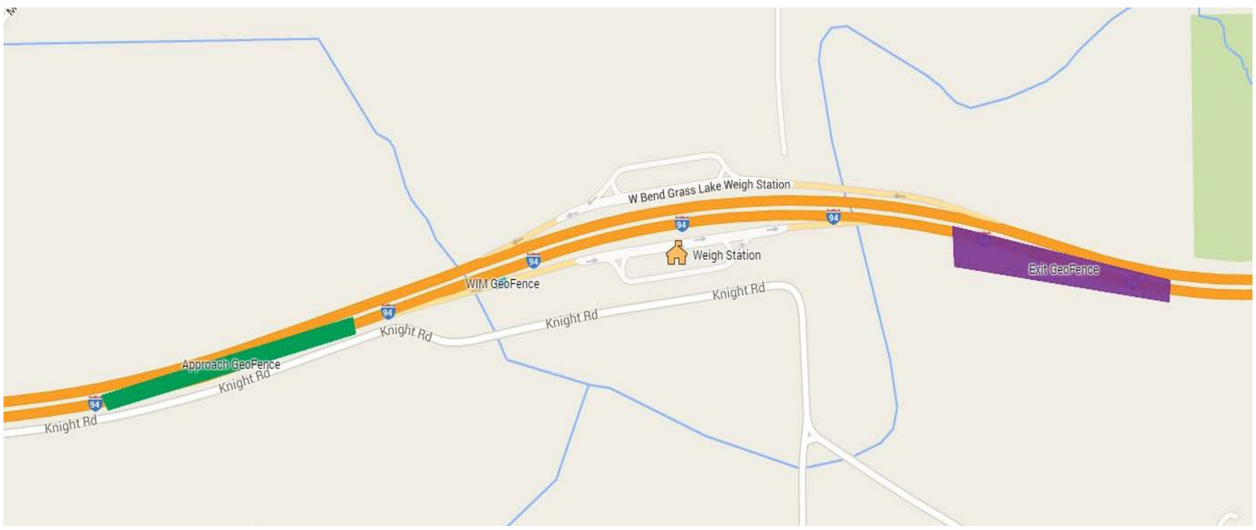
Figure 10. RSU Antenna and Unit

Chapter 4. Test Site Descriptions

Two test sites were chosen for the prototype, one weigh station in Michigan and one in Maryland. Both locations have Internet connectivity which makes access to the cloud system possible. This allows for exchanges to occur between the all of the various systems introduced by Leidos and all of the vendor systems available on the Internet. The following presents summaries of the sites in terms of location, hardware and software and connectivity.

East Grass Lake Weigh Station, MI

The Grass Lake Weigh Station is located on Eastbound Interstate 94: Latitude: 42 17 36 N, Longitude: 84 10 41 W. An overview of of the weigh station and location of geofences and relevant sensors is shown in Figure 11.



Leidos/Google Maps

Figure 11. Michigan Grass Lake Weigh Station SRI Configuration

In Figure 12, the SRI System is deployed to the East Grass Lake Weigh Station in Michigan. This weigh station lacks an LPR reader, which reduces the amount of external interfaces that SRI can integrate with. The site also does not have DSRC support, which makes testing the SRI Mobile App Bluetooth impossible. However, the site does have Aspen and iyeCitation, so the Aspen to iyeCitation Client was tested there.

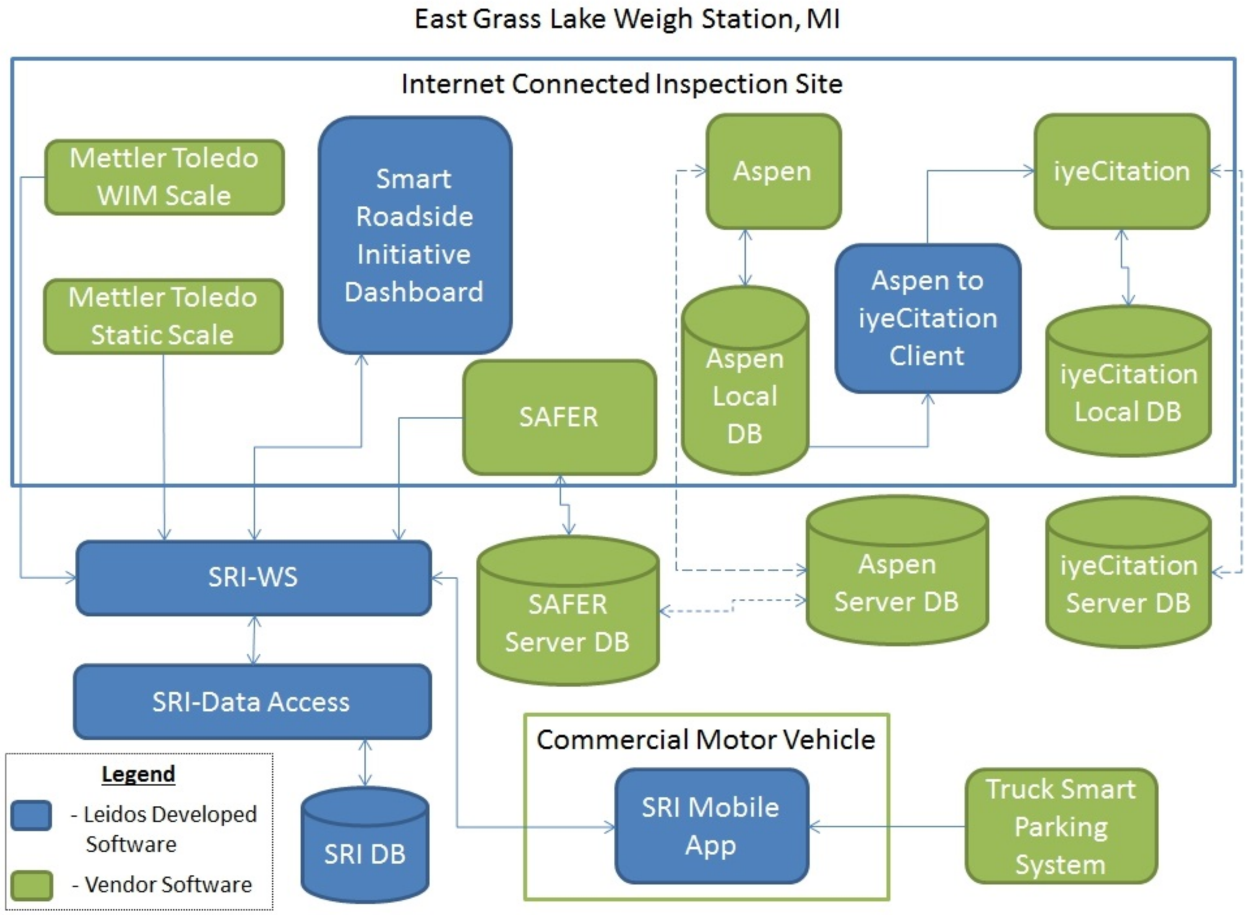


Figure 12. East Grass Lake Weigh Station Communication Diagram

The SRI prototype in Michigan utilized interconnectivity via internet and cellular communications. The SIAS interfaced with Mettler-Toledo to exchange weight information from both the ramp WIM and the static scale at the station. The SIAS also interfaced to SAFER to exchange carrier data, Aspen, and a third-party electronic ticketing system from LexusNexus called iyeCitation to enter and exchange inspection data.

The SRI prototype included a m obile application for truck drivers. This application provided a mechanism for drivers to enter their license number, VIN, USDOT number, and l icense plate number, as well as a photo of their specific vehicle. In addition, this application provided the communication back to the driver regarding their weigh station instructions. The mobile application interfaced with the SIAS to collect data from the SRI Mobile app for presentation to law enforcement users via the SRI Dashboard. The SRI Dashboard contains each source of information available to the user, in the case of the Michigan prototype, this included:

- Mettler-Toledo Ramp WIM,
- Mettler-Toledo Static Scale (Note: Figure 13 presents the display of both ramp and static scale data),

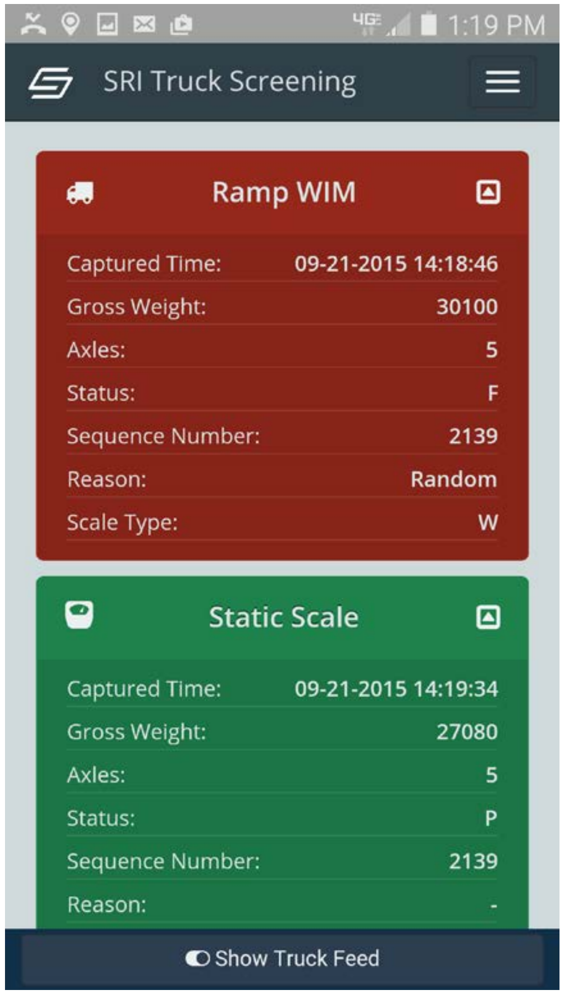


Figure 13. Mettler-Toledo Ramp and Static Scale Data

- SRI mobile website,
- SAFER lookup results (based on USDOT number that is either manually entered by the user or that is received automatically from the SRI mobile application),
- A field to allow the user to enter the vehicle USDOT number (if not available via the SRI mobile application or SAFER),
- An embedded panel to provide access into the MICJIN portal, and
- A button to facilitate the population of iyeCitation with Aspen data (i.e., the means by which the SIAS accesses the inspection data from Aspen and pre-populates the electronic ticket in iyeCitation).

Figure 14 displays the SAFER lookup screens after the user has entered the USDOT number (on the mobile SRI mobile website).

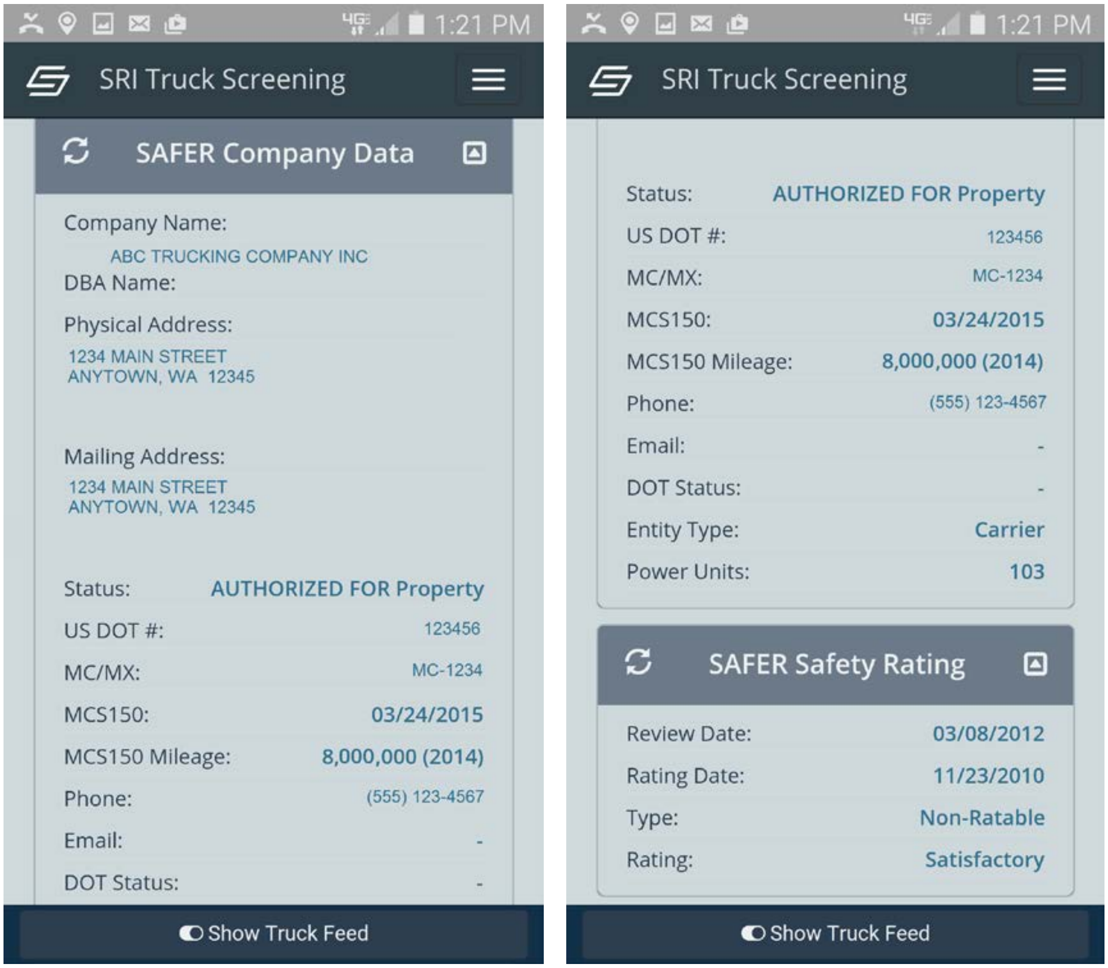


Figure 14. SAFER Data Lookup

The SRI mobile application for the truck driver included:

- Fields for the driver to enter their relevant information (when opening the mobile application for the first time).
- Provided the result of the Mettler-Toledo weight assessment (pass or fail) to the driver via a visual red light/green light screen via cellular communication.
- Provided truck parking information (using the Truck Smart Parking Service, TSPS), which is automatically displayed for the driver while traveling before or after the weigh station. These actions are invoked via multiple geo-fences defined by the SRI prototype.

