Smart Roadside Initiative

System Design Document

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16. Abstract This document describes the software design for the Smart Roadside Initiative (SRI) for the delivery of capabilities related to wireless roadside inspections, electronic screening/virtual weigh stations, universal electronic commercial vehicle identification and truck parking. This document has been updated with the final design as deployed in the field.			
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Chapter 1. Introduction

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

The structure of this System Design Document (SDD) is based on the Institute of Electrical and Electronics Engineers (IEEE) Standard *1016-2009 IEEE Standard for Information Technology – System Design – Software Design Descriptions.* Consistent with this standard[1], this SDD consists of the following sections:

- Section 1 provides an introduction to the document and an overview of the system purpose and scope.
- Section 2 provides a general system description, including the design rationale, or the reasoning and justifications that led to the system as designed. This section also identifies the stakeholders with input and interest to the SDD.
- Section 3 details the system design views and viewpoints.
    - This section includes the design overlay diagrams for each viewpoint.
- Section 4 discusses the specific design elements (i.e., any item occurring in a design view) for the SRI prototype. Potential design elements will be identified by attribute, i.e., name and type; design elements include:
    - Design entity (for example, systems, subsystems, or processes)
    - Design relationship (i.e., the association or correspondence among two or more design entities)
    - Design constraint (i.e., a rule or restriction imposed by a design element; a source should be specified for each constraint).
- Section 5 traces each design element back to the Requirements Traceability Matrix (RTM).

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

[1] IEEE Std 1016-2009; NOTE: this content is not necessarily in the same order as specified by the standard. In addition, some content is not applicable to the SRI design and was therefore excluded.

The original SDD was written based on the SRI ConOps drafted in September 2012. As documented in the revised ConOps of September 2015, there were significant design changes to support the new functionality. In this report, Chapters 1 and 2 references both the original and updated design so the reader can tie back to the original and updated ConOps. Starting with Chapter 3. System Design, all documentation is based on the SRI system that was actually deployed. Any text italicized or noted as "updated" prior to Chapter 3 indicates updated information from the original SDD.

System Purpose

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

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

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

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

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

System Scope

The "SRI system"[2] is not a discrete system, but rather a prototype that will demonstrate the integration of tools, methods, and standards that together have the potential to transform the way commercial vehicle operators, safety enforcement personnel and other authorized

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

users access, apply, and manage information. Per the final SRI Concept of Operations, the SRI prototype will effectively accomplish the following three things:

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

The application of the proposed SRI system within the current operating environment is depicted below in Figure 1-1, *which ties to the original Concept of Operations. Figure 1-2 shows what was actually implemented at both deployed sites.*

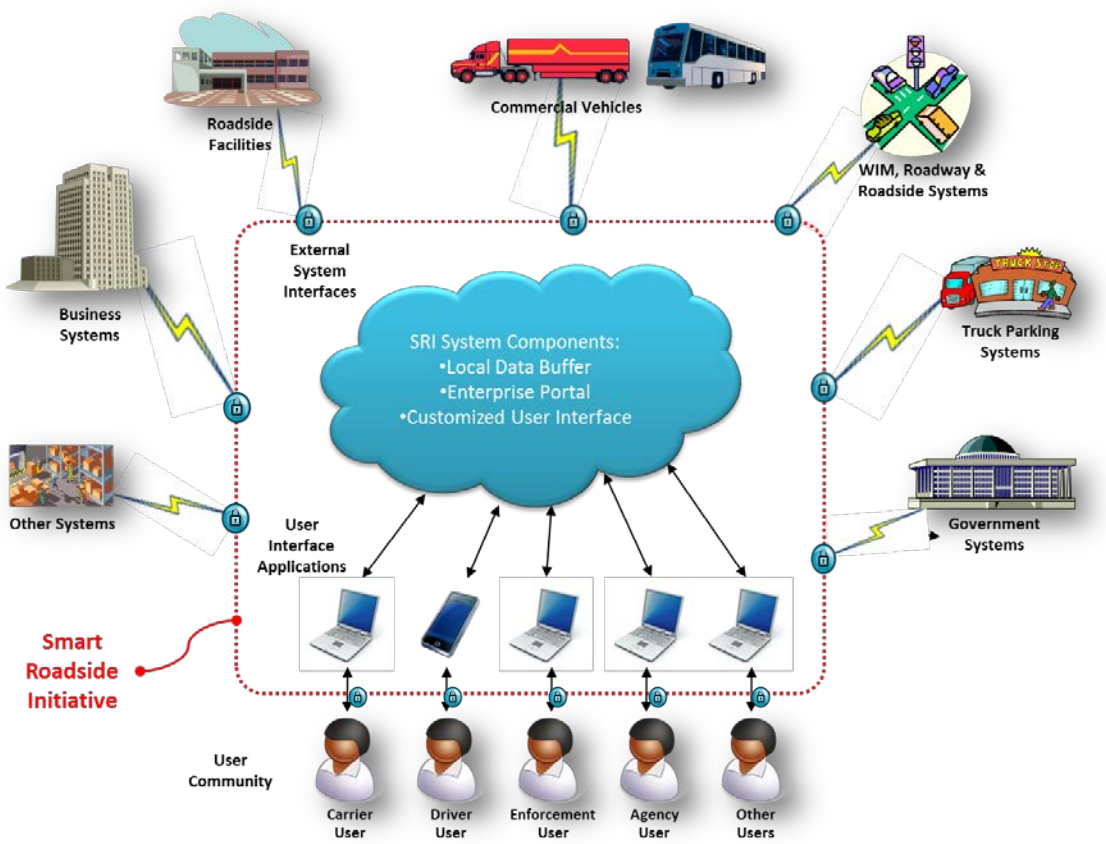

Figure 1-1: SRI High-Level Perspective Framework

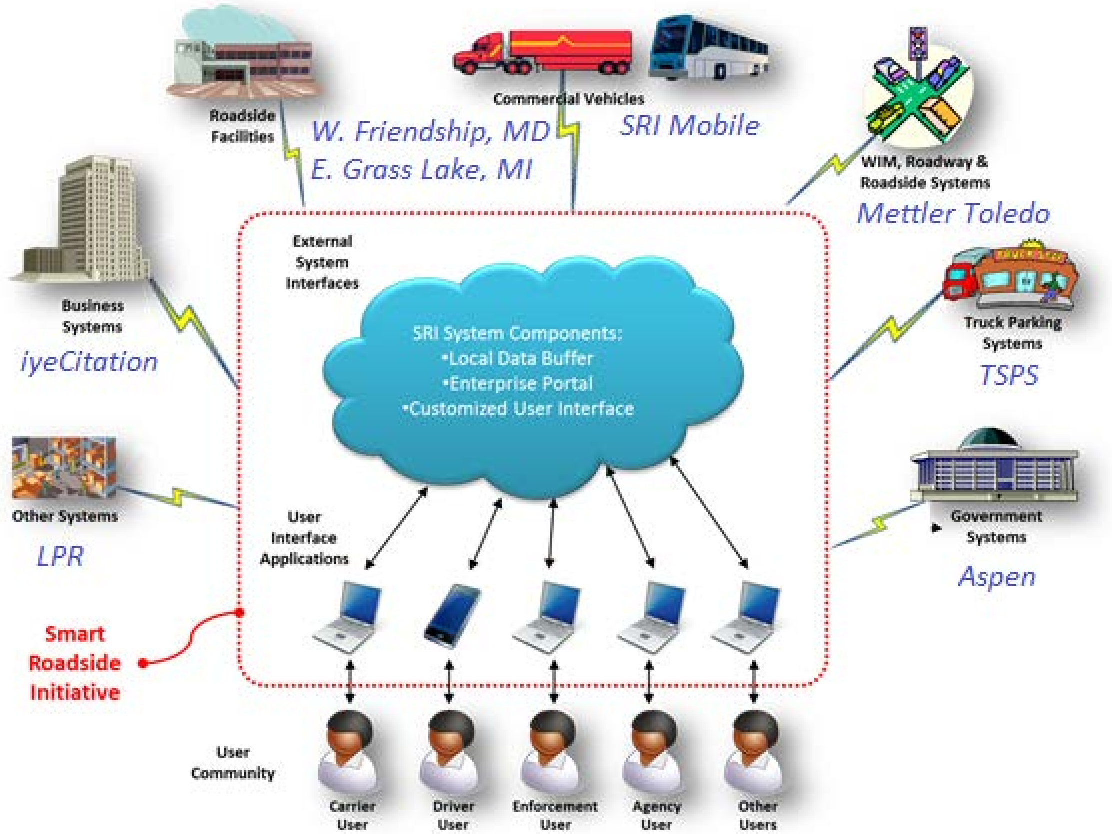

Figure 1-2: SRI High-Level Perspective Framework (Updated)

Definitions, Acronyms and Abbreviations

Table 1-1: Definitions, Acronyms and Abbreviations

Organizations	
CVSA	Commercial Vehicle Safety Alliance
DMV	(State) Department of Motor Vehicles
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
NATSO	National Association of Truck Stop Operators
NHTSA	National Highway Traffic Safety Administration
USDOT	US Department of Transportation
Standards	
CFR	Code of Federal Regulations
CVSP	Commercial Vehicle Safety Plan
CSA	Compliance, Safety, Accountability

Standards (cont'd)	
FMCSR	Federal Motor Carrier Safety Regulations
IEEE	Institute of Electrical and Electronics Engineers
NIST	National Institute of Standards and Technology
SAE	Society of Automotive Engineers
STAA	Surface Transportation Assistance Act
Industry Terms	
API	Application Programming Interface
CAN	Controller Area Network
CDL	Commercial Driver's License
CMRS	Commercial Mobile Radio Services
CMV	Commercial Motor Vehicle
ConOps	Concept of Operations
CVIEW	Commercial Vehicle Information Exchange Window
DOC	Draft Operational Constraint
DOP	Draft Operational Policy
DSRC	Dedicated Short Range Communications
ELD	Electronic Logging Devices
ES	Electronic Screening
HOS	Hours Of Service
IT	Information Technology
MOU	Memorandum of Understanding
OBU	On-board unit
OOS	Out of service
Os/Ow	Oversize/overweight
RFID	Radio Frequency Identification
RSE	Roadside equipment
RSU	Roadside unit
RTM	Requirements Traceability Matrix
SyRS	System Requirements Specifications
TBD	To Be Determined
UID	Universal Identifier
UN	User Need
VIN	Vehicle Identification Number
VMT	Vehicle Miles Traveled
VWS	Virtual Weigh Station
WIM	Weigh-In-Motion
WRI	Wireless Roadside Inspection
Programs	
CVISN	Commercial Vehicle Information Systems and Networks
DRG	Dynamic Route Guidance

Programs (cont'd)	
FRATIS	Freight Advanced Traveler Information System
MCSAP	Motor Carrier Safety Assistance Program
NASI	North American Standard Inspection Program
SRI	Smart Roadside Initiative
SMS	Safety Measurement System
SRIS	Smart Roadside Inspection System
UCR	Unified Carrier Registration
Technologies	
ASN	Abstract Syntax Notation
DSRC	Dedicated Short Range Communications
OAuth	Open standard for AUTHorization
DRG	Dynamic Route Guidance
FRATIS	Freight Advance Traveler Information System
HTTPS	Hypertext Transfer Protocol Secure
NASI	North American Standard Inspection Program
RDBMS	Relational Database Management System
REST	Representational State Transfer
SOAP	Simple Object Access Protocol
SRI	Smart Roadside Initiative
SMS	Safety Measurement System
SRIS	Smart Roadside Inspection System
XML	Extensible Mark-up Language
Wi-Fi	Wireless Local Area Network
Systems	
A&I	Analysis and Information
CAPRI	Compliance, Analysis and Performance Review Information
CDLIS	Commercial Drivers' License Information System
CVIEW	Commercial Vehicle Information Exchange Window
EMIS	Enforcement Management Information System
IFTA	International Fuel Tax Agreement
InfoSys	Federal Motor Carrier Safety Administration Information Systems
ISS	Inspection Selection System
IRP	International Registration Plan
L&I	Licensing and Insurance
MCMIS	Motor Carrier Management Information System
Nlets	National Law Enforcement Telecommunications System
PRISM	Performance and Registration Information Systems Management
SAFER	Safety and Fitness Electronic Records
SENTRI	Secure Electronic Network for Travelers Rapid Inspection
UFA	Uniform Fine Assessment