Sensors

- Mettler-Toledo Ramp Weigh-in-motion scale (WIM), model: MT 4 load cell WIM
- Mettler-Toledo Static Scale (at Station), model: MT 7541 with PDX

Existing Systems/Software

- Aspen
- SAFER (Truck/carrier lookup using USDOT number)
- HTML 5 compliant browser (Firefox) – MI uses IE 8 but can use whatever required
- I-94 Truck parking pilot (Truck Smart Parking Service, TSPS, www.trucksmartparkingservices.com)
- MICJIN Portal – provides single sign on to CDLIS, NLETS, Talon, and MI internal systems
- Internet connectivity:
  - Internet connectivity provided by Verizon
  - Grass Lake Port 443 and 80 are available
  - Mettler-Toledo needs separate Internet connection for their software

Points of Integration for SRI Prototype

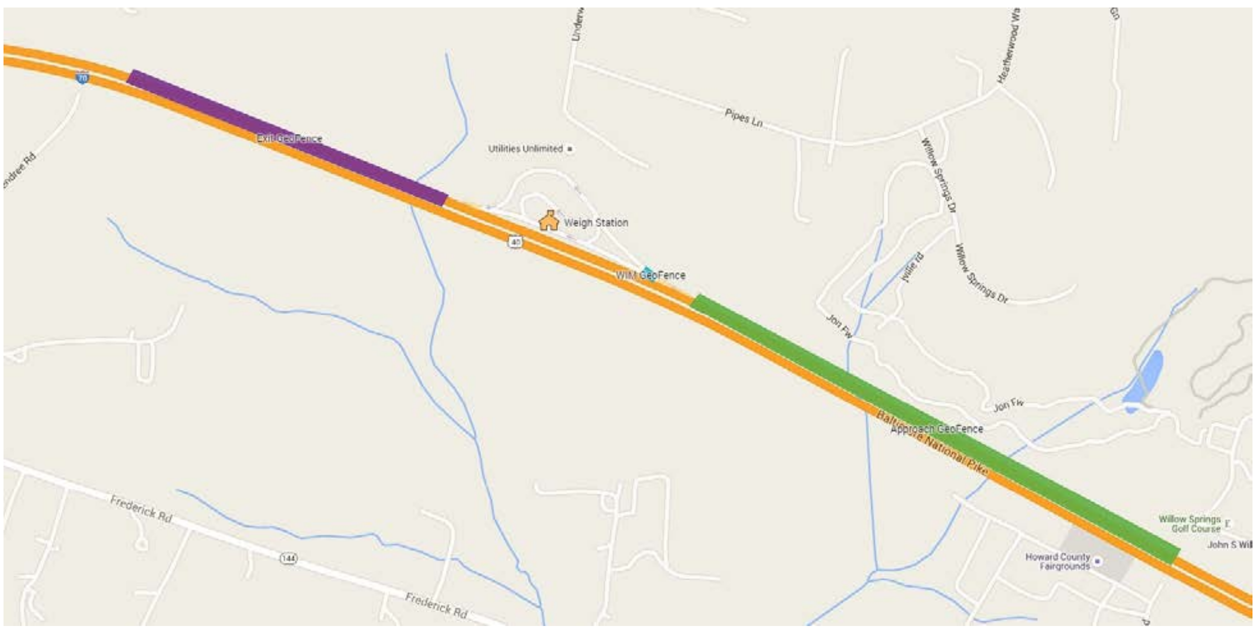
- Mettler-Toledo Ramp WIM
  - Mettler developed application program interface (API) connection to SRI; Leidos developed Web Services integration to SRI
  - Internet connectivity
  - API: RESTful Web services, https
- Mettler-Toledo Static Scale
  - Mettler developed API connection to SRI; Leidos developed Web Services integration to SRI
  - Internet connectivity
  - API Details: RESTful Web Services, https
- Michigan Criminal Justice Information Network (MICJIN) portal, which facilitates access to:
  - Law Enforcement Information Network (LEIN)
  - TALON v 2.08.20 – MI DMV
  - National Law Enforcement Telecommunications System (NLETS)
  - No details needed for the integration with the SRI prototype – SRI user interface included an embedded panel which opened the MICJIN portal.
- TSPS
  - TSPS RESTful web services
- Aspen
  - Software was resident on all officer's laptops, Leidos developed code to retrieve data from Aspen to pre-populate iyeCitation client
  - Connection details:
    - Firebird connection to local database

  - .net connection open database connectivity (ODBC) from local database to executable

- LexusNexus iyeCitation (electronic ticketing)
  - LexusNexus provided available file template and import process
  - Common object module communication from executable to iyeCitation
- SAFER
  - Software was resident on the officer's test laptop, Leidos developed code to retrieve data from Aspen to pre-populate iyeCitation client
  - Internet connectivity was provided through the weigh station's local area network
  - Web servlet

West Friendship Weigh Station, MD

The Maryland test site is located in West Friendship, I-70 Westbound and Route 40 (West of Maryland 32, Exit 80, mile marker 79). An overview of the weigh station and location of geofences and relevant sensors is shown in Figure 15.



Leidos/Google Maps

Figure 15. Maryland West Friendship Weigh Station SRI Prototype Configuration

In Figure 16, the SRI System is deployed at the West Friendship Weigh Station in Maryland. This station provides the most robust use of the system with access to both the Mettler Toledo scales as well as the ELSAG License Plate Readers. Add the integration and support for both the SRI Mobile App Cellular and Bluetooth this makes it the test location with the most comprehensive external interfaces.

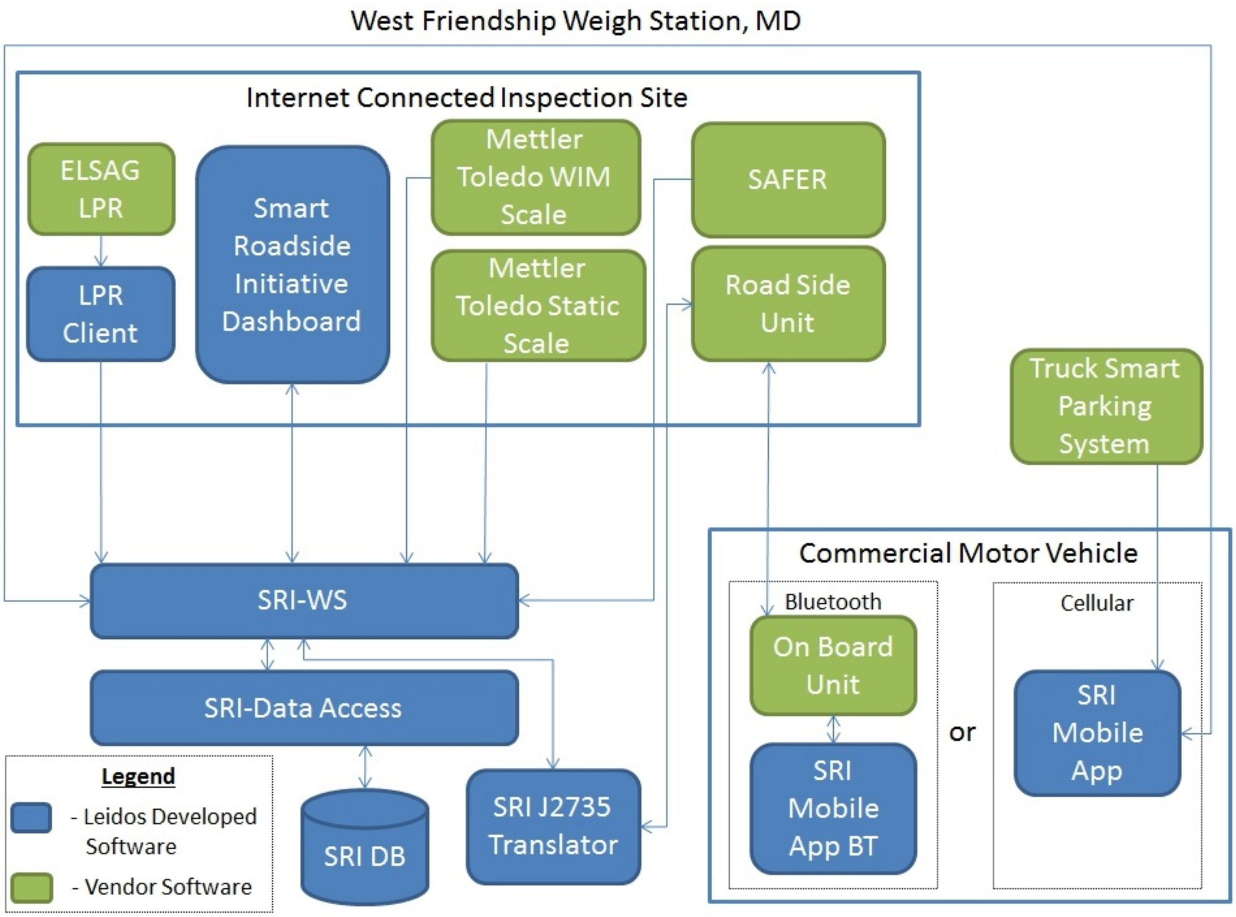


Figure 16. West Friendship Weigh Station Communication Diagram

The SRI prototype in Maryland utilized interconnectivity via internet and cellular communications, but also includes a DSRC protocol to facilitate the communication between the vehicle and the roadside. As depicted in Figure 16 the SRI J2735 Translator was developed to convert BER encocoded J2735 messages to a format compliant with SRI Web Services. It also converted the web service response into a BER encoded J2735 message and sent it back to the RSU. As in Michigan, the SIAS interfaces with Mettler-Toledo to exchange weight information from both the static scale at the station and the ramp weigh-in-motion (WIM). The Maryland prototype also interfaces to a third party LPR from ELSAG. The SIAS exchanges carrier data with SAFER.

The SRI prototype includes a mobile application for truck drivers. This application provides a mechanism for drivers to enter their license number, vehicle identification number (VIN), USDOT number, and license plate number, as well as a photo of their specific vehicle. In a ddition, this application provides the communication back to the driver regarding weigh station instructions – in Maryland, two tests were performed, one via DSRC and the second test via cellular as in Michigan. Therefore, the hardware in Maryland included both a D SRC-enabled OBU in the vehicle and a roadside unit (RSU). The OBU communicates to the SRI Mobile app via Bluetooth.

As in Michigan, the mobile application interfaces with the SIAS; data from the SIAS is configured for presentation to law enforcement users via the SRI Dashboard. The SRI Dashboard contains each source of information available to the user, in the case of the Maryland prototype, this includes:

- Mettler-Toledo Ramp WIM
- Mettler-Toledo Static Scale
- ELSAG LPR
- SRI mobile application
- SAFER lookup results (based on USDOT number that is either entered by the user or that is received from the SRI mobile application)
- A field to allow the user to enter the vehicle USDOT number (if not available via the SRI mobile application or SAFER)

The mobile application for the truck driver includes:

- Fields for the driver to enter their relevant information (when opening the mobile application for the first time)
- The result of the Mettler-Toledo weight assessment (pass or fail) via a visual red light/green light screen via cellular communication

Sensors

- Main line WIM – Cardinal Scale integrated with Drivewyze. (*Equipment would not accept multiple communication connections*)
- Ramp WIM – Mettler-Toledo (upgrade completed just prior to pilot)
- Static Scale – Mettler-Toledo (upgrade completed just prior to pilot)
- Mobile LPR – Mobile Plate Hunter 900 (ELSAG)

Existing Systems/Software

- Maryland's Electronic citation system
- Aspen
- HTML 5 compliant browser (Firefox)
- Drivewyze
- SAFER
- Query Central (out of service carrier information)
- FMCSA Inspection Selection System (ISS)
- NLETS
- Automated Hauling Permit System (AHPS) Bentley v 020604
- CDLIS

Integration to SRI Prototype

- Ramp WIM – Mettler Toledo load cell (equipment upgraded for pilot):
  - Mettler developed API connection to SRI; Leidos developed Web Services integration to SRI

- Internet connectivity
- API Details: RESTful Web Services, https

- Static scale – Mettler Toledo multi-platform load cell
  - Mettler developed API connection to SRI; Leidos developed Web Services integration to SRI
  - Internet connectivity
  - API Details: RESTful Web Services, https

- ESLAG LPR:
  - ELSAG hardware; a new stationary camera was installed for this test
  - Connectivity – Internet connectivity was provided through the weigh stations local area network. Note, LPR images, as available through SRI are presented in Figure 17.

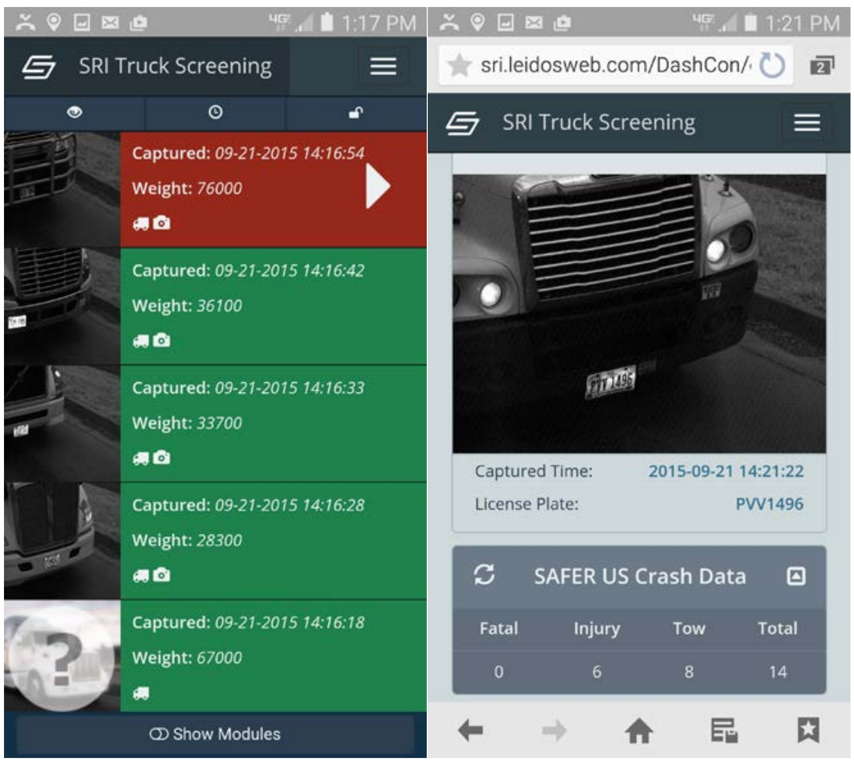


Figure 17. SRI LPR Images

- DSRC network (See Michigan Site Summary)
  - 1 mobile RSU was transported to the test site
  - DSRC + backhaul network to access SRI web services

- Aspen:
  - No existing connectivity to Maryland electronic citation system

- SAFER

- Access via internet connection
- Connection details:
  - Web servlet

Chapter 5. Summary of Stakeholder Involvement

From the outset of the project, the development team sought input from stakeholders representing motor carrier safety and weight enforcement agencies and associations, motor carriers and motor carrier industry associations, technology companies and associations, as well as frequent review and guidance from the project sponsors. The purpose was to develop SRI to meet the needs of users and others interacting with the system by developing a sound Concept of Operations (ConOps) and realizing the concept by fielding and testing a prototype system that leverages and integrates existing technologies and systems. The process involved a series of presentations to stakeholders to gather information, walk through proposed concepts, capabilities and s ystem elements and designs to obtain stakeholder acceptance. These sessions are summarized below.