References

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

- IEEE Std. 1016 – IEEE Standard for Information Technology – Systems Design – Software Design Descriptions (R2009)
- Military Standard 188 (MIL-STD-188). Telecommunications Standards. U.S. Department of Defense. 2004.
- Federal Standard 1037C. “Telecommunications: Glossary of Telecommunication Terms.” General Services Administration. 1996.
- National ITS Architecture. “CVISN Alignment.” U.S. Department of Transportation. Version 7.0. 2012
- Site Survey for Michigan Weigh Stations, Michigan Highway Patrol, 12 July 2012 (Internal Research Team document).
- Wireless Roadside Inspection System Requirements Document (Pre-Pilot Test), USDOT Federal Motor Carrier Safety Administration, Feb 2010
- Smart Roadside Initiative FINAL Concept of Operations – 22 May 2012.
- Smart Roadside Initiative (SRI) Prioritization of Potential SRI Applications – Tasks 2 and 3: Technical Memorandum 3, SAIC, October, 2011
- Smart Roadside Initiative (SRI) User Needs: A Summary of Findings – Tasks 2 and 3: Technical Memorandum 3, SAIC, June, 2011
- Smart Roadside Initiative (SRI) Application Analysis and Assessment of Deployed Systems and Current Research – Tasks 2 and 3: Documentation Review of Deployed Systems and Documentation Review of Current research/Emerging Systems, SAIC, June, 2011
- USDOT System Requirement Specification “5.9 GHz DSRC Roadside Equipment.” Design Specification v. 3.0, USDOT ITS JPO, March 2012
- WSDOT Truck Parking Study – Final Report, Washington State Department of Transportation, December 2005
- I-95 Corridor Coalition Truck Parking Initiative, System Design Version 1.2, FHWA, November 24, 2010
- Statement of Work – Smart Roadside Initiative, USDOT, June 2010

Chapter 2. General System Description

The SRI system is designed to be utilized at multiple weigh station locations and for use by mobile inspectors. The overall system design approach is to aggregate and consolidate various federal, state, and commercial systems into a single dashboard view on weigh station and mobile inspector's computers.

The system design will provide interfaces for external systems that include wireless roadside inspections, electronic screening/virtual weigh stations, universal electronic commercial vehicle identification, and truck parking

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 will allow for a central location of services that can be offered for multiple clients at multiple locations. RESTful (Representational State Transfer) Web Services will be 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 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 resource is typically an XML *or a JSON* document that captures the current or intended state of a resource.

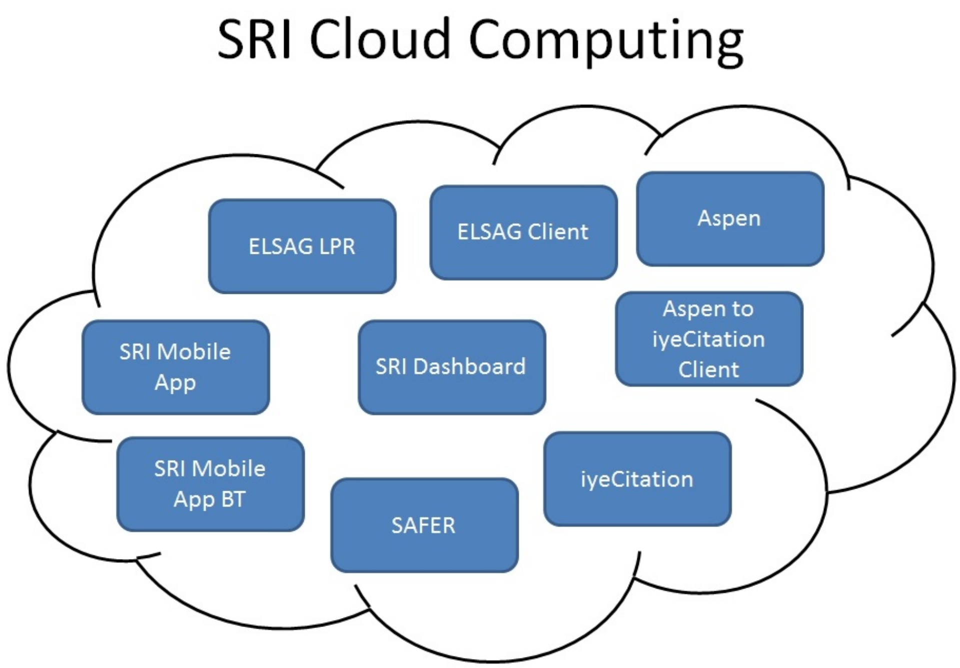

Figure 2-1: SRI Cloud Computing (Updated)

A Java application will be developed to work with the SRI Data Buffer to communicate with RSUs. Previous prototype work has been done on the test bed at Turner Fairbanks Highway Research Center in Virginia. An understanding of how Java communicated with the RSU's native C++ using the JNI was established. This work also created a security protocol utilizing digitally assigned certificates for communication with the RSUs.

Design Rationale (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.

System Overview

The Research Team envisions the basic prototype architecture consisting of four major system elements:

- Vehicle systems, which encompass all system elements and devices on a vehicle;
- Roadside systems, which include all system elements deployed locally in both fixed and mobile applications;
- Back-Office Systems, including systems currently in existence at Federal, State and Local agencies, motor carriers, and service providers as well as those systems that will be implemented among these organizations in the near-term; and
- Communications networks, including the local and wide area public or private networks capable of supporting high-speed data transmission.

SRI Process

Figures 2-2 and 2-3 illustrate two implementations of the SRI architecture. In Figure 2-2 the vehicle communicates to SRI via DSRC. In Figure 2-3 the vehicle communicates to SRI via a cellular network. DSCR requires a fixed roadside device to communicate with the vehicle. The roadside device will be located at a specific weigh station. Passing one of these devices will trigger the inspection process (1). The cellular approach requires establishing a geofence around fixed or permanent inspection sites or weigh stations. The inspection process is triggered when the on board device recognizes that it has entered an inspection geofence area (1). The remaining processes are the same for both architectures.

The SRI on board device will send driver, vehicle and carrier identification along with engine diagnostics and hours of service. At the same time road side sensors will weigh the truck, scan the size and take an electronic footprint (2a).

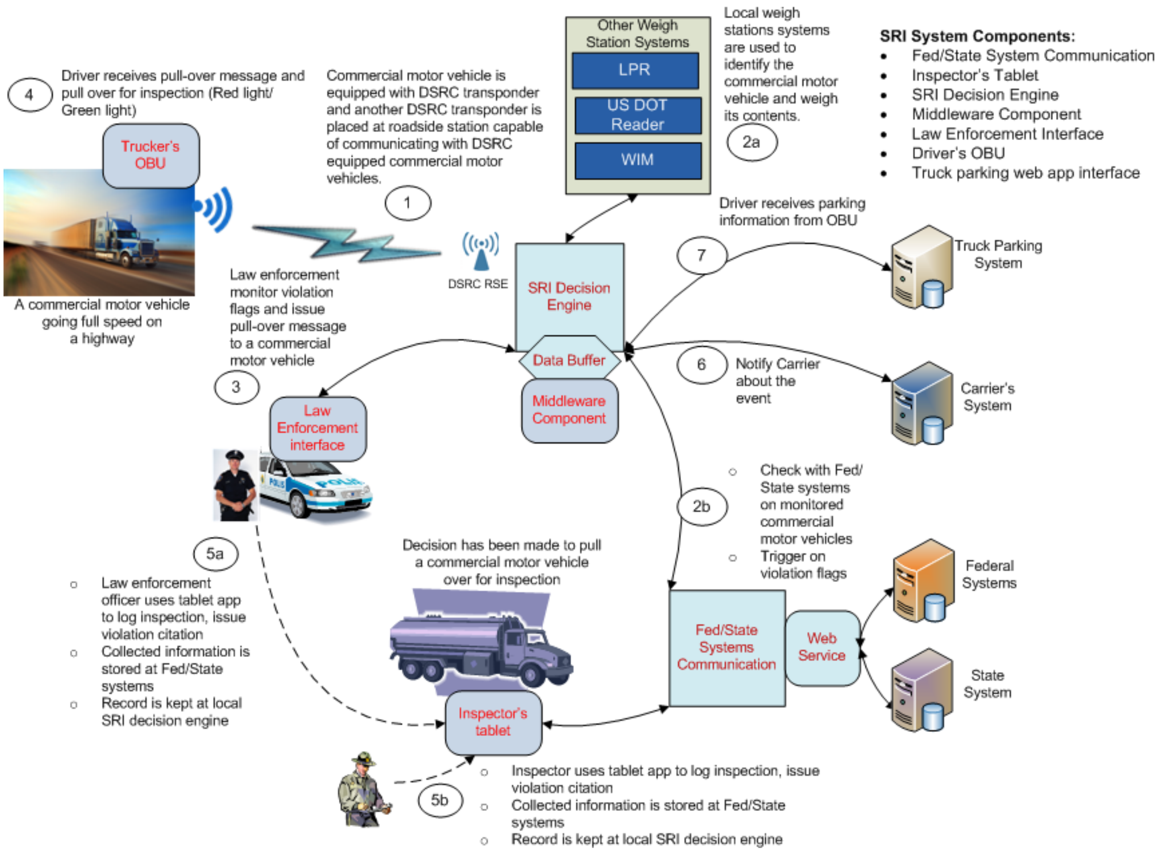

Figure 2-2: Proposed SRI Functional Architecture – DSRC Solution

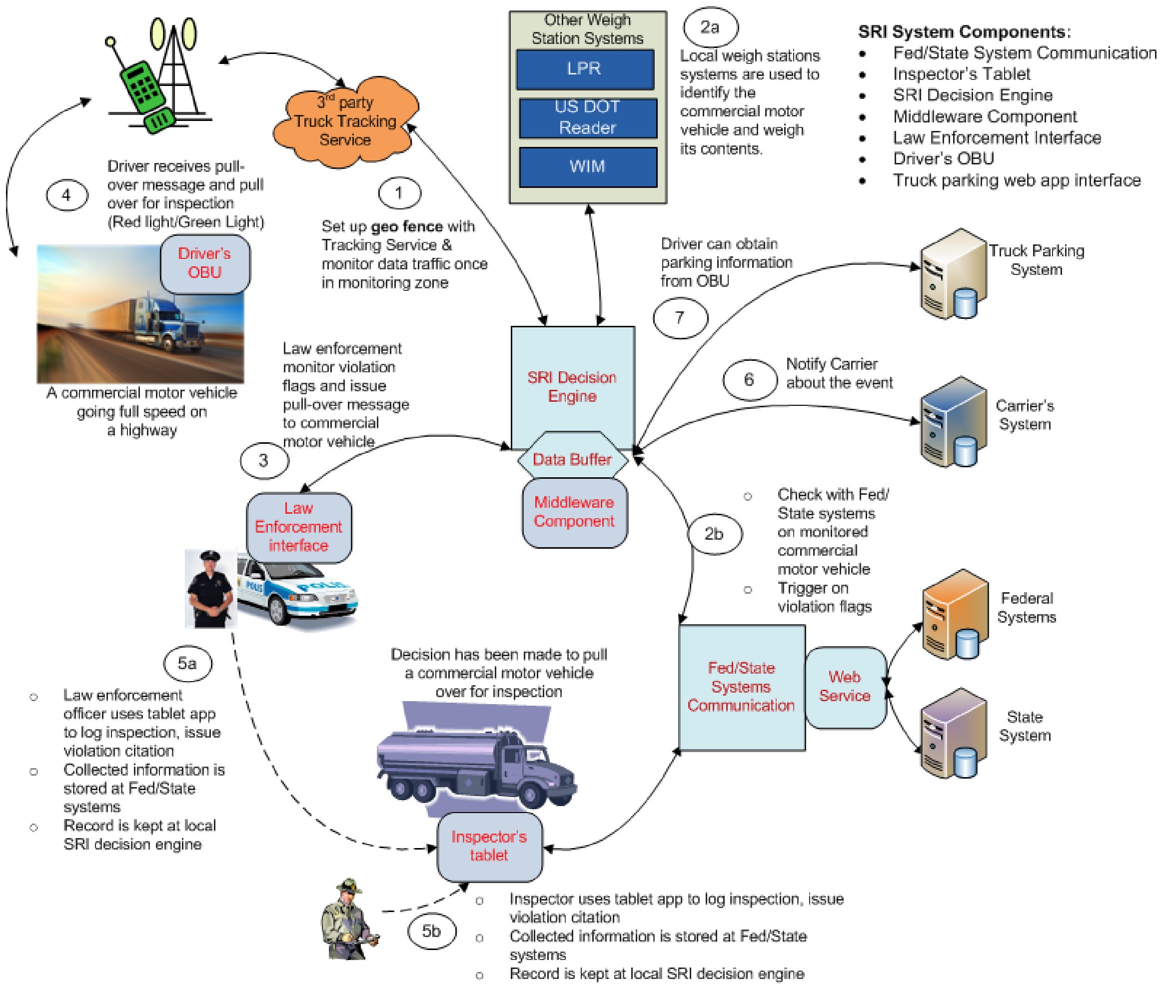

Figure 2-3: Proposed SRI Functional Architecture – Cellular Solution

The SRI server will access central systems and retrieve credentials for the driver, vehicle and carrier (2b). The SRI decision engine will use credential information and sensor values to make a pass/no pass decision (3). Figure 2-4 shows the logic used by the SRI decision engine.