Stakeholder Involvement – Planning and Design

Enforcement Community User Needs Workshop

In April 2011 at the CVSA Spring Meeting in Chicago, Illinois, an E nforcement Community User Needs Workshop was conducted. The overall goal of the workshop was to determine enforcement user needs for the Smart Roadside Initiative and to identify issues and concerns. Four overview presentations were delivered to start the workshop, and then attendees were asked to participate in one of three facilitated break-out discussion groups.

Each breakout session was facilitated by a member of the SRI Team and included representatives from each of the stakeholder groups participating in the workshop. The questions asked of the attendees focused on enforcement procedures and processes; technologies, hardware, data sources, and systems used to conduct inspections; perceived issues and short comings of current activities; and desired improvements.

Motor Carrier User Needs and Preferences Gathering

Motor carrier industry perspectives were garnered through the following methods:

- Interviews were conducted at the February 2011 Technology and Maintenance Council meeting in Tampa, Florida. The SRI Team was able to conduct detailed interviews with 25 TMC participants. Each interview lasted between 10 a nd 15 m inutes, on av erage. Respondents were asked a variety of demographic questions, followed by a brief technology utilization survey, and an i n-depth discussion of the four core SRI applications: UID, WRI, VWS/ e-Permitting, and truck parking.
- An Industry Executive Focus Group was conducted in Atlanta, Georgia, in March 2011. SRI Team member ATRI conducted a foc us group of hi gh-level industry executives in Atlanta in March 2011. Thirteen industry representatives attended a one-hour discussion on SRI and the four core applications. The executives represented a variety of firms ranging in size from roughly 100 pow er units to over 10,000. The for mat was an open discussion that was led by ATRI researchers who explained the various SRI applications

and the as sociated technologies that would potentially be used to implement the applications.

- A driver survey was conducted at the Mid-America Trucking Show held in Louisville, Kentucky, in March-April 2011. This event provided an important opportunity to solicit feedback from commercial vehicle drivers on SRI technologies, needs and requirements, and overall opinions on the SRI program. A paper survey was provided to attendees who were willing to participate, and the survey team collected 130 responses.

Industry ConOps Walkthrough

On April 20, 2012, a virtual focus group of trucking industry technology and maintenance executives was conducted to present elements of the SRI Concept of Operations (ConOps). There were 18 participants as well as 3 representatives from the American Trucking Associations on the call, and the session lasted 90 minutes. The participants were employed by the organizations listed below. The comments provided by employees were not official company statements, nor did they constitute official company approval or disapproval of the SRI concept.

- ABF
- American Trucking Associations
- Bose
- Cummins
- FedEx Freight
- Florida Trucking Association
- Intermec Technologies
- JBT
- McLeod Software
- MHC Truck Leasing
- Ozark Motor Lines
- PeopleNet
- Southeastern Freight Lines
- Transport America

The meeting began with a brief introduction to SRI which included a review of the SRI vision and objectives. After a short overview of the purpose of the ConOps and the ConOps walkthrough, the attendees discussed content, providing their feedback on the Operational Scenarios, Operational Assumptions, and Operational Constraints

Commercial Vehicle Driver Focus Group

On April 23, 2012, a virtual focus group of truck drivers was held to review elements of the Smart Roadside Initiative ConOps. A total of six drivers attended the virtual focus group, which lasted one hour. The drivers were employed by large truck fleets (ABF, Conway, UPS, Wal-Mart, YRC). The comments provided by employees are not official company statements, nor do they constitute official company approval or disapproval of the SRI concept. Due to time constraints and the area of expertise of the audience, only the five ConOps operational scenarios were discussed and driver feedback obtained.

System Requirements Review

On October 2, 2012, the development team presented a S ystem Requirements Review to the following stakeholders:

- Gary Capps, Oak Ridge National Laboratory (ORNL);
- Braxton Vick, Woody Lawless, and Lee Long, Southeastern Freight Lines;
- Mike Nichols, Intermic;
- Rita Goulet, Ontario Ministry of Transportation (MOT);
- Pierre Bolduc and Glen McDonald, Ozark Motor Lines;
- Brent Hilton and Mike Jeffress, Maverick;
- Brooks Snider, Colorado Port of Entry (POE);
- Randy Coplin, Michigan State Police;
- Barry Pekilis TC;
- Mark Savage, Colorado State Police (CSP);
- John Sullivan, Reliable Carriers;
- Mark Mitchell, Cloud Software ITLC;
- Ronald Szapacs, TMC;
- Matt Hanson, Caltrans;
- Mark Bell and Jonathon Sabean, Transport Canada;
- Rick McDonough, New York State (NYS) DOT;
- Kevin Otto, Cummins;
- Chris Flanigan, Kate Hartman, Randy Butler, Jeff Loftus, Tom Kearney, Greg Davies, and Walt Fehr, USDOT.

The objective of the meeting was to review of top level capabilities and conduct a detailed review of each individual requirement in terms of wording, metrics, testing method, etc.

System Architecture Document Review

On October 2, 2012, the development team presented a S ystem Requirements Review to the following stakeholders:

- Gary Capps, ORNL;
- Braxton Vick, Woody Lawless, Lee Long, Southeastern Freight Lines;
- Mike Nichols, Intermic;
- Rita Goulet, MOT Ontario;
- Pierre Bolduc, Transport Canada;
- Glen McDonald, Ozark Motor Lines;
- Brent Hilton, Mike Jeffress, Maverick;
- Brooks Snider, Colorado POE;
- Randy Coplin, Michigan State Police;
- Barry Pekilis, TC;
- Mark Savage, CSP;
- John Sullivan, Reliable Carriers;
- Mark Mitchell, Cloud Software ITLC;
- Ronald Szapacs, TMC;
- Matt Hanson, Caltrans;
- Mark Bell, Jonathon Sabean, Transport Canada;

- Rick McDonough, NYS DOT;
- Kevin Otto, Cummins;
- Peggy Fisher,TireStamp;
- Chris Flanigan, Kate Hartman, Randy Butler, Jeff Loftus, Tom Kearney, Greg Davis and Walt Fehr, USDOT.

The meeting approach/objective was a review of conceptual and functional architecture to determine:

- Consistency with SRI objectives
- Clear definition of elements
- Correct definition and use of terminology
- Complete identification and documentation of all connections

System Design Document Traceability Review

On December 17, 2013, the development team conducted a System Design Document Traceability Review with FHWA that addressed the following:

- Basic operations
- Reliability – system availability
- Operational performance e.g. comm speed, user interface performance
- Some security issues to be addressed after prototype, such as vendor provided userid and password for SRI web service access, and whether SSL was sufficient site security.
- Address orphan user needs from ConOps (see Top Level notes)
- Possible conflict with 3rd party solution providers in business rule usage.

System Design Document Walk Through

On March 20, 2013 this was conducted with representatives from motor carriers, commercial vehicle enforcement and associations and governmental sponsors. The walk though covered the following:

- Review of data structure
- Use case realizations
- System interfaces

Site Visits

In addition, the Team conducted site visits to Missouri, Kentucky, North Carolina, and New Mexico, four States that are currently deploying some SRI-like applications. Two other site visits to Colorado and North Dakota were also conducted, but those sites were using very limited technologies. The research team used these site visits to gain an understanding of State deployment challenges and system operations.

The series of meetings, reviews, walkthroughs and site visits resulted in a Concept of Operations and System Design acceptable to motor carriers, commercial vehicle drivers, and commercial vehicle enforcement officials.

Chapter 6. Prototype Test Summary

Test Approach

The testing of the SRI prototype in the laboratory/development environment included the following levels:

- Unit testing:
  - Tests an individual unit, such as a method (function) in a class, with all dependencies mocked up.
    - This testing was performed by the Leidos development team in the development setting (not in the field). It was approved by the development team leader.
  - SRI prototype unit testing included:
    - Test each node of the SRI prototype individually
    - Test integration of all nodes together.
- Integration testing:
  - Focused on a slice of functionality in a system. This tested many methods and may interact with dependencies like Databases or Web Services.
  - As with unit testing, this testing was performed by the Leidos development team with assistance from developers from external systems (Aspen, iyeCitation, TSPS, and Mettler-Toledo) as required in the development setting (not in the field).
  - SRI prototype integration testing tested connectivity to each node (data retrieval, data posting/display).

Performance, system, and acceptance testing was conducted in the field. Field testing in Grass Lake, Michigan was conducted on August 17-18, 2015. Field testing in West Friendship, Maryland was conducted on August 19-21, 2015. The goals of these tests were:

- Performance testing:
  - Focused on determining how a system performed in terms of responsiveness and stability under a particular workload. It also served to investigate, measure, validate, or verify other quality attributes of the system, such as scalability, reliability and resource usage.
  - For the SRI prototype, this testing was conducted by the development team in the field and allowed the performance of the SRI prototype to be evaluated against the documented performance and security requirements.
- System testing:
  - Conducted on a complete, integrated system to evaluate the system's compliance with its specified system requirements.
    - This test was conducted by the development team in the field and allowed the performance of the SRI prototype to be evaluated against the remaining system requirements: system (e), application (a), interface (i)

  - o System testing relied on the operational scenarios as defined in the SRI ConOps document.
- Acceptance testing:
  - o Conducted to determine if the requirements of a specification or contract are met.
    - For the SRI prototype, the development team providing on-site training to actual end users (law enforcement and motor carriers), as identified below. Following this, the users interacted with the SRI prototype during the test period.

The SRI prototype entered into acceptance testing after all defects were corrected following system testing. It was imperative that SRI prototype testing activities presented minimal impact to normal operations at the weigh stations. The SRI prototype user interface and mobile application used the real flow of information but did not divert or interrupt the normal workflow of the weigh stations. For the evaluation and verification of vehicle weight, the SRI prototype utilized the business rules within the Mettler-Toledo system. On the vehicle side, only truck drivers who agreed to participate in testing the SRI mobile application were required to download the SRI mobile application, enter their information, and receive roadside signals.

The research team primarily conducted testing with on-site law enforcement staff, who participated in the acceptance testing and execution of the operational scenarios. In Maryland, USDOT staff (Walton Fehr) also participated as the “owner” of the USDOT’s SRI Truck (“Silver”). Research team personnel and their roles are as follows:

- Ron Schaefer (RS): test recorder
- Chuckerin Black (CB): lead developer of SRI UI (Cellular)
- Jim Cassady (JC): lead developer of S RI DSRC
- Diane Newton (DN): recorder and driver of test vehicle

Michigan State Police were on site during field testing. The officers were on hand specifically to participate in acceptance testing with respect to the Aspen-iyeCitation integration. They also received installation and user instructions with respect to the SRI UI.

Figure 18. USDOT SRI Truck

Officer Mark Brown was also heavily involved in executing scenario testing (system testing). Other participants included:

- Sgt. Rick Azleton
- Ofc. Mark Brown (M. Brown)
- Sgt. Brett Black

Maryland State Police were also on site during their field testing to receive user instructions and assist as necessary during system testing. Participants included:

- Corporal Anthony
- S/Tpr Hite
- S/Tpr Jefferies
- Tfc Hudaon
- Tfc Derr
- Tfc Hobbs

- CVSI Seifert
- CVSI Brown
- Cadet Diagle

Summary of Test Results

Appendix A presents tables for the Unit, Integration, Performance, Security, System, and Acceptance testing process and results. Each table contains the testing requirements, verification methods, test date and tester, and brief results and notations. These are summarized in the following sections.

Unit and Integration Testing

Unit testing focused on testing:

- Internet connectivity
- Connectivity from each external item (Mettler-Toledo, SAFER, Aspen, iyeCitation, ELSAG, etc.)
- Server issues
- Security

The items tested were:

- Mettler Toledo Ramp WIM
- Mettler Toledo Static Scale
- TSPS Application
- SAFER, Aspen, LexusNexus iyeCitation
- SRI User Interface (UI)
- SRI Mobile Truck Feed
- SRI Mobile Application
- SRI Security
- Arada on-board unit (OBU) and Roadside Unit (RSU) – DSRC (Additional MD element)
- Arada on-board unit (same unit) and SRI Mobile Application – Bluetooth (Additional MD element)
- ELSAG LPR (Additional MD element)

Unit tests included such elements as:

- Assuring that data is posted to the web service
- Data is saved to appropriate database(s)
- Data can be retrieved from external databases via web service and displayed via user interface
- Notifications are generated and received regarding geofence entry/exit
- Verify secure connectivity to mobile applications and onboard computers.
- System security is upheld.

Results:

The Unit testing was performed primarily in April 2015. The result of the Unit testing is that all elements PASSED.

For Integration testing, the same foci and elements were tested as were examined during the Unit testing, but they performed within context of the integrated SRI System. Testing was designed to assess system component performance based on outcomes such as whether the many elements worked together to generate a desired result; e.g., pass/fail (green light/red light) being is displayed from Mettler-Toledo data.

Results: The Integration testing was performed primarily in April, July and August of 2015. The result of the Integration testing is that all elements PASSED.

Security, Performance, and System Testing

The security, performance and system testing either directly tested or demonstrated the SRI systems' ability to meet requirements.

Key security elements tested focused on whether the SRI system would:

- Protect personal data from unauthorized access;
- Protect proprietary information, and government and commercial systems from unauthorized access;
- Protect proprietary information from unauthorized access; and
- Provide read access and read/write access to authenticated users.

Results: The determinations were by inspection or direct testing of system response to true or false log-ins. SRI met security requirements for recognizing authorized access to system(s) and data and protecting system(s) and data from unauthorized access.

Performance and systems testing evaluated the performance of the overall SRI prototype with respect to the following system functions:

- System uptime/availability;
- Data gathering, exchange, data archiving and access via multiple interfaces; and
- Communications.

Key elements focused on during the Performance and System testing included:

- Did the system operate without interruption as designed?
- Was two-way communication properly established and maintained between SRI and test vehicles?
- Did data exchanges occur as designed and in a timely fashion?
- Were exchanges properly logged by the system?
- Did the SRI screening functions and notifications work as designed?