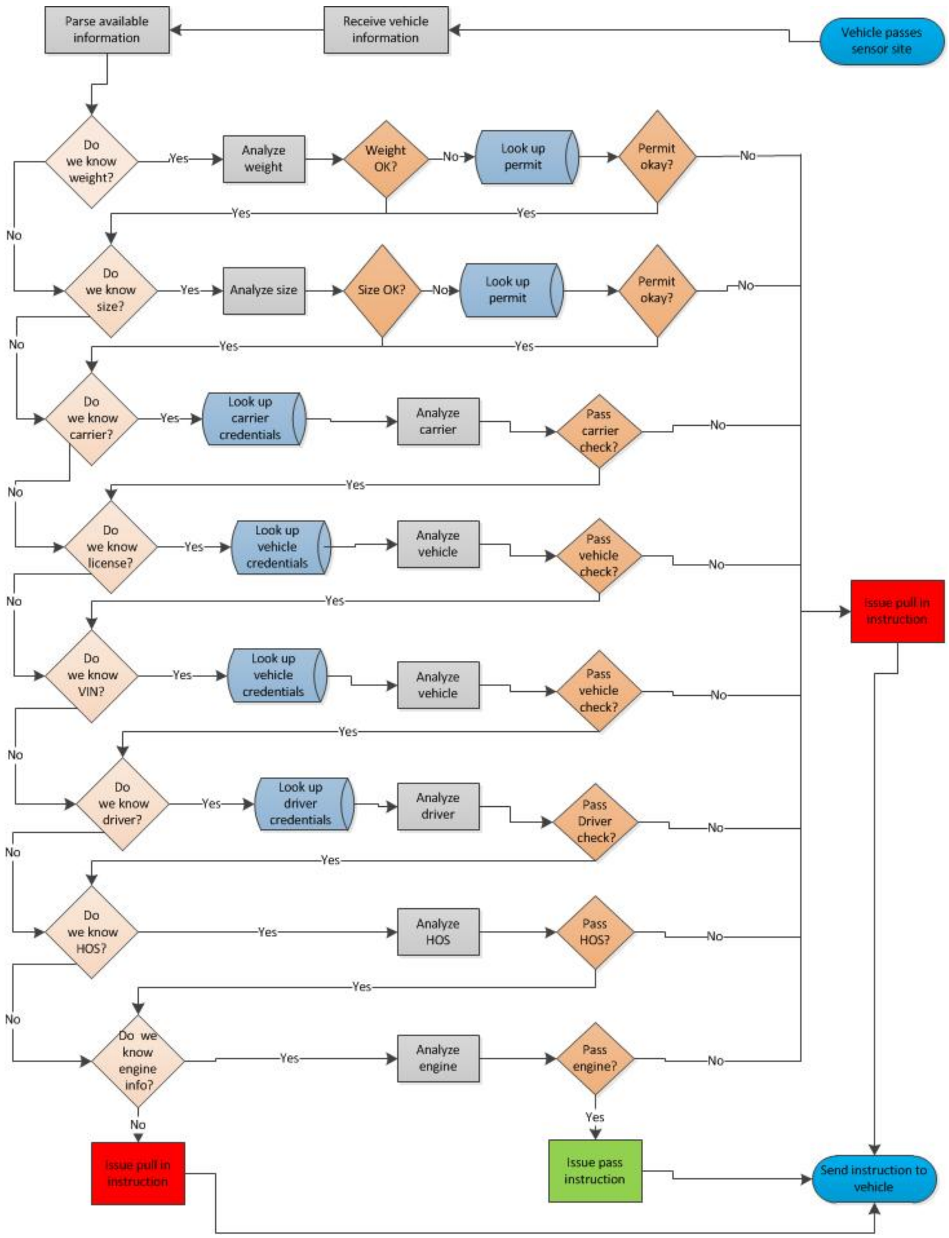

Figure 2-4: Decision Engine Flowchart

The SRI server will send a pass/no pass instruction to the vehicle through either a DSRC roadside device or through the cellular network. The SRI on board device will display instructions to the driver, a pass/no pass signal to the driver (4).

Law enforcement officers will have a view of summary vehicle information as the trucks pass the weigh station/inspection site. They will have a brief opportunity to override the pass/no pass decision and issue a manual instruction to be relayed to the vehicle in the same manner as the automated decision (5a).

After a selected vehicle has stopped in the inspection or static scale area the law officer can request detailed information from SRI Portal application. The SRI Portal application will query central and state systems and return detailed driver, carrier and vehicle information and display that to the law officer (5b). The law officer will perform a physical inspection of the stopped CMV and enter the inspection into the system. If the state is using an electronic ticket system the SRI Portal application will feed violation to the ticketing system and any other state or local systems that have established an interface. The officer will also use the SRI Portal application to send the inspection results to SAFER.

If the carrier is capable of receiving an inspection notification they can receive an e-mail or a direct feed to their transportation management system (6).

Truck parking will use the SRI on board device and the DSRC/cellular communication network to provide information regarding truck parking availability and parking reservation capabilities to drivers for locations that have enabled truck parking systems (7).

SRI Process (Updated)

This section describes what was actually deployed with the new design referencing the original concept diagrams shown in Figure 2-2 and Figure 2-3.

Updated Process Flow for DSRSC

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).

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 capture 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.

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

SRI Prototype Capabilities

New Capabilities

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

- Enhanced exchange of information at roadside (via vehicle-to-infrastructure communication) at mainline speeds to support such activities as mobile enforcement compliance checks;

- SRI will assign unique identifiers to drivers, vehicles, and motor carriers who participate in the system that can be exchanged at mainline speeds;
- 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 proposed SRI enterprise-level application will significantly enhance the exchange of data between the roadside and external systems. As a result of this integration through SRI, the law enforcement community will be 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.

An additional enhanced capability will be the additional sources of data used to support FMCSA's CSA program, in particular the calculation of a motor carrier's safety score. The additional data sources will also provide substantially enhanced visibility into driver and vehicle performance and will significantly expand the total number of data points included in State and Federal motor carrier safety history and credential databases. In particular, these sources of data potentially include (but are not limited to):

- The unique identifiers for the driver, vehicle and motor carrier, including the trailing unit;
- Driver hours of service;
- Vehicle-based maintenance data from the CAN BUS; and
- Telemetry and sensor output data such as that provided from weigh in motion (WIM) technology.

Finally, the use of SRI applications on secondary roads and fixed facility by-pass routes will 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 will be integrated into the SRI decision engine.

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 discussed providing information to motor carriers and drivers about motor carrier services in real-time (e.g., truck parking) as a new capability. The SRI prototype will also examine truck parking detection and notification systems and pilots currently in development and will integrate them into the system design, if deemed feasible based on maturity of these developments.

System Scope

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

To that end, the research team intends to deploy and test the SRI prototype in the Detroit, Michigan metropolitan area with the cooperation of the Michigan State Police and the USDOT's Connected Vehicle Test Bed. The list below indicates the Michigan State Police sites that will be included in the prototype and the physical technology they currently have:

- *East Grass Lake Weigh Station on I-94 Eastbound*
    - *Fixed weigh-in-motion (WIM) scale on ramp connected to the static scale at the weigh station house software*

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

Another component that can be used in this area is the Connected Vehicle Test Bed, anchored in Novi, Michigan, which includes 55 fixed and mobile roadside equipment (RSU) boxes, equipped with DSRC 5.9 GHz to broadcast vehicle messaging data to vehicles. In addition, the test bed provides a back office data center with service delivery nodes and an enterprise network operations center.

The selection of the Michigan site represents an opportunity to test the SRI Prototype in a current operating environment (the East Grass Lake weigh station) and also to test in the next generation connected vehicle environment within the test bed.

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

The list below indicates the Maryland site that will be included in the prototype and the physical technology it currently has:

- *West Friendship, Maryland on I-70 Westbound:*
    - *Fixed weigh-in-motion (WIM) scale on ramp connected to the static scale at the weigh station house software*
    - *ELSAG North America's License Plate Camera and Plate Hunter software to capture and read the CMV's front license plate*

The West Friendship weigh station operates fixed scales on westbound I-70 at West Friendship, MD. The operation also consists of Drivewyze and a Cardinal WIM on the interstate main line.

The site is also equipped with an LPR camera mounted by the WIM that captures and reads license plates from commercial vehicles.

Upon entering the weigh station, drivers of commercial vehicles are directed via a variable message sign controlled through a keyboard located inside the building. Officers manually select one of several pre-set directions for the carrier. These include, "ahead slowly, park and come in, stop, and other simple directions". Port officers enter all truck data into the Port of Entry business system, which also produces electronic citations and permits.

Inspection officers on-site at the weigh station, as well as mobile, select and inspect commercial vehicles and drivers using the FMCSA Aspen, ISS, and Query Central applications. For connectivity, they utilize a hard-wired LAN connection at the fixed sites, and a cellular connection at the mobile sites.

Chapter 3. System Design

Design Concerns

The primary concern is a common one when dealing with systems that are reliant on data that is retrieved from external sources. There is no way to guarantee that the external software systems that feed the SRI System will always be available when the SRI System is in use.

The SRI System aggregates technologies and systems that have already been developed and deployed. These systems need to be operational for full functionality to be realized. If one of these external sources is down, then the screening process could be negatively impacted. An example of this is credential verification. Credentials will not be able to be verified if the external system that SRI relies on becomes unavailable.

Technology

The primary platform used for the SRI System will be the Java Platform. The MySQL DB will be used for data storage and retrieval.

Smart Roadside

Deployed Package

- SRI Dashboard
- SRI Web Services
- SRI Data Access
- SRI Database

Development Toolset

- Eclipse Indigo
- RESTful Webservices/JAXB
- Comet Servlets
- MyBatis
- Spring
- GlassFish Server Open Source Edition 3.1.1
- MySQL Server 5.1, CE
- MySQL Workbench 5.2 CE
- jQuery
- Google Angular
- Firefox 10
- FireBug Firefox Extension
- Poster Firefox Extension

Security

- HTTPS
- Self-Signed Certificate
- 256 bit encryption
- SHA2

Aspen 2 iyeCitation

Deployed Package

- C# Windows Application

Development Toolset

- Microsoft Visual Studio 2012
- Firebird Client DLL
- iyeTek Client API DLL

LPR Windows Client

Deployed Package

- C# Windows Application

Development Toolset

- Microsoft Visual Studio 2012

SRI Mobile Application

Deployed Package

- Android Application

Development Toolset

- Android Studio
- Android Emulator

Test Hardware

- Samsung Galaxy S4

SRI J2735 Translator

Deployed Package

- Java Application

Development Toolset

- Eclipse Juno

Security

- HTTPS
- UPD IPv6 Port 55245

SRI System Views

Overview

Both of the test sites chosen for the prototype 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.

West Friendship Weigh Station, MD

In Diagram 3-1, the SRI System is deployed to 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.