SRI System functions were tested according to the following protocols:

- Compliant CMV – Internet and Cellular Communications “Green Light”: CMV passes over a WIM ramp and receives a “green light” indicating no further weight verification check is required.
- Non-Compliant CMV – Internet and Cellular Communications “Red Light”: CMV passes over a WIM ramp and receives a “red light” indicating WIM weight thresholds were exceeded. The CMV then proceeds to a static scale for additional weight verification (Not tested in Michigan).
- Data Exchange between ASPEN and iyeCitation: The officer accesses the SRI transfer module which pulls the ASPEN report generated for the weight violation and pushes common data elements to iyeCitation.
- Enforcement officer Smartphone scenario: An enforcement officer is located outside of the weigh station (in his patrol vehicle) and uses his Smartphone to access the SRI user interface. He is able to screen vehicles that have passed through the weigh station as he would if he were using the user interface on a desktop computer.
- Real-Time Truck Parking Information System: A CMV driver uses a Smartphone to access the SRI mobile application and generate a geo-coded message seeking information on truck parking facility locations and availability. A third party service provider generates a return message identifying locations and availability to the SRI mobile application.
- Compliant CMV – DSRC “Green Light” (Maryland Only): CMV passes over a WIM ramp and receives a “green light” indicating no additional weight verification check is required.
- Non-Compliant CMV – DSRC “Red Light” (Maryland Only): CMV passes over a WIM ramp and receives a “red light” indicating WIM weight thresholds were exceeded. The CMV then proceeds to a static scale for additional weight verification.

Results: The results of the testing show:

- SRI was able to provide current information in a timely fashion, or as available from integrated data sources, to meet SRI prototype application requirements.
- SRI was able to maintain an overall 99.99% system availability in a 24-hour period, the only downtime being some minimal outages (less than one minute) during times where system was being re-deployed.
- SRI was able to exchange data with external systems within 1 second for 99% of the time and was able to exchange data with the CMV (or proxy automobile) within 1 second for 99% of the time. The exception was for the Maryland pilot, where there was difficulty in maintaining adequate DSRC connectivity.
- SRI logged data transactions per design.
- SRI satisfactorily and accurately accomplished automated weight screening and notifications.
- SRI adequately demonstrated multiple internal and external interfaces for systems (ASPEN, SAFER, iyeCitation, truck parking information sources, and Arada) and users that are secure and compliant with regulations (especially important with regard to safety regulations per driver distraction while interacting with system).

Maryland DSRC issue and suggested corrective action:

In the Maryland pilot the DSRC was tested using DSRC-enabled OBU in the vehicle communicating to the SRI Mobile app via Bluetooth and a roadside unit (RSU). Several technical issues prevented reliable communications between SRI and vehicle. These include:

- The OBU did not release the IP address received previously from the RSU, and the OBU did not rejoin the RSU when it got back in range. Arada addressed this issue after the pilot test.
- Request was sent to wrong RSU. The btrxclient needs to be modified to accept the backend IPv6 address from the Android application instead of getting that from the WSA that the RSU sends. This would have mitigated some of the testing frustration when testing occurred within range of multiple RSUs. It is also a more robust approach, allowing any application to take advantage of the software written instead of only being able to use it for a single application per RSU. This would be a joint effort between Arada and Leidos to define the protocol for providing the IPv6 address
- SRI Mobile didn't read the response from the Bluetooth socket. More testing needs to be conducted to figure out why the mobile app did not always read the response btrxclient wrote to the Bluetooth socket.
- The Bluetooth on the OBU had issues seeing some Android devices even when Bluetooth was enabled and discoverable.
- No response was received from backend service at the OBU. This happened in two ways: 1) backend never received the request and 2) backend response was not received by OBU.
- The distance at which the OBU joined with the RSU and sends that message SRI Mobile was too short. The vehicle was already in the exit ramp to the weigh station before SRI informed the driver the weigh station was there. The time from the Approaching Weigh Station screen to driving over the WIM was a few seconds.

Acceptance Testing

Once system issues were addressed as a result of system testing, user interaction with the SRI system was tested. Enforcement official and participating truck drivers were trained in advance about how to use of the SRI Dashboard (Enforcement) and the mobile applications (CMV drivers and Enforcement). Below are the user-SRI interactions conducted by the participants and validated by the test team:

Drivers

- Enter information into mobile application.
- Receive weigh station instruction via red light/green light.
- View truck parking information (Michigan and Maryland).

Enforcement Officers

- The officer logs into the SRI user interface successfully.
- The officer views the Mettler- Toledo Ramp WIM data presented on the SRI UI.
- The officer views the Mettler-Toledo static scale data presented on SRI UI.

- The officer views data from SRI mobile application on SRI UI.
- The officer selects a truck from the truck feed and view complete data available.
- The officer enters the vehicle's USDOT number on SRI UI.
- SAFER Company Data module populates if USDOT number is available from the SRI mobile application
- If the officer enters the USDOT number, the SAFER Company Data module populates.
- The officer views SAFER US Crash data within a separate module.
- The officer views SAFER US Safety Rating within a separate module.
- The officer views SAFER US Inspections within a separate module.
- The officer launches MiCJIN portal from the SRI UI (Michigan only).
- The officer logs in to MICJIN portal when it is accessed from the SRI UI (Michigan only).
- When executed, iyeCitation electronic ticket is pre-populated with saved Aspen data (Michigan only).
- LPR window appears in SRI UI (Maryland only).
- LPR data appears in SRI UI (Maryland only).

Results: The Acceptance tests successfully demonstrated the system capabilities as used by the participants. There were some issues that occurred during the testing in Michigan:

- The Truck Parking application showed only three locations appearing regardless of direction traveled. This was caused by a TSPS coding change that was later resolved.
- If the user selected finish, park or print on Mettler-Toledo interface, information was not populating SRI UI in the weigh station (this has been resolved).
- Users were unable to log into the MICJIN portal when attempting to access it from the SRI UI due to no MI VPN available on SRI laptop at the weight station.
- Due to security, a separate computer (not the laptop running SRI UI) was used to demonstrate the execution of iyeCitation, in which an electronic ticket was pre-populated with saved Aspen data.

Testing Lessons Learned

The development, deployment and testing of the prototype SRI system provided the team with a number of challenges. In working through these challenges, key lessons were learned, as follows:

DSRC and Bluetooth

DSRC is a reliable and efficient way of exchanging information between vehicles, and between vehicles and the roadside. The use of DSCR in this project was mostly successful but suffered from some implementation issues.

The software written to exchange data between a mobile device and an On Board Unit via Bluetooth was fairly rigid in its implementation and required events to occur in a defined order, which is not always consistent with real-world usage. If an error occurred, the software often needed to be restarted.

Issues were also observed with inconsistent communication between the mobile device and the OBU. The OBU software also relied on the Road Side Unit (RSU) to provide the backend IPv6 address for the message destination, and in some cases the RSU did not release the address. In the future the mobile app software should provide the backend address. The last issue observed in testing was an underlying error in the OBU firmware that made testing difficult.

In summary, the technology will work for CMV weigh station bypass, but improvements need to be made in the OBU software for smooth operation.

Connected Vehicle Development

In the future it would be extremely beneficial to have the connected vehicle hardware at the development location. This would provide a quicker turnaround of unit and integration testing. Having to travel to a test bed, or train another person at the test bed on the application and relay errors found, took considerable time and expense.

Mobile Platform Selection

For the mobile application, the team had two choices for platforms: Apple and Android. The team chose Android for SRI because it seemed to be the best choice at the time, given two primary factors:

1. The only way to distribute the software to phones for this project was the use of the platform stores. Apple has a very rigid distribution model at the time of this decision which didn't allow for easy mobile software deployments necessary for development. With Android, however, the distribution model through the platform store was less restrictive and allowed for much easier and rapid deployments.
2. The other factor in determining the platform choice was the talent pool of the development team. Only one developer on the team had experience with writing an Apple application. The rest of the team had limited Android experience, but they were all well versed in Java, which is the primary development language for the Android platform.

Since the mobile application was developed, the development team observed that during visits to both weigh stations the officers were using iPhones. The SRI user base at those weigh stations were disappointed that the application would not be available for their devices. Also, the majority of Motor Carriers seemed to use iPhones. This combined with advances in Apple's ecosystem has made the team re-evaluate the choice of Android for mobile platforms for future projects.

Apple has not relaxed its requirements for deployment of mobile apps to the Apple store at this writing. What it has done is introduce an app called “TestFlight,” which allows for app developers to quickly invite users to test apps, bypassing the rigid Apple App Store approval process. This puts the platform on par with Android for ease of deployment during the development phase.

GPS Drift and Geofencing

When developing a mobile application that is dependent on GPS location data, care must be taken to allow for inaccurate GPS signals. As noted above, not all mobile devices are equal when it comes to GPS antennae; some devices experience GPS drift when standing still or in motion. This means the GPS position will move even when the mobile device is not moving, or the position will not be completely accurate; e.g., the GPS position may report a device location is off the road when it is in fact in the middle of the lane. When mapping geofences for the application the research team identified a need to expand the geofence wider than initially anticipated to account for inaccurate GPS positioning.

Another lesson learned from the geofence mapping is that it is important to take GPS position fixes from multiple onsite devices when selecting the latitude and longitude for each point of the geofence. Relying on Google Maps or Google Earth does not always line up 100 percent accurately with the actual GPS locations. Choice of a robust mobile platform can also reduce this issue.

System vs. Device Data Generation

The SRI System is an aggregate system relying on outside devices and services to feed the system. All of these feeds are time-sensitive in nature. The data that is received from these feeds have to appear on the screen in near real time or with a very minor delay (seconds). During the course of development, the research team realized that the timestamps coming from these outside devices and services did not always sync up against the SRI system times, even though all devices were synced to Internet Time. A time difference of a few seconds would have serious consequences when trying to associate data as CMVs pull in to the weigh stations at ramp speeds. This led to inaccurate feed associations, failures in data capturing, and failures in weight reporting. This was compounded even more when the SRI Mobile app was released to the Google Play Store. Almost all of the times reported from the outside Android devices had times that were not in sync with the SRI system. Some times were off by hours. Trying to manage all of the devices times would be impossible.

This error was alleviated by eliminating the reliance on the times provided by the outside devices and services. Those outside times were still reported to the SRI Web Services, but now the SRI system was generating its own timestamps when the SRI Web Services were called. Those SRI-generated times were then used to associate data. As a result, SRI only used the times it generated for calculation or association.

Had the SRI research team known that there would be so much time variation among outside devices and services, there would have been a decision not to rely on those sources for timestamps. Instead, the team would have chosen to generate system times based on when the SRI Web Services were called.

Large Scale JavaScript Applications

The rise of JavaScript applications came from the idea of keeping logic work on the client machine and having servers do more of what their name actually represents: “serve” any required data. This is especially true when applications have a large user base that will constantly drive servers to or, worse, over their limits. But what about a smaller scope of users such as would be involved with the Smart Roadside Initiative development and testing? Would there be benefits in using JavaScript as the main workhorse when the server’s resource aren’t being maximized?

This is a question of scalability and how ready SRI is to serve a growing number of users without the immediate requirement of additional hardware. This idea brings JavaScript frameworks into the spotlight, and with it the competition of different organizations to develop a product that will attract developers and fuel the future development cycle of applications made for the web. With so many choices, the research team selected Google’s AngularJS, which is a JavaScript framework for building web applications with HTML, JavaScript, and CSS. AngularJS allowed the research team to develop faster and smarter while also making it possible to create a more robust application such as the dashboard for screening trucks while keeping the code highly maintainable and easily reusable.

Complex interactions between different sensors at a weigh station, such as collecting data from devices such as weigh-in-motion scales, a license plate reader, and a wireless mobile device—all from multiple vehicles—seems daunting. But AngularJS provided a framework that made it much more efficient for code developers to separate build modules and inject them as a dependency wherever they were needed in the application.

The Responsive Web

Every day a new device enters the market, and with it the challenge of ensuring its user base are not excluded from products being built. But with the Smart Roadside Initiative, the users can use the application on a standard resolution on a personal computer at their location. The reason it was made responsive is that, when building applications, it is desirable not only to look ahead, but also to fuel the progress of the endeavor as a whole. The freedom to use any device to access SRI and the information it delivers can drive the addition of other products, components, and use cases for the application. Quick access using mobile smartphones, and an even more mobile work station for officers using tablets to relay information to other end user, is possible thanks to the implementation of responsive web design. This technology should not be an addition but a requirement for future projects.

Vendor Participation in Government Projects

It became very apparent that numerous vendors in the SRI space were very concerned about controlling their future and protecting their investments. They were not interested in the government developing a system that could hurt their financial future. SRI was never intended to encroach into their space, but many vendors believed it would. Future such projects must take into consideration that if it appears the government is trying to solve a problem that the vendors have a solution for already, then the government should try to work with them to make sure their system handles whatever problem the government is trying to solve.

Chapter 7. Conclusions and Recommendations

Identifying and documenting lessons learned and opportunities for expansion and improvement are a critical final step in the prototype process. This section provides documentation to the successes and challenges encountered during the test. Second, it helps understand opportunities that may be explored going forward. The conclusions in this section are from the perspective of the research team and do not include either the qualitative or quantitative analysis or conclusions from the independent USDOT-funded impact assessment of the prototype.

Project Conclusions

Overall, a project like SRI must delicately balance the varying needs of both the government and private sector stakeholders. The walkthrough process revealed the difference in thought between the industry/driver community and the enforcement community. By nature, it is common for these communities to inherently hold opposing opinions, and SRI was no exception with respect to the objectives of SRI and the operation/functions of the prototype. The prototype effort sought to satisfy both sides by offering each unique benefits; however, the development effort focused more on the enforcement user as opposed to the driver. This is not to say the driver was ignored – the mobile app and truck parking were definitely the touch points for that user. The initial vision for SRI had sought to continue the communication to the driver's back office and management systems but we could not find a cooperative carrier that was willing to participate given their concerns of protecting their customer information and drivers.

On the testing side, the deployment tests at both sites concluded that the SRI design, which was intended to consolidate existing weigh station technologies into one system and user interface, was successful. The integration of the SRI Mobile app for the drivers was also successful. The testing of the DSRC Bluetooth connectivity had some issues but ultimately was resolved. The goals set out for the project were met by deploying the SRI integrated framework as designed.

Recommendations

One of the core final products of this project was the technology framework designed and developed to support the multitude of integration points with the technologies available in a weigh station. The test proved that integrating each of the technologies could be done primarily using web services and in a cloud environment with very quick response time. The mobile application for the drivers also proved successful and is a viable option in the current market. All of the source code is available on the USDOT Open Source Application Development Portal to be downloaded for future use.

The structure of the system will require very little modification should another State decide to implement SRI if the current integration services are similar to what was used during the pilots; i.e.

Mettler Toledo, ELSAG, etc. If a new technology or integration point is required then some additional coding will be required. States can choose to do this work themselves or hire a consulting firm to do the work.

SRI does not replace the products currently in the market; it provides the means to integrate the existing technologies into one user interface. This is unique in the market today and there is a very economical way to install and use SRI given the way it was developed. Commercially, any IT company can download the SRI code and begin to market and sell its installation services to the states.

Appendix A. Traceability Matrices

A.1 SRI Prototype Traceability Matrices

In introducing the final SRI prototype traceability matrix, we must first present the proposed architecture for both the DSRC and Cellular solutions. The figures below were included in the original SRI Concept of Operations from May 2012. In Figure 19, the vehicle communicates to SRI via DSRC. In Figure 20, the vehicle communicates to SRI via a cellular network. DSCR requires a fixed roadside device to communicate with the vehicle. The roadside device was located at the West Friendship, Maryland weigh station. In the figures, the items are numbered sequentially, starting with #1, which indicates the triggering of the inspection process by the passing of a device in the CMV.

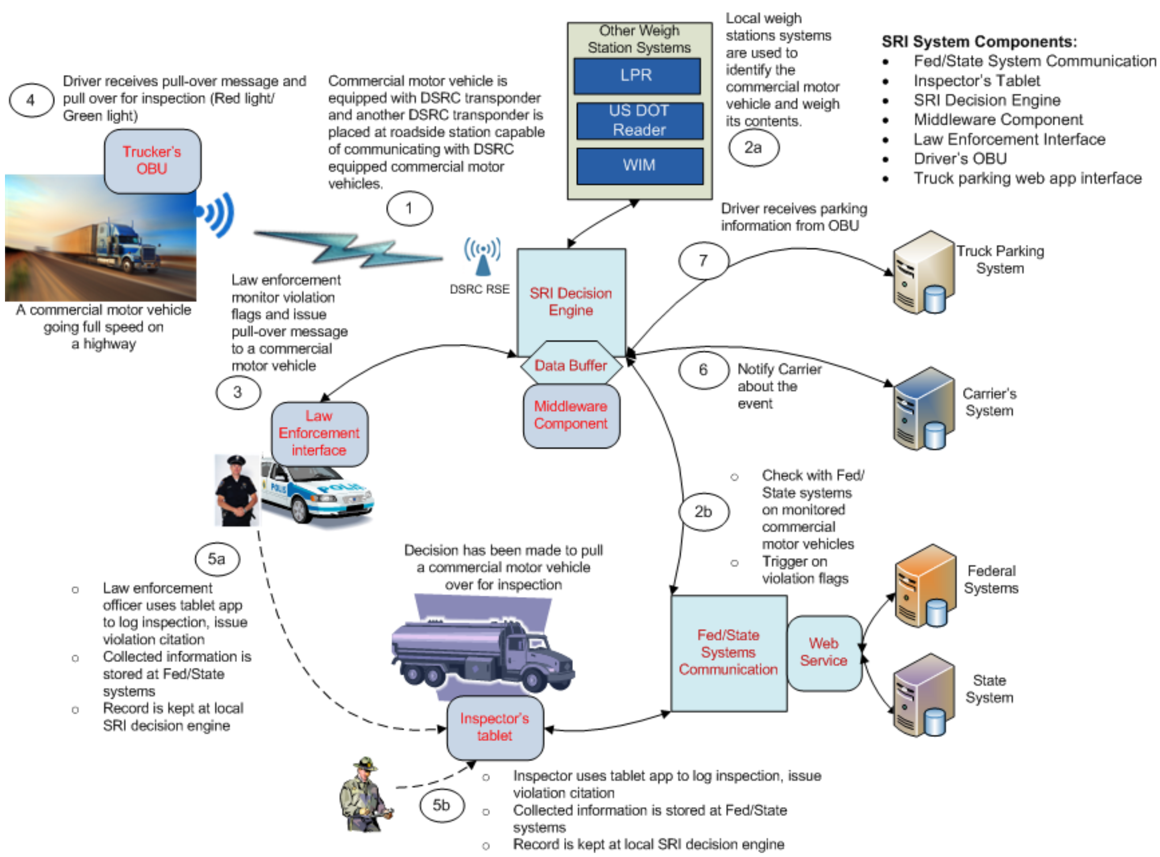


Figure 19. Proposed SRI Functional Architecture – DSRC Solution

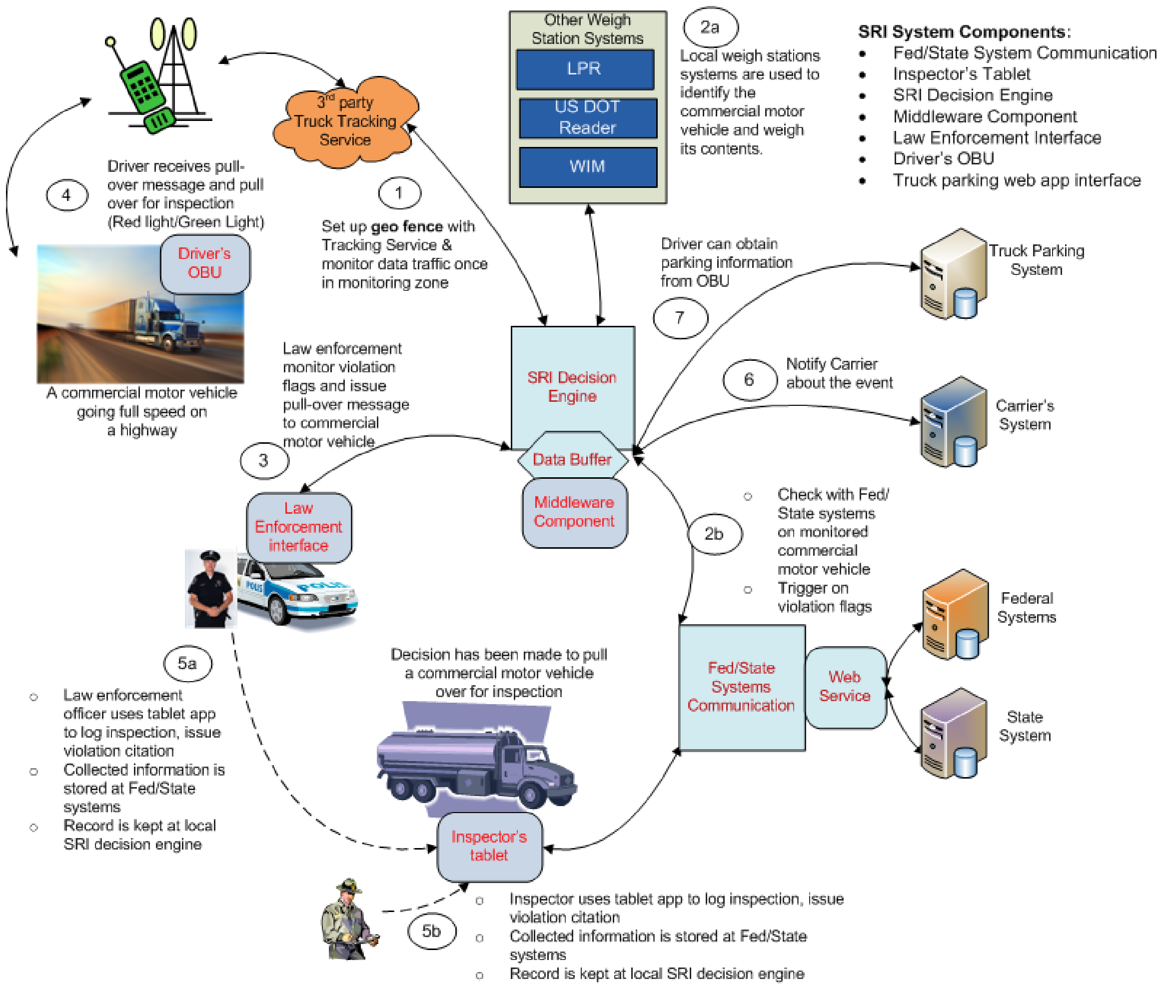


Figure 20. Proposed SRI Functional Architecture – Cellular Solution

The sections below summarize what was actually deployed with the final prototype design, while still referencing the original concept diagrams shown above. The bullets are numbered to correspond to the numbered elements within the original architecture figures. These sections are included to document how the riginal architectures changed in the final deployment of the SRI prototype.

A.1.1 Updated Process Flow for DSRC

1) Commercial Motor Vehicle (CMV) is equipped with an Android phone with the SRI Mobile App Bluetooth installed. It communicates the credential information to the On Board Unit (OBU) via Bluetooth. The OBU communicates the data to the Road Side Unit (RSU) via DSRC once the OBU is within range of the RSU. The RSU then communicates the data to the SRI J2735 Translator via UDP over IPV6. The SRI Translator communicates the data to the Truck Feed SRI Web Services over TCPIP via the Internet.

2a) Local weigh station systems identify the weight of the vehicle, and captures License Plate image and data if available.

2b) Look up Company Snapshot data utilizing the SAFER SRI Web Service. The DOT number will be supplied by the SRI Mobile App Bluetooth credentials.

3) SRI issues pass/fail messages based up weight or random stops.

4) SRI Mobile App Bluetooth receives message from SRI regarding pass/fail based upon weight or random stops.

5a) Law enforcement uses Aspen to log inspection.

5b) Law enforcement uses Aspen 2 iyeCitation to transfer logged inspection information to iyeCitation for citation violation.

6) Carrier is notified of the event via ticket issued.

7) SRI Mobile App Bluetooth receives upcoming truck parking stops via the Truck Smart Parking Services (TSPS).

A.1.2 Updated Process Flow for Cellular

1) Commercial Motor Vehicle (CMV) is equipped with an Android phone with the SRI Mobile App installed. It communicates the credential information to the Truck Feed SRI Web Services over TCPIP via the Internet.

2a) Local weigh station systems identify the weight of the vehicle, and captures License Plate image and data if available.

2b) Look up Company Snapshot data utilizing the SAFER SRI Web Service. The DOT number will be supplied by the SRI Mobile App Bluetooth credentials.

3) SRI issues pass/fail messages based up weight or random stops.

4) SRI Mobile App Bluetooth receives message from SRI regarding pass/fail based upon weight or random stops.

5a) Law enforcement uses Aspen to log inspection.

5b) Law enforcement uses Aspen 2 iyeCitation to transfer logged inspection information to iyeCitation for citation violation.

6) Carrier is notified of the event via ticket issued.

7) SRI Mobile App Bluetooth receives upcoming truck parking stops via the Truck Smart Parking Services (TSPS).

A.1.3 Final SRI Traceability Matrix

The Final SRI Traceability Matrix is presented below in Tables 1 through 5. This matrix references the System Architecture diagrams (from the original SRI Concept of Operations) presented in earlier in this Appendix. The "Cellular" and/or "DSRC" distinction and associated numbers, refer to the numbered elements on either the Cellular or DSRC diagrams, and as ultimately deployed (and described in Section A.1.1 and A.1.2).

Table 1. SRI Traceability Matrix - System Requirements (e)

Req ID	Requirement	Source	Verification Method	System Architecture	Michigan and/or Maryland or Future Demonstration[1]
e.001	SRI shall be designed to operate in conjunction with and not interfere with existing systems.	UN14	Inspect	Cellular - 1, 2a, 2b, 6, 7	MI, MD
e.002	SRI shall monitor roadside equipment.	DOP01	Inspect	DSRC-1	MI, MD
e.003	SRI shall monitor external system availability.	DOP01	Inspect	2a, 2b, 6, 7	MI, MD
e.004	SRI shall provide continuous system health availability information.[2]	DOP01	Inspect	All	MI, MD
e.005	The SRI Prototype System shall be deployed and tested at a fixed facility on the Interstate System.	DOP03	Demonstrate	DSRC -All	MI, MD
e.006	The SRI Prototype System shall be deployed and tested in a mobile environment on selected secondary routes.	DOP03	Demonstrate	Cellular -All	F
e.007	The SRI prototype shall use the USDOT number as the unique identifier for the carrier.	DOP04	Inspect	Both - 1, 4	MI, MD
e.008	The SRI prototype shall use the VIN number as the unique identifier for the CMV.	DOP04	Inspect	Both -1, 4	MI, MD
e.009	The SRI prototype shall use the CDL number as the unique identifier for the CMV driver.	DOP04 UN12	Inspect	Both -1, 4	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	Both -1, 4	F
e.010	The SRI prototype shall verify that all information originates from an authoritative source.	DOP05	Inspect	Both -1, 4	F
e.011	Both interstate and intrastate vehicles/carriers shall be able to use the SRI prototype.	UN 08	Demonstrate	All	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.	UN 08	Demonstrate	All	MI, MD

Req ID	Requirement	Source	Verification Method	System Architecture	Michigan and/or Maryland or Future Demonstration[1]
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	Both - 3	MI, MD
e.014	SRI shall provide an interface to all commercial drivers that is compliant with existing safety regulations.	DOC01	Demonstrate	Both - 3	MI, MD

[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.

Table 2. SRI Traceability Matrix - Application Requirements (a)

Req ID	Requirement	Source	Verification Method	System Architecture	Michigan and/or Maryland or Future Demonstration[1]
a.001	SRI shall be consistent with the ITS National Architecture and associated standards such as the CVISN National Architecture.	UN08	Analyze	ALL	MI, MD
a.002	SRI shall provide an interface and processing modules for truck parking applications.	UN10	Demonstrate	Both - 7	MI
a.002.1	*SRI shall provide information about the availability of truck parking spaces.*	UN10	Demonstrate	Both - 7	MI
a.002.2	*SRI shall provide current parking availability information at a specific facility.*	UN10	Demonstrate	Both - 7	MI
a.002.3	*SRI shall provide predicted future parking availability information at a specific facility.*	UN10	Demonstrate	Both - 7	F
a.002.4	*SRI shall provide 24x7 access to truck parking information.*[2]	UN10	Demonstrate	Both - 7	MI
a.002.5	*SRI shall provide a graphical interface to stationary (i.e., dispatcher/ operator/driver/traffic analyst/other) users.*	UN05	Demonstrate	Both - 7	MI
a.002.6	*SRI shall provide a user interfaces to non-stationary drivers when integrated in-vehicle display systems exist.*	UN07	Demonstrate	Both - 7	F
a.002.7	*SRI shall allow a stationary user to submit requests for automated truck parking information.*	UN05	Demonstrate	Both - 7, 6	MI
a.002.8	*SRI shall allow a user to receive the results of an automated request for truck parking information.*	UN05	Demonstrate	Both - 7	MI
a.003	SRI shall provide an interface and processing modules for enforcement screening applications.	UN10	Demonstrate	Both - 3	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	Both - 3	MI, MD
a.004	SRI shall provide a processing capability that automates the roadside inspection tasks.	T007	Analyze	Both - 3 (SRI Decision Engine), 5a, 5b	F
a.004.1	*The SRI system shall determine if a CMV complies with jurisdictional licensing requirements.*	T002	Test	Both - 3, 2b	F
a.004.2	*The SRI system shall determine if a driver complies with jurisdictional licensing requirements.*	T002	Test	Both - 3, 2b	F
a.004.3	*The SRI system shall determine if a driver complies with HOS requirements.*	T007	Test	Both - 3, 2b	F