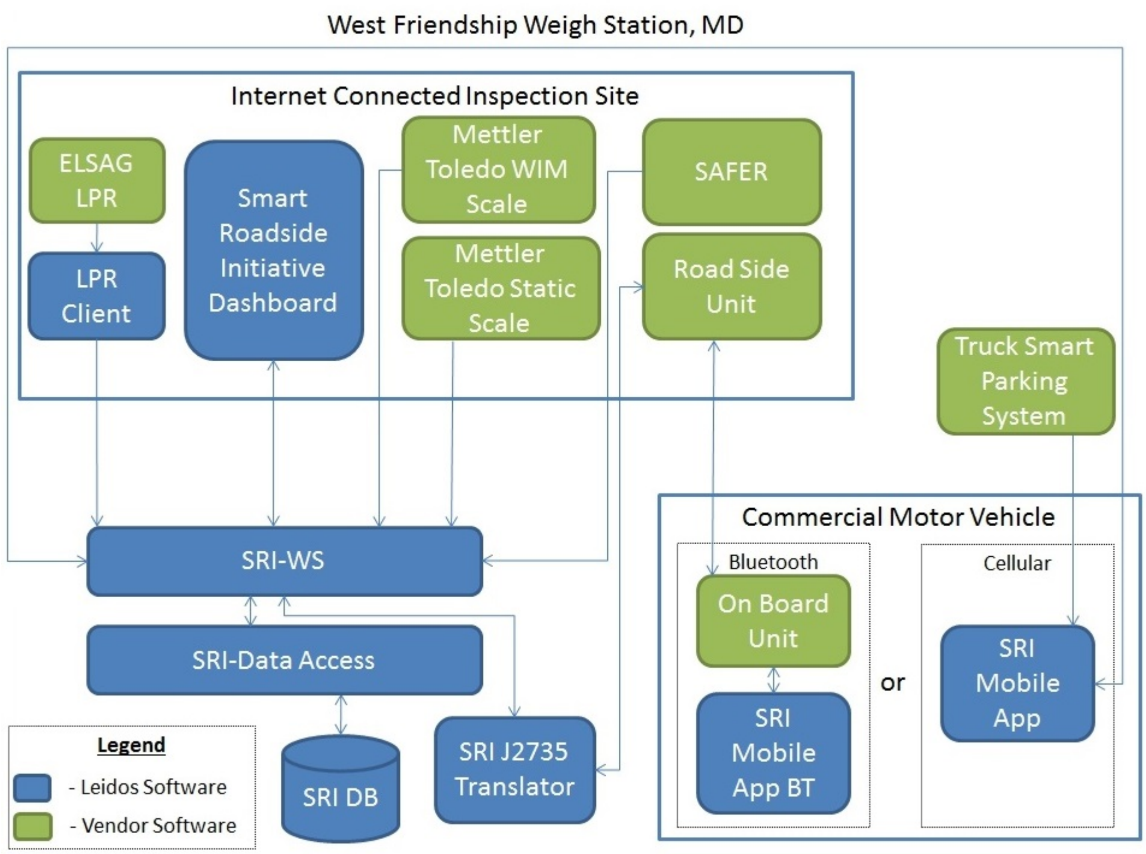

Figure 3-1: West Friendship Weigh Station Communication Diagram

East Grass Lake Weigh Station, MI

In Diagram 3-2, 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 the testing of the SRI Mobile App Bluetooth impossible. However, the site does have Aspen and iyeCitation so testing of the Aspen to iyeCitation Client can occur here.

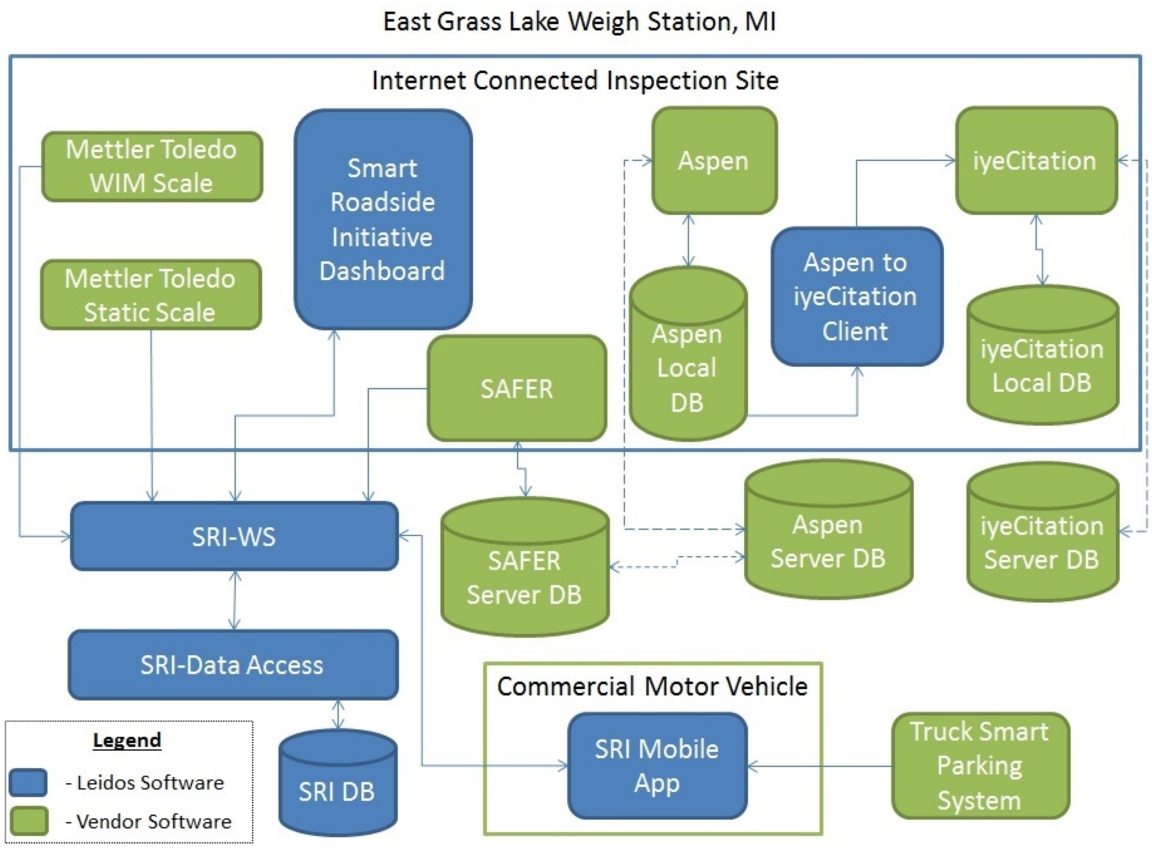

Figure 3-2: East Grass Lake Weigh Station Communication Diagram

Chapter 4. Design Elements

Data Structure Design

The SRI System will use a Relational Database Management System for the storage and retrieval of information. MySQL will be the RDBMS that will be used for the SRI-DB.

MySQL is an open source Relational Database Management System that is very popular when it comes to distributed development. It is ideal for usage by the SRI System. This DB will contain data for usage by all inspection locations in this prototype.

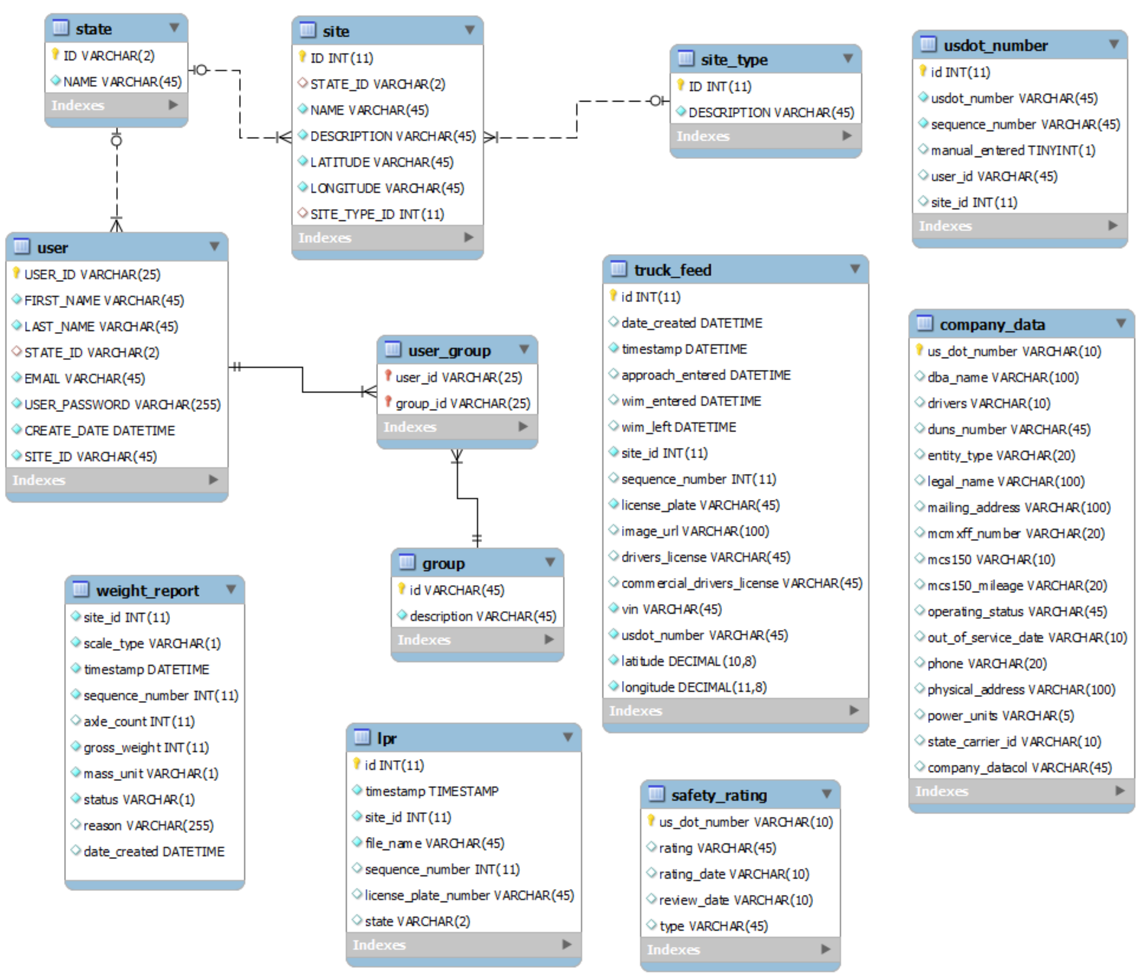

Figure 4-1: SRI System ER Diagram for Inspection Location

External System Interfaces

Mettler Toledo Scale Systems

Structure Overview

This section describes the method of data exchange between the weigh station systems from Mettler Toledo and SRI (Smart Roadside Initiative). Mettler Toledo currently employs both static scales and WIM (Weigh In Motion) scales at the Michigan Monroe Weigh Stations. Both the static scales and the WIM scales employ the use of the Mettler Toledo Weigh Station system. These systems currently log and display the weights of vehicles traveling along the Interstate and weigh station ramp. A client will be created by Mettler Toledo to send that information to a web service created by Leidos for the SRI system to display in a browser.

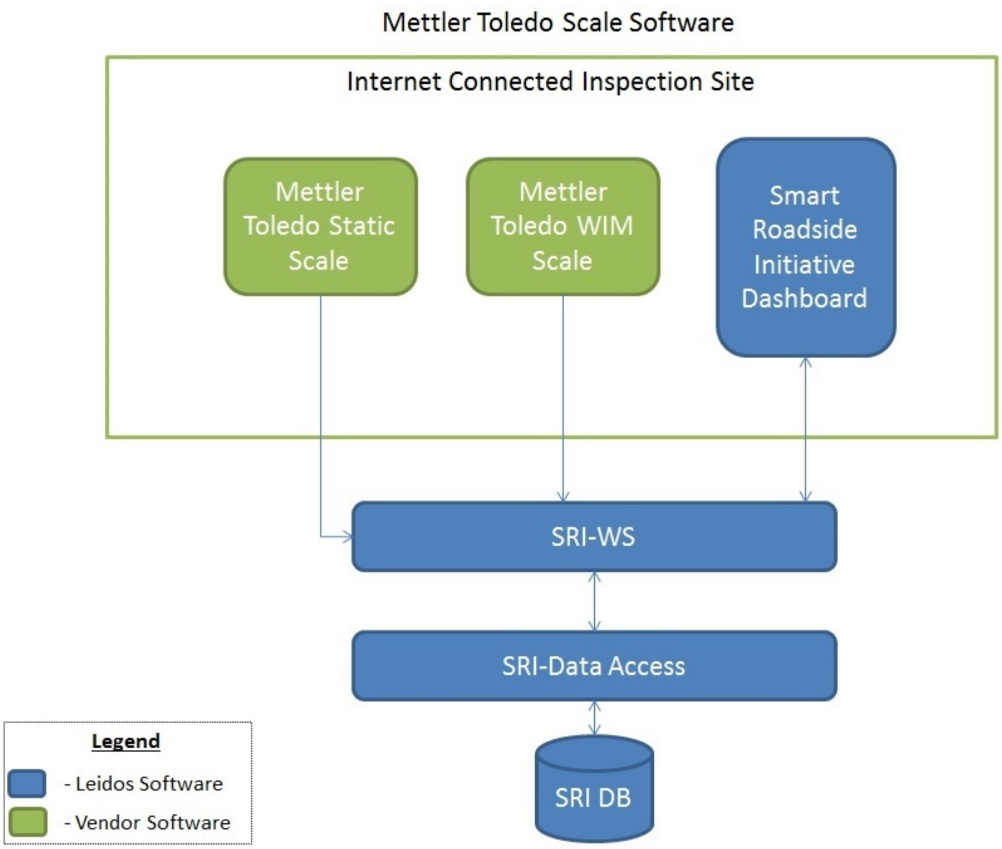

Figure 4-2: Mettler Toledo Software

Relationship to Protocols and Other Structures

HTTP and HTTPS will be the protocol used by the client to send vehicle weight information to the web service. The RESTful web service will be available through a URL and will receive data via the HTTP method of GET and HTTP type of POST. Data will be transmitted using a JSON object.

Initially the client will communicate to the web service utilizing the unsecure HTTP port 80 to test connectivity. However after the connectivity test is complete, the secure HTTPS port 443 will be used. A simple Java test client will be created by Leidos to serve as a guide for Mettler Toledo.

Structures

This section will detail the structure of both of the uses for the RESTful web service. The structures for both the reporting of the WIM weight and the static scale weight are identical. And the URL for posting the data is the same. Server side validation will ensure that only static scale weights will get saved as static scale weights service calls and vice versa.

JSON Structures

JSON is an open standard format that uses human-readable text to transmit data objects consisting of attribute–value pairs. It is used primarily to transmit data between a server and web application, as an alternative to XML. This will be the internet media type that the RESTful web services will utilize.

Key	Data Type	Description
siteId	Integer	Will be used to uniquely identify the weigh station
scaleType	Character	'W' for WIM, 'S' for Static Scale, only needs to be set for Report Weight
timestamp	String	yyyy-mm-dd hh:mm:ss
sequenceNumber	Integer	Sequence Number
axleCount	Integer	Number of axles (optional, place holder for possible future use)
declaredWeight	Integer	Declared weight (optional, place holder for possible future use)
grossWeight	Integer	Gross Weight
massUnit	Character	'K' for Kilograms, 'P' for Pounds
status	Character	'P' for Pass, 'F' for Fail
reason	String	Reason for failure

Report Weight

```
{
      "siteId": ,
      "scaleType": "",
      "timestamp": "",
      "sequenceNumber": ,
      "axleCount": "",
      "declaredWeight": "",
      "grossWeight": "",
      "massUnit": "",
      "status": "",
      "reason": ""
}
```

Report Static Scale Weight


```
{
	"siteId": ,
	"timestamp": "",
	"sequenceNumber": ,
	"axleCount": "",
	"declaredWeight": "",
	"grossWeight": "",
	"massUnit": "",
	"status": "",
	"reason": ""
}
```


RESTful Webservice	HTTP Method	URL
Report Weight	POST	http://sri.leidosweb.com/DashCon/resources/sec/mettlerToledo

Aspen 2 iyeCitation

Structure Overview

This section describes the method of data retrieval and exchange between the Aspen and the iyeCitation systems. Both Aspen and iyeCitation are client server systems that currently do not exchange data with each other. To accomplish this, the Aspen 2 iyeCitation system will pull data from the local Aspen Database (with credentials provided by the Aspen development team), format the data into a xml, and upload that data to iyeCitation via iyeTek's Client API and Messaging protocol.

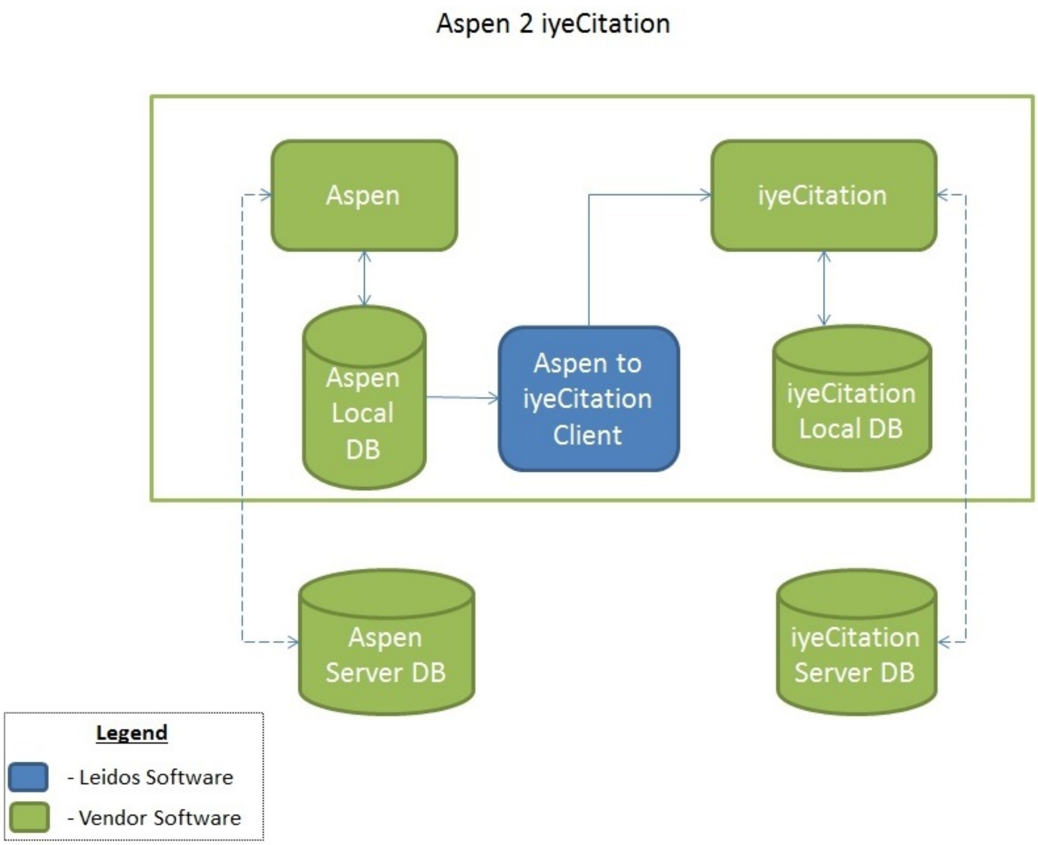

Figure 4-3: Aspen 2 iyeCitation Communication Diagram

Relationship to Protocols and Other Structures

Aspen uses a Firebird Database for data storage. Aspen 2 iyeCitation will use the FirebirdClient dll from nuget.org (https://www.nuget.org/packages/EntityFramework.Firebird/4.8.0) for data retrieval.

The connection will be as follows:
"User=SYSDBA;Password=masterkey;DataSource=localhost;Port=3050;Dialect=3;Charset=NONE;Role=;Connection lifetime=15;Pooling=true;MinPoolSize=0;MaxPoolSize=50;Packet Size=8192;ServerType=0;Database="

iyeCitation provides a utility dll for data exchange named iyeTek.LEMSFramework.ClientAPI Aspen 2 iyeCitation will utilize this for providing Aspen data to the iyeCitation client. The data objects used will be LEINLoadResponseVehicleMessage and LEINLodadResponsePersonMessage. The iyeTek.LEMSFramework.ClientAPI.Client object will be used to initiate the data exchange.

Structures

The data structures for the Aspen application will be driven off of two tables from the Firebird datababse; inspmain and vehicle. C# data objects will be created to access the properties of the tables.

The data structures for the iyeCitation application will be provided by the iyeTek.LEMSFramework.ClientAPI dll. A converter object will be created to convert Aspen data objects to iyeCitation data objects. Those converted data ojects will then be passed to the client via the iyeTek.LEMSFramework.ClientAPI.Client object.

ELSAG LPR (License Plate Reader)

Structure Overview

This section describes the method of data exchange between ELSAG North America's LPR System and Smart Roadside. The ELSAG LPR system uses a mobile camera affixed to a pole beside the WIM scale to capture license plate images from CMV's after they approach the WIM scale. The software then stores the image as a jpg and the license plate text (if it can be determined) as a txt file. These files are then read by the SRI LPR Uploader to the SRI Web Services.

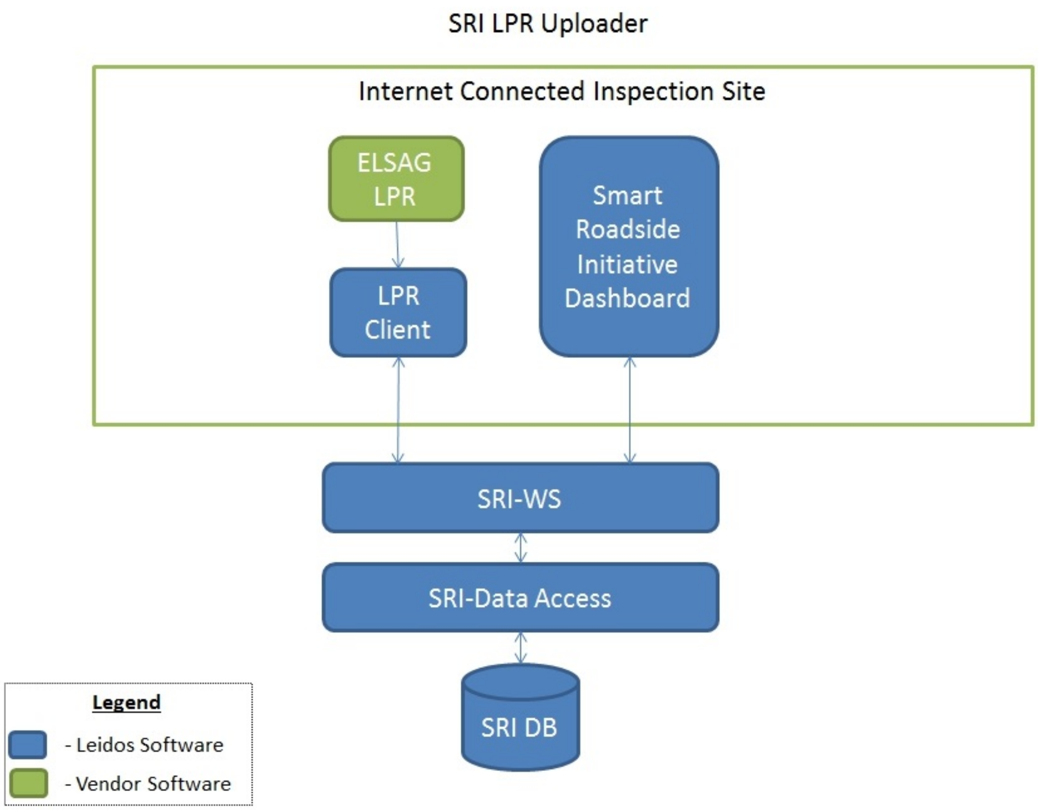

Figure 4-4: SRI LPR Uploader Communication Diagram

Relationship to Protocols and Other Structures

The FileSystemEventHandler will be used to watch the image and text directory. When a new file gets deposited into the watched directory, the program will process the text file and then the image file. Since both files have the same file name except for the extension, the files are easily managed.

HTTP and HTTPS will be the protocol used by the client to send LPR information to the web services. The RESTful web services will be available through the 2 URLs (one for the LPR text and one for the LPR image). The web services will receive data via the HTTP method of GET and HTTP type of POST. Data will be transmitted using a JSON object for the text and a MultipartFormDataPost for the image.

Structures

This section will detail the structure of both of the RESTful web services. Two web services are used. One for the text of the LPR and the other for the image.

JSON Structure

JSON is an open standard format that uses human-readable text to transmit data objects consisting of attribute–value pairs. It is used primarily to transmit data between a server and web application, as an alternative to XML. This will be the internet media type that the RESTful web services will utilize.

Key	Data Type	Description
id	Integer	Blind Primary Key
timestamp	String	yyyy-mm-dd hh:mm:ss
siteId	Integer	Will be used to uniquely identify the weigh station
filename	String	Original file name
sequenceNumber	Integer	Sequence Number
licensePlateNumber	String	License Plate Number

License Plate

```
{
      " timestamp": ,
      " siteId": "",
      "filename": "",
      "sequenceNumber": "",
      "licensePlateNumber": ""
}
```

POST LPR

RESTful Webservice	Media Type	URL
POST LPR	JSON	http://sri.leidosweb.com/DashCon/resources/lpr
POST LPR Image	Multipart Form Data	http://sri.leidosweb.com/DashCon/resources/lpr/saveImage

SAFER

Structure Overview

This section describes the method of data exchange between the FMCSA Safety and Fitness Electronic Records (SAFER) system and the Smart Roadside system. SAFER offers company safety data and related services to industry and the public over the Internet. Accessing the data provided by SAFER can be accomplished by utilizing a publicly accessible servlet provided by the website, https://safer.fmcsa.dot.gov. The type of data provided by safer is the Company Snapshot given the USDOT number.