Req ID	Requirement	Source	Verification Method	System Architecture	Michigan and/or Maryland or Future Demonstration[1]
a.004.4	*The SRI system shall determine if a CMV complies with jurisdictional size requirements.*	T006	Test	Both - 3, 2a, 2b	F
a.004.5	*The SRI system shall determine if a CMV complies with designated safety requirements.*	T002	Test	Both - 3, 2b	F
a.004.6	*The SRI system shall determine if a CMV complies with weight requirements.*	T006	Test	Both - 3, 2b	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	Both - 3, 2b	F
a.004.8	*SRI shall provide the data necessary to document inspection events and outcomes.*	UN10	Analyze	Both - 3	MI, MD
a.004.9	*SRI shall formulate alarms for user notification via the user interface(s).*	UN05	Test	Both - 3, 4	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	Both - 3	F
a.004.11	*The SRI prototype shall obtain vehicle-based maintenance data from the vehicle CAN BUS where available.*	UN04	Demonstrate	Both - 3, 4	F
a.004.12	*SRI shall provide vehicle-based maintenance data obtained from the vehicle to the carrier.*	UN05	Demonstrate	Both - 6	F
a.004.13	*SRI shall provide driver-based safety information obtained from the vehicle to the carrier.*	UN05	Demonstrate	Both - 6	F
a.005	SRI shall provide an interface for Tier 1 users.	UN10	Demonstrate	Both - 3, 4, 5, 6	MI, MD
a.005.1	*SRI shall provide an interface for CMV Enforcement Officers and supervisors to enter data.*	UN10	Demonstrate	Both - 5a, 5b	MI, MD
a.005.2	*SRI shall provide an interface for CMV Enforcement Officers and supervisors to execute processes.*	UN10	Demonstrate	Both - 5a, 5b	MI, MD
a.005.3	*SRI shall provide an interface for CMV Enforcement Officers and supervisors to receive information and alerts.*	UN10	Demonstrate	Both - 3	MI, MD
a.005.4	*SRI shall provide an interface for CMV drivers to receive information. ~~and alerts~~.*	UN10	Demonstrate	Both - 4	MI, MD
a.005.5	*SRI shall provide an interface for motor carriers to view information and receive alerts.*	UN10	Demonstrate	Both - 6	F

Req ID	Requirement	Source	Verification Method	System Architecture	Michigan and/or Maryland or Future Demonstration[1]
a.006	SRI shall conduct the analytical and data fusion functions necessary to evaluate CMV, carrier, and driver compliance.	UN10	Analyze	Both - 6, 7	F
a.007	SRI shall comply with nationwide interoperability standards currently used for the USDOT V2X Program.	UN09	Inspect	Both - 3 (SRI Decision Engine)	MD
a.007.1	*SRI shall comply with SAE STD J2735.*	DOP06 UN014	Inspect	All	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	All	MD
a.007.3	*SRI shall comply with SAE J1929.*	DOP06 UN014	Inspect	All	F
a.007.4	*SRI shall comply with IEEE Standard 802.11p.*	DOP06 UN014	Inspect	All	MD
a.008	SRI shall provide vehicle system information that is used by SRI to users.	DOP06 UN014	Demonstrate	All	F
a.008.1	*SRI shall provide designated vehicle system information to the driver through the driver application.*	UN09 UN14	Demonstrate	Both - 4, 6	F
a.008.2	*SRI shall provide applicable vehicle system information to the carrier through the carrier application.*	UN09	Demonstrate	Both -4	F
a.001	SRI shall be consistent with the ITS National Architecture and associated standards such as the CVISN National Architecture.	UN09	Analyze	Both -6	MI, MD
a.002	SRI shall provide an interface and processing modules for truck parking applications.	UN09	Demonstrate	Both -6	MI

[1] Colorado replaced by Maryland (MD).
[2] Depending on availability of TSPS application.

Table 3. SRI Traceability Matrix - Performance Requirements (p)

Req ID	Requirement	Source	Verification Method	System Architecture	Michigan and/or Maryland or Future Demonstration[1]
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	All	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	Both - 2a, 2b, 6, 7	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	DSRC-1	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	Both - 4	MI, MD
p.001.4	*SRI data exchanges shall be time stamped when the exchange was completed.*	P002	Test	All	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	Both - 4	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	Both - 4	MI, MD
p.002.2	*SRI shall maintain two-way communications with each properly equipped vehicle as it exits the weigh station.*	UN08	Demonstrate	Both - 4	F
p.003	The SRI system shall be able to maintain an overall 99% in a 24 hour period system availability.	UN05	Inspect	All	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	All	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	All	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	All	MI, MD
p.005	SRI shall be designed to accommodate multiple users with different user needs and requirements.	P005	Demonstrate	All	MI,MD
p.006	SRI shall provide sanitized data to external systems for public use.[2]	UN03	Inspect	Both - 4	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	All	F

Req ID	Requirement	Source	Verification Method	System Architecture	Michigan and/or Maryland or Future Demonstration[1]
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	Both - 3 (SRI Decision Engine)	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	Both - 3	F
p.007.3	*SRI shall issue Randomly generated pull-in for safety inspection signals.*	UN10	Test	Both - 1	F
p.007.4	*SRI shall issue Manually generated pull-in for safety inspection signals.*	UN10	Test	Both - 1	F
p.007.5	*SRI shall issue Automatically generated pull-in for safety inspection signals.*	UN10	Test	Both - 1	F
p.007.6	*SRI shall perform checks on Vehicle/Carrier/Driver Safety Information when making the "Pass/Need To Stop" determination.*	T002	Analyze	Both - 1, SRI Decision Engine	~~F~~
p.007.7	*SRI shall perform checks on Vehicle Credentials when making the "Pass/Need To Stop" determination.*	T002	Analyze	Both - 1, SRI Decision Engine	~~F~~
p.007.8	*SRI shall perform checks on Driver and Carrier Credentials/Status when making the "Pass/Need To Stop" determination.*	T002	Analyze	Both - 1, SRI Decision Engine	F
p.007.9	*SRI shall perform checks on Vehicle ~~Size and~~ Weight Information when making the "Pass/Need To Stop" determination.*[3]	T006	Analyze	Both - 1, SRI Decision Engine	MI, MD

[1] Colorado replaced by Maryland (MD).
[2] Sanitized data refers to data that has had proprietary or sensitive information removed.
[3] SRI prototype only performed checks on vehicle weights (checks meaning data collected was verified by a decision engine – in this case, Mettler-Toledo.

Table 4. SRI Traceability Matrix - Security Requirements (s)

Req ID	Requirement	Source	Verification Method	System Architecture	Michigan and/or Maryland or Future Demonstration[1]
s.001	SRI shall protect personal data from unauthorized access.	UN06	Inspect	All	MI, MD
s.002	SRI shall protect proprietary information from unauthorized access.	UN06	Inspect	All	MI, MD
s.003	SRI shall protect proprietary systems from unauthorized access.	UN06	Inspect	Both - 2a, 2b, 6, 7	MI, MD
s.004	SRI shall provide read access and read/write access to authorized users.	DOP09	Test	Both - 3, 4,5a, 5b	MI, MD
s.005	SRI shall provide read access and read/write access to authenticated users.	DOP09	Test	Both - 3, 4,5a, 5b	MI, MD

[1] Colorado replaced by Maryland (MD).

Table 5. SRI Traceability Matrix - Interface Requirements (i)

Req ID	Requirement	Source	Verification Method	System Architecture	Michigan and/or Maryland or Future Demonstration[1]
i.001	SRI shall be designed to receive vehicle, and operator information ~~from~~ through vehicle OBU.[2]	T001 UN01 UN02	Demonstrate	Both - 4	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	Both - 4	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	DSRC-1	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	DSRC-1	MD
i.003	SRI shall receive ~~size and~~ weight information from SRI-capable Roadside Unit ~~Equipment (RSE~~RSU).	T003 UN02	Demonstrate	DSRC-1 2a	MD
i.003.1	*Telemetry and sensor output data shall comply with SAE J2735.*	DOP 02	Inspect	DSRC-1	F
i.004	SRI shall send information received from external back office systems to SRI-capable Roadside Unit ~~Equipment (RSE~~ RSU).	T003 UN02	Demonstrate	Both - 1, 6	F

Req ID	Requirement	Source	Verification Method	System Architecture	Michigan and/or Maryland or Future Demonstration[1]
i.004.1	*SRI data exchanges between external back office systems and RSEs shall be formatted for compliance with these systems.*	DOP 02	Inspect	Both - 1, 6	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	Both - 2a, 2b	MI, MD
i.005.1	*SRI shall access and provide current information in real-time or as available from integrated data sources.*	T004	Analyze	All	MI, MD
i.005.2	*SRI shall access from authoritative data sources the information necessary to validate vehicle ~~size and~~ weight information.*	T004	Inspect	Both - 2a, 2b	MI, MD
i.006	SRI shall interface with truck parking systems.	T007	Demonstrate	Both - 7	MI
i.007	SRI shall provide designated collected data to back office external systems (~~systems TBD~~ Aspen,iyeCitation).	UN03	Demonstrate	Both - 2b	MI, MD
i.008	SRI shall receive designated data from back office external systems (~~systems TBD~~ SAFER).	UN04	Demonstrate	Both - 2b	MI, MD
i.008.1	*SRI shall send data from sensors ~~and the CAN BUS in~~ SAE J2735 compliant format.*	UN04	Inspect	Both - 2a, 4	F
i.009	SRI shall provide a driver interface that is compliant with driver safety regulations.	UN07	Demonstrate	Both - 4	MI, MD
i.010	SRI shall include trailing equipment identification pulled by uniquely identifiable CMV power units.	UN13	Inspect	Both - 4	F
i.010.1	*SRI shall conform to SAE J1939 to support communications to/from CAN for tractor/trailer combinations.*	DOP02	Demonstrate	Both - 4	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	All	MD
i.012	SRI shall facilitate the real-time exchange of truck parking information.	UN011	Analyze	Both - 7	MI
i.012.1	*SRI shall ~~exchange~~ receive data with parking systems to support truck parking functionality.*	UN04	Analyze	Both - 7	MI

[1] Colorado replaced by Maryland (MD)
[2] OBU bluetooth to mobile app.

Appendix B. Testing Results

Unit and Integration Testing

Table 6. Unit Testing Summary

Item to Test	Test Description	Test Date	Responsibility	Result
Mettler Toledo Ramp WIM	• Write test app that posts to web services • Verify posts get to web services • Verify data is saved to database • Verify that data can be retrieved via web services • Verify that data is displayed to user interface	4/27/15	CB	Pass
Mettler Toledo Static Scale	• Write test app that posts to web services • Verify posts get to web services • Verify data is saved to database • Verify that data can be retrieved via web services • Verify that data is displayed to user interface	4/27/15	CB	Pass
TSPS Application	• Write test app that performs an HTTP GET to TSPS web services • Verify that data is returned • Verify that data is displayed to user interface	4/24/15	CB	Pass
SAFER	• Write test app that performs an HTTP GET to web services • Verify posts get to web services • Verify data is saved to database • Verify that data can be retrieved via web services • Verify that data is displayed to user interface	4/24/15	CB	Pass
Aspen	• Write test app that pulls data from Aspen database • interface	7/3/15	CB	Pass
LexusNexus iyeCitation	• Write test app that sends data to iyeCitation • Verify that data is displayed to user	7/3/15	CB	Pass

Item to Test	Test Description	Test Date	Responsibility	Result
SRI User Interface (UI)	• Write test app that encapsulates all other unit tests to verify integration	8/12/15	CB	Pass
SRI Mobile Truck Feed	• Write test app that posts to web services • Verify posts get to web services • Verify data is saved to database • Verify that data can be retrieved via web services • Verify that data is displayed to user interface	4/24/15	CB	Pass
SRI Mobile Application	• Write test page that posts to web services • Verify posts get to web services • Verify data is saved to database • Verify that data can be retrieved via web services • Verify that data is displayed to user interface • Verify that application sends web service notification when vehicle enters geofence	4/24/15	CB	Pass
SRI Security	• Verify SSL connection on secure sections (dashboard) • Verify log-in page re-direct for non-authenticated requests to secure sections • Verify valid user ID, password to establish authenticated session	3/26/15	CB	Pass

Table 7. Unit Testing Summary - Additional Maryland Elements (DSRC, LPR)

Item to Test	Test Description	Test Date	Responsibility	Result
Arada on-board unit (OBU) and Roadside Unit (RSU) – DSRC	• Verify test programs for OBU and RSU (written by Arada)	8/5/2015	JVC	Pass
Arada on-board unit and SRI Mobile Application - DSRC	• Verify SRI mobile application pairs to Arada OBU via Bluetooth • Verify data is received by Leidos server for translation (SRI J2735 Translator) • Verify posts get to web services • Verify that application sends web service notification when vehicle enters geofence	8/5/2015	JVC	Pass

Item to Test	Test Description	Test Date	Responsibility	Result
ELSAG LPR	• Write test app that watches LPR directory for new image and text files • Verify image and text files are being saved to LPR directory • Verify posts get to web services • Verify data is saved to database • Verify that data can be retrieved via web services • Verify that data is displayed to user interface	8/17/2015	CB	Pass

Table 8. Integration Test Summary

Item to Test	Test Description	Test Date	Responsibility	Result
Mettler-Toledo WIM	• Verify receipt of web service posts	4/27/15 8/17/15	CB – EGL CB - WFS	Pass
Mettler-Toledo Static	• Verify receipt of web service posts	4/27/15 8/17/15	CB – EGL CB - WFS	Pass
SAFER	• Verify company snapshot servlet is returning valid company information • Post company snapshot to web services • Verify data is saved to database • Verify that data can be retrieved via web services • Verify that data is displayed to user interface	7/23/15 8/19/15	CB – EGL CB - WFS	Pass
Aspen	• Pull data from Aspen database	7/23/15	CB	Pass
LexusNexus iyeCitation	• Post data to iyeCitation • Verify data is displayed in iyeCitation	7/23/15	CB	Pass
SRI User Interface (UI)	• Verify integration	8/20/15	CB	Pass
SRI Mobile Truck Feed	• Write test app that posts to web services • Verify posts get to web services • Verify data is saved to database • Verify that data can be retrieved via web services • Verify that data is displayed to user interface	7/23/15 8/19/15	CB – EGL CB - WFS	Pass
SRI Mobile Application	• Write test page that posts to web services • Verify posts get to web services	7/23/15 8/19/15	CB – EGL CB - WFS	Pass

Item to Test	Test Description	Test Date	Responsibility	Result
	• Verify data is saved to database • Verify that data can be retrieved via web services • Verify that data is displayed to user interface • Verify that application sends web service notification when vehicle enters geofence			
SRI Security	• Verify SSL connection on secure sections (dashboard) • Verify log-in page re-direct for non-authenticated requests to secure sections • Verify valid user ID, password to establish authenticated session	4/27/15	CB	Pass
TSPS Application	• Get data from TSPS web services • Verify that data is returned • Verify that data is displayed to user interface	7/23/15 8/19/15	CB – EGL CB - WFS	Pass
SRI Mobile Application	• Verify pass/fail (green light/red light) displayed from Mettler-Toledo data	7/23/15 8/19/15	CB – EGL CB - WFS	Pass

Table 9. Integration Test Summary - Additional Maryland Elements (DSRC, LPR)

Item to Test	Test Description	Test Date	Responsibility	Result
Arada on-board unit (OBU) and Roadside Unit (RSU) – DSRC	• Integration of SRI web service to OBU verified by Arada	8/20/2015	JVC	Pass
Arada on-board unit and SRI Mobile Application – DSRC	• Verify pass/fail (green light/red light) displayed from Mettler-Toledo data	8/20/2015	JVC	Pass
ELSAG LRP	• Verify posts get to web services • Verify data is saved to database • Verify image files are saved to the web directory • Verify that data can be retrieved via web services • Verify that data is displayed to user interface	8/20/15	CB	Pass

B.1.2 Performance and Security Testing

Table 10. Michigan Performance Test Results

Req ID	Requirement	Source	Verification Method	Test Date	Notes
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		
p.001.1	*SRI shall be able to exchange data with external systems within 5 seconds, 99% of the time*	P002 UN05 UN11	Test	8/17/15	External system = Mettler-Toledo
p.001.3	*SRI shall be able to exchange data with CMV within 5 seconds, 99% of the time.*	P002 UN05 UN11	Test	8/17/15	Rental car not CMV
p.001.4	*SRI data exchanges shall be time stamped when the exchange was completed.*	P002	Test	8/17/15	
p.002	SRI shall provide the capability to establish two-way communications with each properly equipped vehicle approaching the weigh station.	UN08	Demonstrate	8/17/15	
p.002.1	*SRI shall maintain two-way communications with each properly equipped vehicle as it passes through the weigh station.*	UN08	Demonstrate	8/17/15	
p.003	The SRI system shall be able to maintain an overall 99.99% in a 24-hour period system availability.	UN05	Inspect	8/17/15	There were some minimal outages (less than one minute) during times where system was being re-deployed
p.003.1	*The SRI Prototype will log each system outage with the date, time, length (in minutes), and cause of the outage.*	P003	Inspect	8/17/15	Available in Glassfish App Server logs
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	8/17/15	
p.005	SRI shall be designed to accommodate multiple users with different user needs and requirements.	P005	Demonstrate	8/17/15	MD testing/install was being conducted concurrent with MI scenario testing.
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	8/17/15	(Mettler-Toledo decision engine, with SRI interpretation of result
p.007.9	*SRI shall perform checks on Vehicle Weight Information when making the "Pass/Need To Stop" determination.*	T006	Analyze	8/17/15	data integrated from Mettler-Toledo

Table 11. Michigan Security Test Results

Req ID	Requirement	Source	Verification Method	Test Date	Performed By
s.001	SRI shall protect personal data from unauthorized access.	UN06	Inspect	8/17/15	RS
s.002	SRI shall protect proprietary information from unauthorized access.	UN06	Inspect	8/17/15	RS
s.003	SRI shall protect proprietary systems from unauthorized access.	UN06	Inspect	8/17/15	RS
s.004	SRI shall provide read access and read/write access to authorized users.	DOP09	Test	8/17/15	Write = entering USDOT number for SAFER lookup RS
s.005	SRI shall provide read access and read/write access to authenticated users.	DOP09	Test	8/17/15	RS

Table 12. Maryland Performance Testing Results

Req ID	Requirement	Source	Verification Method	Test Date	Performed By
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	8/21/15	CB, JC, RS
p.001.1	*SRI shall be able to exchange data with external systems within 5 seconds, 99% of the time*	P002 UN05 UN11	Test	8/21/15	CB, JC, RS
p.001.2	*SRI shall be able to exchange data with Roadside Equipment within 5 seconds, 99% of the time.*	P002 UN05 UN11	Test	8/21/15	CB, JC, RS
p.001.3	*SRI shall be able to exchange data with CMV within 5 seconds, 99% of the time.*	P002 UN05 UN11	Test	8/21/15	CB, JC, RS
p.001.4	*SRI data exchanges shall be time stamped when the exchange was completed.*	P002	Test	8/21/15	CB, JC, RS
p.002	SRI shall provide the capability to establish two-way communications with each properly equipped vehicle approaching the weigh station.	UN08	Demonstrate	8/21/15	CB, JC, RS
p.002.1	*SRI shall maintain two-way communications with each properly equipped vehicle as it passes through the weigh station.*	UN08	Demonstrate	8/21/15	CB, JC, RS
p.003	The SRI system shall be able to maintain an overall 99.99% in a 24- hour period system availability.	UN05	Inspect	8/21/15	CB, JC, RS
p.003.1	*The SRI Prototype will log each system outage with the date, time, length (in minutes), and cause of the outage.*	P003	Inspect	8/21/15	CB, JC, RS
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	8/21/15	CB, JC, RS
p.005	SRI shall be designed to accommodate multiple users with different user needs and requirements.	P005	Demonstrate	8/21/15	CB, JC, RS (see MI explanation – had system open via multiple devices by multiple users in multiple locations)

Req ID	Requirement	Source	Verification Method	Test Date	Performed By
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	8/21/15	CB, JC, RS
p.007.6	*SRI shall perform checks on Vehicle/Carrier/Driver Safety Information when making the "Pass/Need To Stop" determination.*	T002	Analyze	NO	Only weight was checked and verified
p.007.7	*SRI shall perform checks on Vehicle Credentials when making the "Pass/Need To Stop" determination.*	T002	Analyze	NO	Only weight was checked and verified
p.007.9	*SRI shall perform checks on Vehicle Weight Information when making the "Pass/Need To Stop" determination.*	T006	Analyze	8/21/15	CB, JC, RS

Table 13. Maryland Security Test Results

Req ID	Requirement	Source	Verification Method	Test Date	Performed By
s.001	SRI shall protect personal data from unauthorized access.	UN06	Inspect	8/21/15	CB, JC, RS
s.002	SRI shall protect proprietary information from unauthorized access.	UN06	Inspect	8/21/15	CB, JC, RS
s.003	SRI shall protect proprietary systems from unauthorized access.	UN06	Inspect	8/21/15	CB, JC, RS
s.004	SRI shall provide read access and read/write access to authorized users.	DOP09	Test	8/21/15	CB, JC, RS
s.005	SRI shall provide read access and read/write access to authenticated users.	DOP09	Test	8/21/15	CB, JC, RS

B.1.3 System and Acceptance Testing

Table 14. Michigan System Testing Items

Item to Test	Test Description	Test Date	Responsibility
Compliant CMV – Internet and Cellular Communications “Green Light”	CMV passes over a WIM ramp and receives a “green light” indicating no further weight verification check is required.	8/17/15	RS
Compliant CMV – Internet and Cellular Communications “Red Light”	CMV passes over a WIM ramp and receives a “red light” indicating WIM weight thresholds were exceeded. The CMV then proceeds to a static scale for additional weight verification.	8/18/15 12:09 p.m.	RS and M. Brown (MSP)
Compliant CMV – Internet and Cellular Communications “Red Light” and Illegal Bypass	CMV passes over a WIM ramp and receives a “red light” indicating additional weight verification is required. The CMV does not proceed to a static scale but ignores the signal and returns to the mainline.	DID NOT TEST	Cannot simulate without participating CMV
Data Exchange between ASPEN and iyeCitation	An enforcement officer determines that a CMV will be given an overweight citation. The officer accesses the SRI UI and Prototype System which pulls the ASPEN report generated for the weight violation and pushes common data elements to iyeCitation.	8/17/15	M. Brown (MSP)
Real-Time Truck Parking Information System	A CMV driver uses a Smartphone to access the SRI mobile application and generate a geo-coded message seeking information on truck parking facility locations and availability. A third party service provider generates a return message identifying locations and availability to the SRI mobile application.	8/17/15	RS
Enforcement officer smart phone scenario	An enforcement officer is located outside of the weigh station (in his patrol vehicle) and uses his Smartphone to access the SRI user interface. He is able to screen vehicles that have passed through the weigh station as he would if he were using the user interface on a desktop computer.	8/17/15	RS and M. Brown (MSP)

Table 15. Michigan System Test Criteria

Req ID	Requirement	Source	Verification Method	Test Date	Performed By
e.001	SRI shall be designed to operate in conjunction with and not interfere with existing systems.	UN14	Inspect	8/17/15	RS
e.003	SRI shall monitor external system availability.	DOP01	Inspect	8/17/15	RS, If external systems are unavailable, SRI does not show any information.
e.004	SRI shall provide continuous system health availability information.(dependent on weigh station hours of operation – may need to delete	DOP01	Inspect	8/17/15	RS, e.003 was met. Check on Glassfish notification
e.005	The SRI Prototype System shall be deployed and tested at a fixed facility on the Interstate System.	DOP03	Demonstrate	8/17/15	RS
e.007	The SRI prototype shall use the USDOT number as the unique identifier for the carrier.	DOP04	Inspect	8/17/15	RS
e.008	The SRI prototype shall use the VIN number as the unique identifier for the CMV.	DOP04	Inspect	8/17/15	RS
e.009	The SRI prototype shall use the CDL number as the unique identifier for the CMV driver.	DOP04 UN12	Inspect	8/17/15	RS
e.012	SRI shall collect, store, and provide real-time on-line interactive access to historical vehicle, driver and carrier safety data at the weigh station. (for security reasons, information stored by SRI will be discarded after 23 hours.	UN 08	Demonstrate	8/17/15	RS
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	8/17/15	RS
e.014	SRI shall provide an interface to all commercial drivers that is compliant with existing safety regulations.	DOC01	Demonstrate	8/17/15	RS (rental car only – no participating CMV drivers in MI)

Table 16. Michigan System Test Criteria – Application Requirements (a)

Req ID	Requirement	Source	Verification Method	Test Date	Performed By
a.001	SRI shall be consistent with the ITS National Architecture and associated standards such as the CVISN National Architecture.	UN08	Analyze	TBD	
a.002	SRI shall provide an interface and processing modules for truck parking applications.	UN10	Demonstrate	8/17/15	RS
a.002.1	*SRI shall provide information about the availability of truck parking spaces.*	UN10	Demonstrate	8/14/15	RS
a.002.2	*SRI shall provide current parking availability information at a specific facility.*	UN10	Demonstrate	8/14/15	RS
a.002.4	*SRI shall provide 24x7 access to truck parking information (depending on availability of TSPS application*	UN10	Demonstrate	8/17/15	RS
a.002.5	*SRI shall provide a graphical interface to stationary (i.e., dispatcher/operator/driver/traffic analyst/other) users.*	UN05	Demonstrate	8/17/15	RS
a.002.7	*SRI shall allow a stationary user to submit requests for automated truck parking information.*	UN05	Demonstrate	8/14/15	RS (not verified as this action is conducted within the TSPS application)
a.002.8	*SRI shall allow a user to receive the results of an automated request for truck parking information.*	UN05	Demonstrate	8/14/15	RS (not verified as this action is conducted within the TSPS application)
a.003	SRI shall provide an interface and processing modules for enforcement screening applications.	UN10	Demonstrate	8/17/15	RS
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	8/17/15	RS
a.004.8	*SRI shall provide the data necessary to document inspection events and outcomes.*	UN10	Analyze	8/17/15	RS
a.005	SRI shall provide an interface for Tier 1 users.	UN10	Demonstrate	8/17/15	RS
a.005.1	*SRI shall provide an interface for CMV Enforcement Officers and supervisors to enter data.*	UN10	Demonstrate	8/17/15	RS (USDOT number manually enteres for SAFER lookup)
a.005.2	*SRI shall provide an interface for CMV Enforcement Officers and supervisors to execute processes.*	UN10	Demonstrate	8/17/15	RS and M. Brown with MSP (Aspen to iyeCitation integration)

Req ID	Requirement	Source	Verification Method	Test Date	Performed By
a.005.3	*SRI shall provide an interface for CMV Enforcement Officers and supervisors to receive information and alerts.*	UN10	Demonstrate	8/17/15	RS
a.005.4	*SRI shall provide an interface for CMV drivers to receive information.*	UN10	Demonstrate	8/17/15	RS (no participating drivers in MI, simulated with rental car/ test smart phone)

Table 17. Michigan System Test Criteria – Interface Requirements (i)

Req ID	Requirement	Source	Verification Method	Test Date	Performed By
i.001.1	*SRI shall exchange vehicle, owner and operator information from Aspen to iyeCitation).*	DOP 02	Analyze	8/17/15	RS and M. Brown, MSP
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	8/17/15	RS
i.005.1	*SRI shall access and provide current information in real-time or as available from integrated data sources.*	T004	Analyze	8/17/15	RS (Mettler-Toledo, Aspen, SAFER iyeTech)
i.005.2	*SRI shall access from authoritative data sources the information necessary to validate vehicle weight information.*	T004	Inspect	8/17/15	RS (Mettler-Toledo)
i.006	SRI shall interface with truck parking systems.	T007	Demonstrate	8/17/15	RS (TSPS)
i.007	SRI shall provide designated collected data to back office external systems (Aspen,iyeCitation).	UN03	Demonstrate	8/17/15	RS and M.Brown (MSP)
i.008	SRI shall receive designated data from back office external systems (SAFER).	UN04	Demonstrate	8/17/15	RS
i.009	SRI shall provide a driver interface that is compliant with driver safety regulations.	UN07	Demonstrate	8/17/15	RS
i.012	SRI shall facilitate the real-time exchange of truck parking information.	UN011	Analyze	8/14/15	RS
i.012.1	*SRI shall receive data with parking systems to support truck parking functionality.*	UN04	Analyze	8/14/15	RS