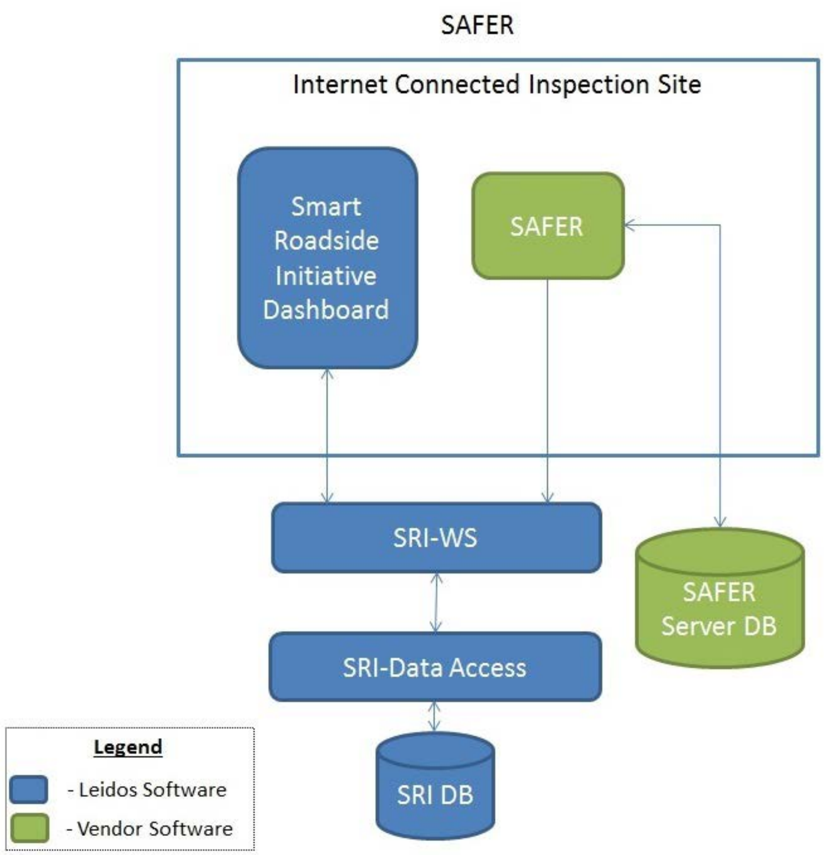

Figure 4-5: Safer Communication Diagram

Relationship to Protocols and Other Structures

HTTP and HTTPS will be the protocol used by the client to retrieve the Company Snapshot data from the FMCSA SAFER servlet. The servlet is available through a URL and will receive data via the HTTP request and HTTP type of GET. Data will be returned using an HTML page. A parser will convert this into a JAXB object which will then be utilized by the SRI web services to present to the SRI Dashboard.

Structures

This section will detail the structure of the request URL, the servlet called, and the query parameter used. Since the response will be of document type HTML, a custom parser will be detailed here, as well. The SAFER SRI Web Service structure and JSON response will be defined.

SAFER Servlet

Safer Servelt	HTTP Method	URL	Query String Parameter
Query	GET	https://safer.fmcsa.dot.gov/query.asp	USDOT#

Response Type	Static Query Parameters
HTML	?searchtype=ANY&query_type=queryCarrierSnapshot&query_param=USDOT&query_string=

HTML Structure

The structure of the HTML document returned is divided into 5 data sections grouped by tables. Each of the tables can be parsed JAXB objects. The 5 data sections are as follows:

1. Company Data
2. US Inspection Data
3. Canada Inspection Data
4. US Crash Data
5. Canada Crash Data

Safer USDOT Data Web Service

RESTful Webservice	HTTP Method	URL
Safer USDOT Data	GET	http://sri.leidosweb.com/DashCon/resources/safer/{usDotNumber}

Safer USDOT Data JSON Structure


```
{
      canadaCrashData: {
      fatal: "0",
      injury: "0",
      total: "0",
      tow: "0"
      },
            canadaInspectionData: {
                  inspections: {
                  driver: "0",
                  vehicle: "0"
            },
                  outOfService: {
                  driver: "0",
                  vehicle: "0"
            },
                  outOfServicePercent: {
                  driver: " 0% ",
                  vehicle: " 0% "
            }
      },
      companyData: {
            dbaName: "TWO MEN AND A TRUCK OF BOYNTON DELRAY",
            drivers: "8",
            dunsNumber: "--",
            entityType: " Carrier ",
            legalName: "W & W MOVING SOLUTIONS LLC",
            mailingAddress: " 130 LANSING IS DR INDIAN HARBOUR BEACH, FL
            32937 ",
            mcmxffNumber: " MC-852029 ",
            mcs150: "10/06/2014",
            mcs150Mileage: "20,000 (2014)",
            operatingStatus: " AUTHORIZED FOR HHG ",
            outOfServiceDate: " None ",
            phone: "(561) 404-8807",
            physicalAddress: " 1515 N CONGRESS AVE DELRAY BEACH, FL 33445
            ",
            powerUnits: "6",
            stateCarrierId: "",
            usDOTNumber: "2465358"
      },
      safetyRating: {
            rating: "None ",
            ratingDate: "None ",
            reviewDate: "None ",
            type: "None "
      },
      usCrashData: {
```

```
            fatal: "0",
            injury: "0",
            total: "0",
            tow: "0"
      },
      usInspectionData: {
            inspections: {
                  driver: "13",
                  hazmat: "0",
                  iep: "0",
                  vehicle: "10"
            },
            natAveragePercent: {
                  driver: "5.51%",
                  hazmat: "4.50%",
                  iep: "N/A",
                  vehicle: "20.72%"
            },
            outOfService: {
                  driver: "1",
                  hazmat: "0",
                  iep: "0",
                  vehicle: "0"
            },
            outOfServicePercent: {
                  driver: " 7.7% ",
                  hazmat: " % ",
                  iep: " 0% ",
                  vehicle: " 0% "
            }
      }
}
```


SRI Mobile App Cellular

Structure Overview

This section describes the method of data retrieval from TSPS (Truck Smart Parking Services) and its interaction with SRI Mobile App. This section will also describe the method of data exchange between SRI Mobile App and the SRI Web Services.

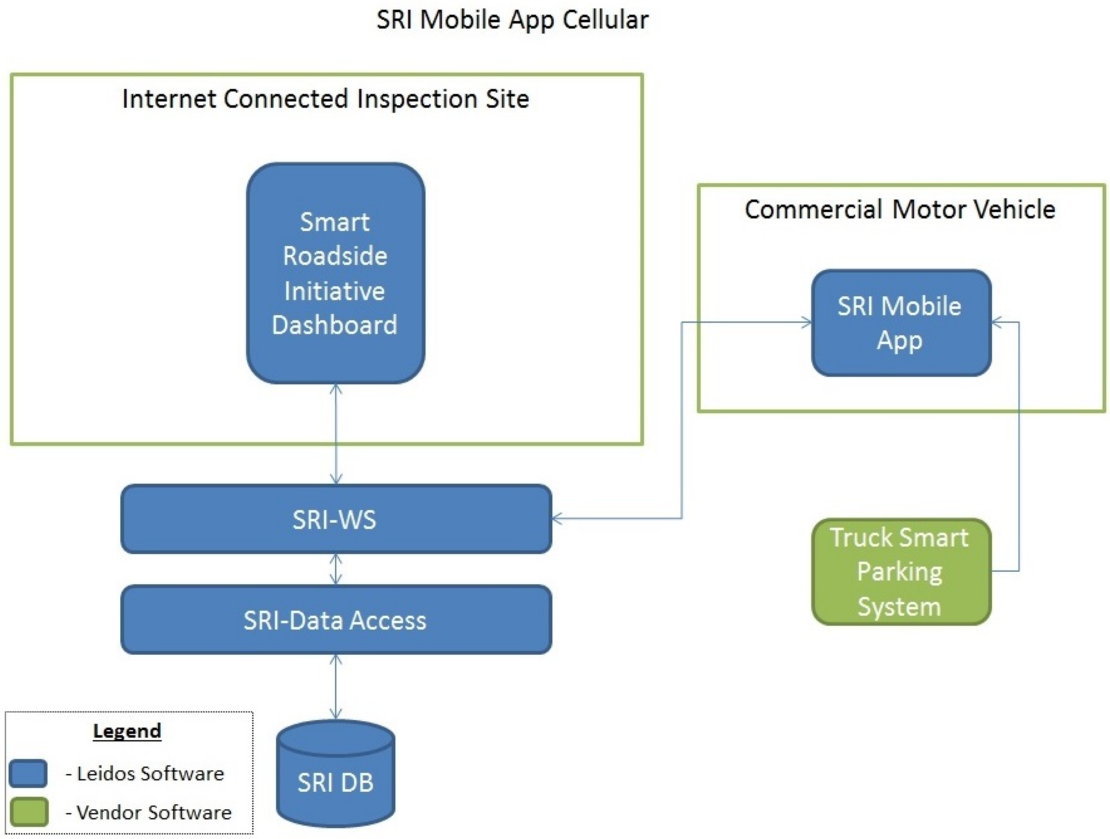

Figure 4-6: SRI Mobile App Cellular Communication Diagram

Relationship to Protocols and Other Structures

HTTP and HTTPS will be the protocols used by the client to send driver and vehicle credential information from the SRI Mobile App to the SRI Web Service. The RESTful web services will be available through URLs and will receive data via the HTTP method of POST. Data will be transmitted using a JSON object.

TSPS provides a web service that can be used to return the available information for truck stops ahead of a location. This includes parking availability and some truck stop descriptive features. The protocol for the web service is HTTPS and requires an authentication token supplied by the web service provider.

SRI Web Services

RESTful Webservice	Media Type for POST	URL
Approach Enter	JSON	http://sri.leidosweb.com/DashCon/resources/truck/approachEnter
Truck Image	Multipart Form Data	http://sri.leidosweb.com/DashCon/resources/truck/saveImage
WIM Enter	JSON	http://sri.leidosweb.com/DashCon/resources/truck/wimEnter
WIM Leave	JSON	http://sri.leidosweb.com/DashCon/resources/truck/wimLeave

TSPS Get Truck Stops Ahead of Me

RESTful Webservice	HTTP Method	URL
Truck Stops Ahead of Me	GET	https://onlineparkingnetwork.net/api/v1/truckstops/ahead.json

Response Type	Query Param 1	Query Parram 2	Query Param 3
JSON	lat	lon	bearing

Structures

This section will detail the structures of both of the uses for the RESTful web service. The structures for both the reporting of the WIM weight and the static scale weight are identical. And the URL for posting the data is the same. Server side validation will ensure that only static scale weights will get saved as static scale weights service calls and vice versa.

JSON Structures

JSON is an open standard format that uses human-readable text to transmit data objects consisting of attribute–value pairs. It is used primarily to transmit data between a server and web application, as an alternative to XML. This will be the internet media type that the RESTful web services will utilize.

Truck Feed JSON Post Parameter

```
{
      id:,
      siteId:,
      timestamp:,
      licensePlate:,
      driversLicense:,
      commercialDriversLicense:,
      vin:,
      usdotNumber:,
      latitude:,
      longitude:,
      sequenceNumber:
}
```

TSPS JSON Response

```
 [
      {
            id: ,
            promiles_id:,
            name: "",
            logo_medium_url: "",
            logo_thumb_url: "",
            logo_icon_url: "",
```

```
            logo_url: "",
            latitude:,
            longitude:,
            exit_number: "",
            highway_name: "",
            location_text: "”,
            accepts_reservations:,
            count:,
            flow:,
            capacity:,
            low_threshold:
      },{
            // Truck Stop #2...
      }
]
```

SRI Mobile App Bluetooth

Structure Overview

This section describes the method of data exchange between the SRI Mobile App Bluetooth (BT), OBU (On Board Unit), the RSU (Road Side Unit), SRI J2735 Translator, and the SRI Web Services.

Communication between the SRI Mobile App BT and the OBU will take place using a Bluetooth socket. When the OBU starts, it will begin scanning for available Bluetooth devices. Upon startup of SRI Mobile, the app will prepare a Bluetooth socket that has been assigned a UUID for this application. Once this connection has been made, this Bluetooth socket will be used for all future communication between SRI Mobile BT and the OBU.

Two data frames have been defined for the interface between SRI Mobile BT and the J2735 Translator. These data frames are defined in ASN.1 and use existing J2735 data elements and frames needed to supply all of the information needed for the application. The ASN.1 definition of the data frames can be found in the next section.

The DriverVehicleInformationData frame is used to pass data about the driver and CMV (Commercial Motor Vehicle) when the CMV gets within Digital Short Range Communication (DSRC) range of an RSU. This frame is populated with data by SRI Mobile BT then BER encoded and passed down the Bluetooth socket to the OBU. From here the OBU passes RSU which then will forward the encoded data frame to the J2735 Translator running on a backend server.

The J2735 Translator is a Java application which is listening on an agreed upon UDP port for data from the RSU. Once a data frame is received on the UDP port, it is decoded and then translated into the appropriate format for an SRI Web Service call. The J2735 Translator processes the response from the web service call, translates that into the appropriate data frame, BER encodes the data frame, and then sends the encoded frame back to the RSU via UDP.

The data frame sent by the SRI Mobile BT app and the data frame returned by the J2735 Translator is dependent on the area of the weigh station the CMV has entered. Below you can find table of the data frames sent and received by SRI Mobile BT for each area of the weigh station.

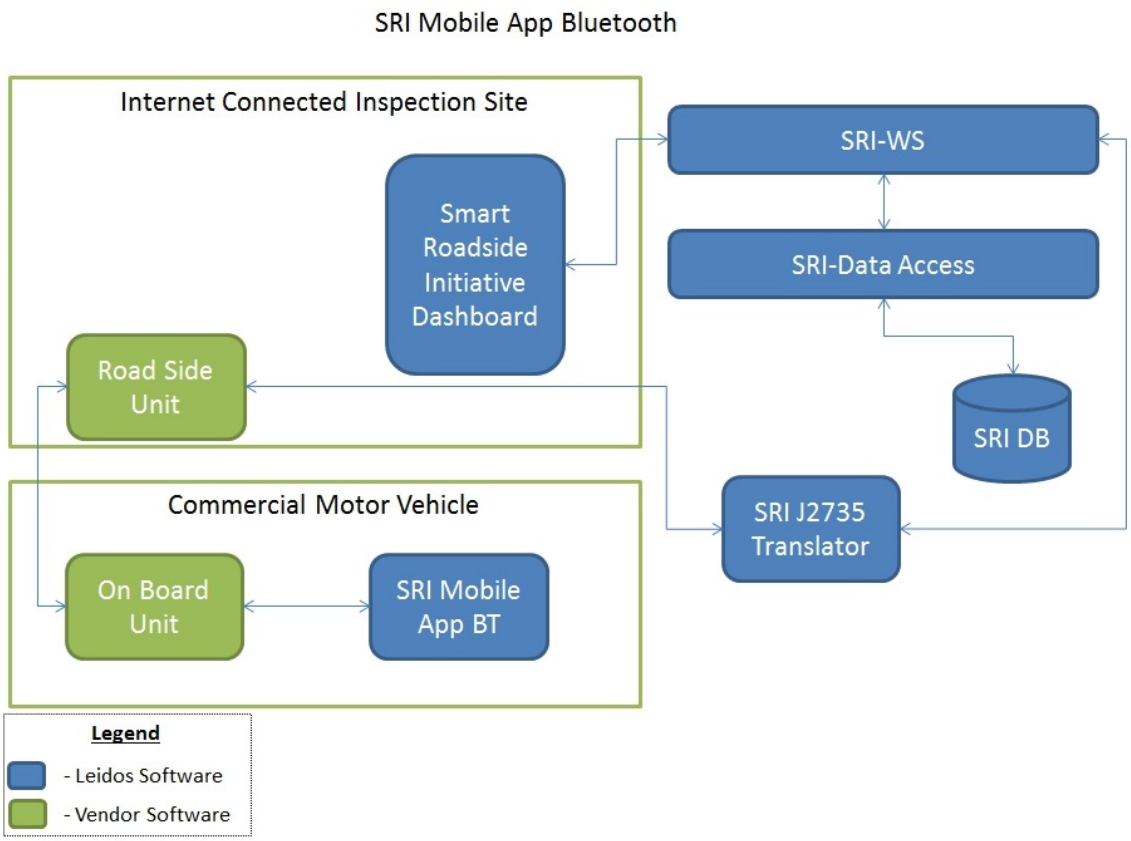

Figure 4-7: SRI Mobile App Bluetooth Communication Diagram

Data Format ASN.1

```
SRI DEFINITIONS IMPLICIT TAGS::= BEGIN

-- ==============================================
-- SRI Messages
-- ==============================================

DriverVehicleInformationData::= SEQUENCE {
        id                                      [0]UTF8String OPTIONAL,
        siteId                                  [1]UTF8String,
        driversLicenseNumber                    [2]UTF8String OPTIONAL,
        cdlNumber                               [3]UTF8String OPTIONAL,
        vin                                     [4]UTF8String,
```

```
        usdotNumber                             [5]UTF8String,
        plateNumber                             [6]UTF8String,
        lat                                     [7]Latitude,    -- in 1/10th micro degrees
        lon                                     [8]Longitude,   -- in 1/10th micro degrees
        fullDate                                [9]DDateTime
}

WeightResultData::=SEQUENCE {
        id                              [0]UTF8String,
        siteId                          [1]UTF8String,
        fullDate                        [2]DDateTime,
        weightResult                    [3]UTF8String
}


Latitude ::= INTEGER (-900000000..900000001)
        -- LSB = 1/10 micro degree
        -- Providing a range of plus-minus 90 degrees

Longitude ::= INTEGER (-1800000000..1800000001)
        -- LSB = 1/10 micro degree
        -- Providing a range of plus-minus 180 degrees

DDateTime ::= SEQUENCE {
        year    [0]DYear OPTIONAL,      -- 2 bytes
        month   [1]DMonth OPTIONAL,     -- 1 byte
        day     [2]DDay OPTIONAL,       -- 1 byte
        hour    [3]DHour OPTIONAL,      -- 1 byte
        minute  [4]DMinute OPTIONAL,    -- 1 byte
        second  [5]DSecond OPTIONAL     -- 2 bytes
}

DYear ::= INTEGER (0..9999) -- units of years

DMonth ::= INTEGER (0..15) -- units of months
        -- Integer values from one to 12 representing the month within a year.
        -- The range 13 to 14 and the value zero are all reserved.
        -- The value of 15 SHALL represent an unknown value.

DDay ::= INTEGER (0..31) -- units of days

DHour ::= INTEGER (0..31) -- units of hours
        -- Integer values from zero to 23 representing the hours within a day
        -- The range 24 to 30 is reserved.
        -- The value of 31 SHALL represent an unknown value

DMinute ::= INTEGER (0..63) -- units of minutes
        -- integer values from zero to 59 representing the minutes within an hour.
        -- The range 60 to 62 is reserved.
        -- The value of 63 SHALL represent an unknown value,

DSecond ::= INTEGER (0..65535) -- units of miliseconds
        -- integer values from zero to 60999 representing the milliseconds within a minute.
        -- A leap second is represented by the value range 60001 to 60999.
        -- The value of 65535 SHALL represent an unavailable value in the range of the minute,
other values from 61000 to 65534 are reserved.

END
```

Data Frame Usage

Weigh Station Area	Data Frame sent by SRI Mobile BT	Data Frame Returned to SRI Mobile BT
In DSRC Range	Data Frame sent by SRI Mobile BT	DriverVehicleInformationData
WIM Enter	DriverVehicleInformationData	DriverVehicleInformationData
WIM Exit	DriverVehicleInformationData	WeightResultData

Relationship to Protocols and Other Structures

HTTP and HTTPS will be the protocols used by the client to send driver and vehicle credential information from the SRI J2735 Translator to the SRI Web Service. The RESTful web services will be available through URLs and will receive data via the HTTP method of POST. Data will be transmitted using a JSON object.

SRI Web Services

RESTful Webservice	Media Type for POST	URL
Approach Enter	JSON	http://sri.leidosweb.com/DashCon/resources/truck/approachEnter
Truck Image	Multipart Form Data	http://sri.leidosweb.com/DashCon/resources/truck/saveImage
WIM Enter	JSON	http://sri.leidosweb.com/DashCon/resources/truck/wimEnter
WIM Leave	JSON	http://sri.leidosweb.com/DashCon/resources/truck/wimLeave

Truck Feed JSON Post Parameter

```
{
      id:,
      siteId:,
      timestamp:,
      licensePlate:,
      driversLicense:,
      commercialDriversLicense:,
      vin:,
      usdotNumber:,
      latitude:,
      longitude:,
      sequenceNumber:
}
```

SRI Responsive Framework

The Smart Roadside Initiative (SRI) web application's front end is built on top of a fully customized version of Bootstrap, an industry de facto front end framework for web development. Using Bootstrap's grid system allows developers to design and implement a flexible structure for web pages to be consumed in a variety of devices and screen sizes.

The *SRI* system is primarily designed to be used on a personal computer's browser with a high definition resolution to maximize the screen real estate when displaying the application's multiple modules, allowing users to fully consume the information SRI converges.

A customized version of Bootstrap enables developers to allow SRI to be used on tablets and appreciated on mobile smartphones as well. This mobile freedom transforms SRI into a system that literally delivers information to users at their fingertips. With the advancement of Cascading Style Sheet (CSS) technology, developers are now able to determine a browser's screen size and use this information to determine different styles for different devices.

Bootstrap takes it one step further by building a framework that developers can use to structure their web application's user interface. At a high level, this is done by using the framework's multiple CSS classes which enable developers to structure layouts, position elements, and control which element is visible and how it rendered on different screen sizes.

An extensive documentation can be viewed on www.getbootstrap.com.

Chapter 5. Traceability Matrix

From the system requirements specifications (SyRS): the table on the following page contains the SRI Requirement Traceability Matrix which maps the SRI SyRS to their corresponding source. Most cases the source is a user need, operational policy or constraint from the ConOps. In some cases, it relates to a stated capability from the ConOps – these capabilities are defined and traced below:

Table 5-1: Conceptual SRI System Top-Level Capabilities and Performance Metrics

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

In addition, Tables 5-2 through 5-6 each contain a column specifying whether the requirement applies to the currently identified prototype locations in Michigan (indicated by an "M") and/or Maryland (indicated by a "MD") or whether the Research Team has determined that the requirement could only be met by a future demonstration of SRI (as indicated by an "F"). Next to this column, there is a column indicating which portion of the SRI architecture – DSRC or cellular – to which it maps.

All of the items in the Traceability Matrix marked with an "F" are dependent on external systems still in development. Testing of these items can't be completed until these systems are completed.

Lastly, Tables 5-2 through 5-6 each include a column indicating the verification method that will be used to determine whether the system design satisfies the requirement. In traditional systems engineering, one of four methods are typically selected: test, demonstration, analysis or inspection, defined as follows:[3]

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

Finally, the traceability matrix was expanded for this SDD to include a column labeled 'System Architecture' which maps each requirement to a specific element of the SRI System Architecture. Note that the entries in this column correspond to the labeling of the architecture diagrams presented earlier in this SDD, specifically Figures 2-2 and 2-3.