Table 18. Maryland System Test Items

Item to Test	Test Description	Test Date	Responsibility
Compliant CMV – Internet and Cellular Communications “Green Light”	CMV passes over a WIM ramp and receives a “green light” indicating no further weight verification check is required.	8/21/15	CB, JC, RS (tested both via rental vehicle and USDOT commercial vehicle ‘Silver’)
Compliant CMV – Internet and Cellular Communications “Red Light”	CMV passes over a WIM ramp and receives a “red light” indicating WIM weight thresholds were exceeded. The CMV then proceeds to a static scale for additional weight verification.	8/21/15	CB, JC, RS (tested both via rental vehicle and USDOT commercial vehicle ‘Silver’)
Compliant CMV – Internet and Cellular Communications “Red Light” and Illegal Bypass	CMV passes over a WIM ramp and receives a “red light” indicating additional weight verification is required. The CMV does not proceed to a static scale but ignores the signal and returns to the mainline.	NO	Could not simulate this with USDOT commercial vehicle
Compliant CMV – DSRC “Green Light”	CMV passes over a WIM ramp and receives a “green light” indicating no additional weight verification check is required.	8/21/15	CB, JC, RS (tested in rental vehicle)
Non-Compliant CMV – DSRC “Red Light”	CMV passes over a WIM ramp and receives a “red light” indicating WIM weight thresholds were exceeded. The CMV then proceeds to a static scale for additional weight verification.	8/21/15	CB, JC, RS (tested in rental vehicle)
Non-Compliant CMV – DSRC “Red Light” and Illegal Bypass	CMV passes over a WIM ramp and receives a “red light” indicating additional weight verification is required. The CMV does not proceed to a static scale but ignores the signal and returns to the mainline.	No	Could not simulate this with USDOT commercial vehicle
Enforcement officer smart phone scenario	An enforcement officer is located outside of the weigh station (in his patrol vehicle) and uses his Smartphone to access the SRI user interface. He is able to screen vehicles that have passed through the weigh station as he would if he were using the user interface on a desktop computer.	8/21/15	CB, JC, RS

Table 19. Maryand System Test Criteria

Req ID	Requirement	Source	Verification Method	Test Date	Performed By
e.001	SRI shall be designed to operate in conjunction with and not interfere with existing systems.	UN14	Inspect	8/21/15	CB, JC, RS
e.002	SRI shall monitor roadside equipment.	DOP01	Inspect	8/21/15	CB, JC, RS
e.003	SRI shall monitor external system availability.	DOP01	inspect	8/21/15	CB, JC, RS
e.004	SRI shall provide continuous system health availability information.(dependent on weigh station hours of operation	DOP01	Inspect	TBD	Check available Glassfish logs
e.005	The SRI Prototype System shall be deployed and tested at a fixed facility on the Interstate System.	DOP03	Demonstrate	8/21/15	CB, JC, RS
e.007	The SRI prototype shall use the USDOT number as the unique identifier for the carrier.	DOP04	Inspect	8/21/15	CB, JC, RS
e.008	The SRI prototype shall use the VIN number as the unique identifier for the CMV.	DOP04	Inspect	8/21/15	CB, JC, RS
e.009	The SRI prototype shall use the CDL number as the unique identifier for the CMV driver.	DOP04 UN12	Inspect	8/21/15	CB, JC, RS
e.012	SRI shall collect, store, and provide real-time on-line interactive access to historical vehicle, driver and carrier safety data at the weigh station. (for security reasons, information stored by SRI will be discarded after 23 hours.	UN 08	Demonstrate	8/21/15	CB, JC, RS
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	8/21/15	CB, JC, RS
e.014	SRI shall provide an interface to all commercial drivers that is compliant with existing safety regulations.	DOC01	Demonstrate	8/21/15	CB, JC, RS

Table 20. Maryand System Test Criteria - Application Requirements (a)

Req ID	Requirement	Source	Verification Method	Test Date	Performed By
a.001	SRI shall be consistent with the ITS National Architecture and associated standards such as the CVISN National Architecture.	UN08	Analyze		CB
a.003	SRI shall provide an interface and processing modules for enforcement screening applications.	UN10	Demonstrate	8/21/15	CB, JC, RS (Mettler Toledo)
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	Demonstrate	8/21/15	CB, JC, RS (LPR)
a.004.8	*SRI shall provide the data necessary to document inspection events and outcomes.*	UN10	Demonstrate	8/21/15	CB, JC, RS
a.005	SRI shall provide an interface for Tier 1 users.	UN10	Demonstrate	8/21/15	CB, JC, RS
a.005.1	*SRI shall provide an interface for CMV Enforcement Officers and supervisors to enter data.*	UN10	Demonstrate	8/21/15	CB, JC, RS (USDOT number manually entered for SAFER lookup)
a.005.2	*SRI shall provide an interface for CMV Enforcement Officers and supervisors to execute processes.*	UN10	Demonstrate	NO	Michigan only – did not integrate to an electronic ticketing system in MD
a.005.3	*SRI shall provide an interface for CMV Enforcement Officers and supervisors to receive information and alerts.*	UN10	Demonstrate	8/21/15	CB, JC, RS
a.005.4	*SRI shall provide an interface for CMV drivers to receive information.*	UN10	Demonstrate	8/21/15	CB, JC, RS
a.007	SRI shall comply with nationwide interoperability standards currently used for the USDOT V2X Program.	DOP06 UN014	Inspect	8/21/15	CB, JC, RS
a.007.1	*SRI shall comply with SAE STD J2735.*	DOP06 UN014	Inspect	8/21/15	JC
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	8/21/15	JC (Arada)
a.007.4	*SRI shall comply with IEEE Standard 802.11p.*	DOP06 UN014	Inspect	8/21/15	JC

[1] To be verified with Arada

Table 21. Maryand System Test Criteria - Interface Requirements (i)

Req ID	Requirement	Source	Verification Method	Test Date	Performed By
i.001	SRI shall be designed to receive vehicle, and operator information through vehicle OBU (OBU Bluetooth to mobile application for presentation to driver)	T001 UN01 UN02	Demonstrate	8/21/15	JC (in rental car only[1])
i.002.1	*Vehicle information should be conformant to standards SAE J2735 and IEEE P1609.*	DOP 02	Inspect	8/21/15	JC (in rental car only)
i.003	SRI shall receive weight information from SRI-capable Roadside Unit, RSU).	T003 UN02	Demonstrate	8/21/15	JC (in rental car only) – weight information is only received by the SRI UI from Mettler-Toledo. SRI RSU provides pass/fail results to OBU.
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	8/21/15	CB, JC, RS
i.005.1	*SRI shall access and provide current information in real-time or as available from integrated data sources.*	T004	Analyze	8/21/15	CB, JC, RS
i.005.2	*SRI shall access from authoritative data sources the information necessary to validate vehicle weight information.*	T004	Inspect	8/21/15	CB, JC, RS
i.007	SRI shall provide designated collected data to back office external systems (Aspen,eyiyeCitation).	UN03	Demonstrate	NO	Michigan only
i.008	SRI shall receive designated data from back office external systems (SAFER).	UN04	Demonstrate	8/21/15	CB, JC, RS
i.009	SRI shall provide a driver interface that is compliant with driver safety regulations.	UN07	Demonstrate	8/21/15	CB, JC, RS
i.011	SRI information exchanges shall be compliant with appropriate communications protocols, such as SAE J2735, P1609 for DSRC, RESTful web services for cellular and Abstract Syntax Notation (ASN.1) for DSRC.	DOP10	Inspect	8/21/15	CB, JC, RS

[1] This initial testing took place at Turner-Fairbank Highway Research Center in a rental car. Testing with the SRI truck was not completely successful.

Table 22. Michigan Acceptance Test Items - Driver

Item to Test	Test Description	Test Date	DSRC Communi-cation	Cellular Communi-cation	Weigh station Access	Mobile Access	Responsi-bility
Enter information into mobile application	• License number x • VIN # x • USDOT # x • License Plate # x • Photo (optional) x	8/17/15	-	RS	N/A	N/A	-
Receive weigh station instruction via red light/green light	• Please follow roadside signs • Red light (pull in) • Green light (bypass)	8/17/15	-	RS	N/A	N/A	-
View truck parking information (MICHIGAN only)	• Truck parking application (TSPS) automatically launches when exiting a defined geofence	8/17/15	-	RS	N/A	N/A	Issues noted on 8/17 with only three locations appearing regardless of direction traveled

Table 23. Michigan Acceptance Test Items – Enforcement Officer

Item to Test	Test Description	Test Date	DSRC Communi-cation	Cellular Communi-cation	Weigh station Access	Mobile Access	Responsi-bility
Successful log-in to SRI user interface	• User credentials are entered and accepted by the SRI UI and the application launches	8/17/15	-	RS	yes	yes	-
Mettler- Toledo Ramp WIM data is presented on SRI UI	• Captured Time, Gross Weight, Axles, Status, Sequence Number, Reason.	8/17/15	-	RS	yes	yes	-
Mettler-Toledo static scale data is presented on SRI UI	• Captured Time, Gross Weight, Axles, Status, Sequence Number, Reason.	8/17/15	-	RS	yes	yes	Issue noted on 8/17/15 that was resolved on 8/18: if user selected finish, park or print on MT interface, information was not populating SRI UI in the WS

Item to Test	Test Description	Test Date	DSRC Communi-cation	Cellular Communi-cation	Weigh station Access	Mobile Access	Responsi-bility
Data from SRI mobile application is presented on SRI UI	• License number x • VIN # x • USDOT # x • License Plate # x • Photo (optional) x	8/17/15	-	RS	yes	yes	-
Select a truck from the truck feed and view complete data available	• Yes or no	8/17/15	-	RS	yes	yes	-
USDOT number can be entered on SRI UI	• Yes or no	8/17/15	-	RS	yes	yes	-
SAFER Company Data module populates if USDOT number is available from the SRI mobile application	• Company Name, DBA Name, Physical Address, Mailing Address, Status, US DOT Number, MC/MX, MCS 150, MCS 150 Mileage, Phone, Email, DOT Status, Entity Type, Power Units	8/17/15	-	RS	yes	yes	-
SAFER Company Data module populates if user enters USDOT number	• Company Name, DBA Name, Physical Address, Mailing Address, Status, US DOT Number, MC/MX, MCS 150, MCS 150 Mileage, Phone, Email, DOT Status, Entity Type, Power Units	8/17/15	-	RS	yes	yes	-
US Crash data from SAFER	• Fatal, Injury, Tow, Total	8/17/15	-	RS	yes	yes	Not within a separate module – separate box within SRI UI
SAFER US Safety Rating is presented	• Review Date, Rating Date, Type, Rating	8/17/15	-	RS	yes	yes	Not within a separate module – separate box within SRI UI
SAFER US Inspections is presented	• Driver, Hazardous Materials, Intermodal Equipment Provider, Vehicle	8/17/15	-	RS	yes	yes	Not within a separate module – separate box within SRI UI

Table 24. Michigan Acceptance Test Items – Michigan Only

Item to Test	Test Description	Test Date	DSRC Communi-cation	Cellular Communi-cation	Weigh station Access	Mobile Access	Responsi-bility
Launch MiCJIN portal from SRI UI (MICHIGAN only)	• Portal successfully opens and log-in screen appears	8/17/15	-	RS and M.Brown (MSP)	yes	-	-
Log in to MICJIN portal when accessed from SRI UI	• Log in credentials can be entered, and credentials are accepted	8/17/15	-	-	no	-	No MI VPN available on SRI laptop at WS.
When executed, iyeCitation electronic ticket is pre-populated with saved Aspen data (MICHIGAN only)	• Electronic ticket in iyeCitation opens with draggable modules pre-populated from Aspen • For Vehicle - License Plate #, Plate State, Make, Type, Vehicle Year • For Driver – First Name, Last Name, Driver's License #, Driver's License State	8/17/15	-	-	yes	-	Separate computer was used for this test (not the laptop running SRI UI) due to security.

Table 25. Maryland Acceptance Test Items - Driver

Item to Test	Test Description	Test Date	DSRC Communication	Cellular Communication	Type of access	Responsibility
Enter information into mobile application	• License number • VIN # • USDOT # • License Plate # • Photo (optional)	8/21/15	• License number x • VIN # x • USDOT # x • License Plate # x	• License number x • VIN # x • USDOT # x • License Plate # x • Photo (optional) x	N/A	RS, CB, JC
Receive weigh station instruction via red light/green light	• Please follow roadside signs • Red light (pull in) • Green light (bypass)	8/21/15	Rental car only not CMV	yes	N/A	RS, CB, JC

Table 26. Maryland Acceptance Test Items – Enforcement Officer

Item to Test	Test Description	Test Date	DSRC Communi-cation	Cellular Communi-cation	Weigh station Access	Mobile Access	Responsi-bility
Successful log-in to SRI user interface	• User credentials are entered and accepted by the SRI UI and the application launches	8/21/15	-	yes	yes	yes	RS, CB, JC
Mettler- Toledo Ramp WIM data is presented on SRI UI	• Captured Time, Gross Weight, Axles, Status, Sequence Number, Reason.	8/21/15	-	yes	yes	yes	RS, CB, JC
Mettler-Toledo static scale data is presented on SRI UI	• Captured Time, Gross Weight, Axles, Status, Sequence Number, Reason.	8/21/15	-	yes	yes	yes	RS, CB, JC
Data from SRI mobile application is presented on SRI UI	• License number • VIN # • USDOT # • License Plate # • Photo (optional)	8/21/15	-	yes	yes	yes	RS, CB, JC
Select a truck from the truck feed and view complete data available	• Yes or no	8/21/15	-	yes	yes	yes	RS, CB, JC
USDOT number can be entered on SRI UI	• Yes or no	8/21/15	-	yes	yes	yes	RS, CB, JC
SAFER Company Data module populates if USDOT number is available from the SRI mobile application	• Company Name, DBA Name, Physical Address, Mailing Address, Status, US DOT Number, MC/MX, MCS 150, MCS 150 Mileage, Phone, Email, DOT Status, Entity Type, Power Units	8/21/15	-	yes	yes	yes	RS, CB, JC
SAFER Company Data module populates if user enters USDOT number	• Company Name, DBA Name, Physical Address, Mailing Address, Status, US DOT Number, MC/MX, MCS 150, MCS 150 Mileage, Phone, Email, DOT Status, Entity Type, Power Units	8/21/15	-	yes	yes	yes	RS, CB, JC

Item to Test	Test Description	Test Date	DSRC Communi-cation	Cellular Communi-cation	Weigh station Access	Mobile Access	Responsi-bility
SAFER US Crash data from SAFER is presented within a separate module	• Fatal, Injury, Tow, Total	8/21/15	-	yes	yes	yes	RS, CB, JC
SAFER US Safety Rating is presented within a separate module	• Review Date, Rating Date, Type, Rating	8/21/15	-	Yes	yes	yes	RS, CB, JC
SAFER US Inspections is presented within a separate module	• Driver, Hazardous Materials, Intermodal Equipment Provider, Vehicle	8/21/15	-	yes	Yes	yes	RS, CB, JC

Table 27. Maryland Acceptance Test Items – Maryland Only

Item to Test	Test Description	Test Date	DSRC Communi-cation	Cellular Communi-cation	Weigh station Access	Mobile Access	Responsi-bility
LPR window appears in SRI UI	-	8/21/15	-	yes	yes	yes	RS, CB, JC
LPR data appears in SRI UI	• Photo • License plate number • Date/Timestamp	8/21/15	-	yes	yes	yes	RS, CB, JC

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