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

Matrices

Table 5-2: SRI Requirements Traceability Matrix

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

[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 5-3. SRI Application Requirements (a) Traceability Matrix

Req ID	Requirement	Source	Verification Method	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	MI, MD
a.002	SRI shall provide an interface and processing modules for truck parking applications.	UN10	Demonstrate	MI
a.002.1	*SRI shall provide information about the availability of truck parking spaces.*	UN10	Demonstrate	MI
a.002.2	*SRI shall provide current parking availability information at a specific facility.*	UN10	Demonstrate	MI
a.002.3	*SRI shall provide predicted future parking availability information at a specific facility.*	UN10	Demonstrate	F
a.002.4	*SRI shall provide 24x7 access to truck parking information.*[2]	UN10	Demonstrate	MI
a.002.5	*SRI shall provide a graphical interface to stationary (i.e., dispatcher/operator/driver/traffic analyst/other) users.*	UN05	Demonstrate	MI
a.002.6	*SRI shall provide a user interfaces to non-stationary drivers when integrated in-vehicle display systems exist.*	UN07	Demonstrate	F
a.002.7	*SRI shall allow a stationary user to submit requests for automated truck parking information.*	UN05	Demonstrate	MI
a.002.8	*SRI shall allow a user to receive the results of an automated request for truck parking information.*	UN05	Demonstrate	MI
a.003	SRI shall provide an interface and processing modules for enforcement screening applications.	UN10	Demonstrate	MI, MD
a.003.1	*SRI shall provide the ability for roadside systems to integrate roadside systems data and make it available to Roadside System SRI user applications.*	UN09	Analyze	MI, MD
a.004	SRI shall provide a processing capability that automates the roadside inspection tasks.	T007	Analyze	F
a.004.1	*The SRI system shall determine if a CMV complies with jurisdictional licensing requirements.*	T002	Test	F
a.004.2	*The SRI system shall determine if a driver complies with jurisdictional licensing requirements.*	T002	Test	F
a.004.3	*The SRI system shall determine if a driver complies with HOS requirements.*	T007	Test	F
a.004.4	*The SRI system shall determine if a CMV complies with jurisdictional size requirements.*	T006	Test	F
a.004.5	*The SRI system shall determine if a CMV complies with designated safety requirements.*	T002	Test	F
a.004.6	*The SRI system shall determine if a CMV complies with weight requirements.*	T006	Test	F

Req ID	Requirement	Source	Verification Method	Michigan and/or Maryland or Future Demonstration[1]
a.004.7	*The SRI system shall determine if a CMV has a legally issued permit to exceed the legal limits for size and/or weight at the current location of the CMV.*	T002	Test	F
a.004.8	*SRI shall provide the data necessary to document inspection events and outcomes.*	UN10	Analyze	MI, MD
a.004.9	*SRI shall formulate alarms for user notification via the user interface(s).*	UN05	Test	F
a.004.10	*SRI shall automatically identify to the enforcement personnel approaching vehicles that have been flagged as potentially needing maintenance or to be put out of service due to violation of designated vehicle, driver and/or carrier safety regulations.*	UN11	Demonstrate	F
a.004.11	*The SRI prototype shall obtain vehicle-based maintenance data from the vehicle CAN BUS where available.*	UN04	Demonstrate	F
a.004.12	*SRI shall provide vehicle-based maintenance data obtained from the vehicle to the carrier.*	UN05	Demonstrate	F
a.004.13	*SRI shall provide driver-based safety information obtained from the vehicle to the carrier.*	UN05	Demonstrate	F
a.005	SRI shall provide an interface for Tier 1 users.	UN10	Demonstrate	MI, MD
a.005.1	*SRI shall provide an interface for CMV Enforcement Officers and supervisors to enter data.*	UN10	Demonstrate	MI, MD
a.005.2	*SRI shall provide an interface for CMV Enforcement Officers and supervisors to execute processes.*	UN10	Demonstrate	MI, MD
a.005.3	*SRI shall provide an interface for CMV Enforcement Officers and supervisors to receive information and alerts.*	UN10	Demonstrate	MI, MD
a.005.4	*SRI shall provide an interface for CMV drivers to receive information. ~~and alerts.~~*	UN10	Demonstrate	MI, MD
a.005.5	*SRI shall provide an interface for motor carriers to view information and receive alerts.*	UN10	Demonstrate	F
a.006	SRI shall conduct the analytical and data fusion functions necessary to evaluate CMV, carrier, and driver compliance.	UN09	Analyze	F
a.007	SRI shall comply with nationwide interoperability standards currently used for the USDOT V2X Program.	DOP06 UN014	Inspect	MD
a.007.1	*SRI shall comply with SAE STD J2735.*	DOP06 UN014	Inspect	MD

Req ID	Requirement	Source	Verification Method	Michigan and/or Maryland or Future Demonstration[1]
a.007.2	*SRI shall comply with the relevant sections of IEEE 1609 (including Architecture, Resource Manager, Security Services, Networking Services, Multi-Channel Operations, over-the-air data exchange protocol for ITS) and the version updates available at the time of design.*	DOP06 UN014	Inspect	MD
a.007.3	*SRI shall comply with SAE J1929.*	DOP06 UN014	Inspect	F
a.007.4	*SRI shall comply with IEEE Standard 802.11p.*	DOP06 UN014	Inspect	MD
a.008	SRI shall provide vehicle system information that is used by SRI to users.	UN09 UN14	Demonstrate	F
a.008.1	*SRI shall provide designated vehicle system information to the driver through the driver application.*	UN09	Demonstrate	F
a.008.2	*SRI shall provide applicable vehicle system information to the carrier through the carrier application.*	UN09	Demonstrate	F

[1] Colorado replaced by Maryland (MD).

[2] Depending on availability of TSPS application.

Table 5-4. SRI Performance Requirements (p) Traceability Matrix

Req ID	Requirement	Source	Verification Method	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	MI, MD
p.001.1	*SRI shall be able to exchange data with external systems within 2 seconds, 99% of the time.*	P002 UN05 UN11	Test	MI, MD
p.001.2	*SRI shall be able to exchange data with Roadside Equipment within 2 seconds, 99% of the time.*	P002 UN05 UN11	Test	MI, MD
p.001.3	*SRI shall be able to exchange data with CMV within 2 seconds, 99% of the time.*	P002 UN05 UN11	Test	MI, MD
p.001.4	*SRI data exchanges shall be time stamped when the exchange was completed.*	P002	Test	MI, MD
p.002	SRI shall provide the capability to establish two-way communications with each properly equipped vehicle approaching the weigh station.	UN08	Demonstrate	MI, MD
p.002.1	*SRI shall maintain two-way communications with each properly equipped vehicle as it passes through the weigh station.*	UN08	Demonstrate	MI, MD
p.002.2	*SRI shall maintain two-way communications with each properly equipped vehicle as it exits the weigh station.*	UN08	Demonstrate	F
p.003	The SRI system shall be able to maintain an overall 99% system availability in a 24-hour period.	UN05	Inspect	MI, MD
p.003.1	*The SRI Prototype will log each system outage with the date, ~~GMT~~time, length (in minutes), and cause of the outage.*	P003	Inspect	MI, MD
p.003.2	*The SRI Prototype will identify the user responsible for system outages that occur as a result of system breach or tampering.*	P003	Test	F
p.004	SRI shall be able to communicate "Pass/Need to stop" instructions to a driver in time for compliance with the instruction.	UN07	Test	MI, MD
p.005	SRI shall be designed to accommodate multiple users with different user needs and requirements.	P005	Demonstrate	MI,MD
p.006	SRI shall provide sanitized data to external systems for public use.[2]	UN03	Inspect	F
p.007	SRI shall provide an initial automated inspection capability that will expedite and supplement the existing visual and manual inspection processes.	UN010	Analyze	F

Req ID	Requirement	Source	Verification Method	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	MI, MD
p.007.2	*SRI shall include a manual override function for the automatically generated decision for vehicles to pull in for safety inspection.*	UN11	Demonstrate	F
p.007.3	*SRI shall issue Randomly generated pull-in for safety inspection signals.*	UN10	Test	F
p.007.4	*SRI shall issue Manually generated pull-in for safety inspection signals.*	UN10	Test	F
p.007.5	*SRI shall issue Automatically generated pull-in for safety inspection signals.*	UN10	Test	F
p.007.6	*SRI shall perform checks on Vehicle/Carrier/Driver Safety Information when making the "Pass/Need To Stop" determination.*	T002	Analyze	~~F~~
p.007.7	*SRI shall perform checks on Vehicle Credentials when making the "Pass/Need To Stop" determination.*	T002	Analyze	~~F~~
p.007.8	*SRI shall perform checks on Driver and Carrier Credentials/Status when making the "Pass/Need To Stop" determination.*	T002	Analyze	F
p.007.9	*SRI shall perform checks on Vehicle ~~Size and~~ Weight Information when making the "Pass/Need To Stop" determination.*[3]	T006	Analyze	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 5-5. SRI Security Requirements (s) Traceability Matrix

Req ID	Requirement	Source	Verification Method	Michigan and/or Maryland or Future Demonstration[1]
s.001	SRI shall protect personal data from unauthorized access.	UN06	Inspect	MI, MD
s.002	SRI shall protect proprietary information from unauthorized access.	UN06	Inspect	MI, MD
s.003	SRI shall protect proprietary systems from unauthorized access.	UN06	Inspect	MI, MD
s.004	SRI shall provide read access and read/write access to authorized users.	DOP09	Test	MI, MD

Req ID	Requirement	Source	Verification Method	Michigan and/or Maryland or Future Demonstration[1]
s.005	SRI shall provide read access and read/write access to authenticated users.	DOP09	Test	MI, MD

[1] Colorado replaced by Maryland (MD).

Table 5-6. SRI Interface Requirements (i) Traceability Matrix

Req ID	Requirement	Source	Verification Method	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	MD
i.001.1	*SRI shall exchange vehicle, owner and operator information ~~with appropriate state and federal systems~~ (i.e.,from Aspen ~~and Query Central~~to iyeCitation).*	DOP 02	Analyze	MI, MD
i.002	SRI shall receive vehicle safety performance data and designated vehicle~~, carrier~~ and driver information from SRI-capable Roadside Unit (RSU) ~~Equipment (RSE).~~	T002 UN02	Inspect	F
i.002.1	*Vehicle ~~safety performance data and vehicle, carrier and driver~~ information should be conformant to standards SAE J2735 and IEEE P1609.*	DOP 02	Inspect	MD
i.003	SRI shall receive ~~size and~~ weight information from SRI-capable Roadside Unit ~~Equipment (RSE~~RSU).	T003 UN02	Demonstrate	MD
i.003.1	*Telemetry and sensor output data shall comply with SAE J2735.*	DOP 02	Inspect	F
i.004	SRI shall send information received from external back office systems to SRI-capable Roadside Unit ~~Equipment (RSE~~ RSU).	T003 UN02	Demonstrate	F
i.004.1	*SRI data exchanges between external back office systems and ~~RSE~~ RSUs shall be formatted for compliance with these systems.*	DOP 02	Inspect	F
i.005	SRI shall access external, authoritative information sources in a manner that ensures all relevant information is reliable, secure, and up-to-date.	T004	Analyze	MI, MD
i.005.1	*SRI shall access and provide current information in real-time or as available from integrated data sources.*	T004	Analyze	MI, MD
i.005.2	*SRI shall access from authoritative data sources the information necessary to validate vehicle ~~size and~~ weight information.*	T004	Inspect	MI, MD

Req ID	Requirement	Source	Verification Method	Michigan and/or Maryland or Future Demonstration[1]
i.006	SRI shall interface with truck parking systems.	T007	Demonstrate	MI
i.007	SRI shall provide designated collected data to back office external systems (~~systems TBD~~ Aspen,iyeCitation).	UN03	Demonstrate	MI, MD
i.008	SRI shall receive designated data from back office external systems (~~systems TBD~~ SAFER).	UN04	Demonstrate	MI, MD
i.008.1	*SRI shall send data from sensors ~~and the CAN BUS in~~ SAE J2735 compliant format.*	UN04	Inspect	F
i.009	SRI shall provide a driver interface that is compliant with driver safety regulations.	UN07	Demonstrate	MI, MD
i.010	SRI shall include trailing equipment identification pulled by uniquely identifiable CMV power units.	UN13	Inspect	F
i.010.1	*SRI shall conform to SAE J1939 to support communications to/from CAN for tractor/trailer combinations.*	DOP02	Demonstrate	F
i.011	SRI information exchanges shall be compliant with appropriate communications protocols, such as SAE J2735, P1609 for DSRC, Cellular Digital Packet Data for CMRS, and ~~XML/SOAP~~ RESTful web services for cellular and Abstract Syntax Notation (ASN.1) for DSRC ~~Ethernet connections~~.	DOP10	Inspect	MD
i.012	SRI shall facilitate the real-time exchange of truck parking information.	UN011	Analyze	MI
i.012.1	*SRI shall ~~exchange~~ receive data with parking systems to support truck parking functionality.*	UN04	Analyze	MI

[1] Colorado replaced by Maryland (MD).

[2] OBU Bluetooth to mobile app.

Appendix A – User Needs

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Where UN03, UN04, and UN05 specify the need to accommodate data and information exchange, this need speaks specifically to the need for SRI to provide the ability to integrate data received from roadside devices with data received from in-vehicle systems and make that data available to the external systems described in UN03 and UN04 while distributing data to roadside and in-vehicle systems. Information from multiple sources will need to be accessed and analyzed simultaneously in order to deliver the specified capabilities.

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

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

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

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

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

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

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

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

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

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

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