Smart Roadside Initiative Gap Analysis

Target Functionality and Gap Analysis

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Steven A. Capecci	
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16. Abstract

This document summarizes the "target" functionality for the Smart Roadside Initiative, as well as the operational, institutional, and technical gaps that currently impede the deployment of three of its operational scenarios (electronic mainline screening, virtual weigh stations, and truck parking systems). Specific attention is given to gaps that exist between the "target" functionality and the current design of the Smart Roadside Initiative Prototype. Recommendations to address these gaps also are presented. This document is the final piece of analysis associated with the SRI Gap Analysis project. It integrates information from the project's State of the Practice report, which summarized the States' current deployment of advanced roadside technologies with findings from the project's assessment of private-sector technology usage, review of U.S. DOT's SRI Prototype project, and assessment of how the Vehicle-to-Infrastructure component of the Connected Vehicle program could support SRI functionality.

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Executive Summary

The Smart Roadside Initiative (SRI) was designed to break down information silos at the roadside in order to improve motor carrier safety and mobility, as well as the operational efficiency of motor carriers and the public-sector agencies that regulate them. Jointly conceived by the Federal Highway Administration (FHWA), the Federal Motor Carrier Safety Administration (FMCSA), and public- and private-sector stakeholders, SRI looks to build on the previous Intelligent Transportation Systems (ITS) research conducted by the United States Department of Transportation (U.S. DOT), as well as existing State and local ITS deployments. SRI was envisioned to extend and enhance the benefits associated with a myriad of Federal, State, and private-sector programs/technology deployments through additional collaboration, coordination, and data sharing. To support the continued advancement of the SRI program, U.S. DOT commissioned this SRI Gap Analysis project, in order to:

- Document the currently available and emerging roadside technologies for commercial vehicle operations (CVO);
- Analyze the functionality being developed as part of the Smart Roadside Prototype;
- Document the "target" SRI functionality; and
- Identify operational, institutional, and technical gaps that would hinder the deployment of the SRI "target" functionality.

The purpose of this report is to document the "target" functionality for the Smart Roadside Initiative, as well as the operational, institutional, and technical gaps that currently impede the deployment of three of its operational scenarios (electronic mainline screening, virtual weigh stations, and truck parking systems). Specific attention is given to gaps that exist between the "target" functionality and the current design of the SRI Prototype, which has been commissioned by U.S. DOT.

In order to systematically analyze the "target" functionality and potential gaps that exist, this report continues to analyze SRI functionality across five core functional elements. These functional elements include:

- **Identify—**Accurately identifying commercial vehicles, motor carriers, and/or commercial vehicle drivers while the vehicle remains in motion.
- **Select, Check, and Verify—**This functional area has two distinct applications across the operational scenarios. Within the mainline screening and VWS scenarios, activities in this functional area determine which commercial vehicles should be targeted for a roadside inspection based on dimensional/performance data collected at the roadside (e.g., weight, height, brake performance) and credential and safety data (e.g., credential status, safety scores). Within the truck parking scenario, activities in this functional area are designed to determine the real-time availability of truck parking at a facility.

- **Control—**Managing the movement of commercial vehicles through a facility.
- **Collection and Payment—**Electronically collecting payment of fees at a site.
- **Analysis—**Analyzing site operational data to modify site or enforcement operations.

These functional areas are the same ones used to organize the stakeholder input during the 2008 Smart Roadside Workshop. These functional areas also were used as the framework for analysis in this project's State of the Practice Report.

Based on this framework, it was determined that the "target" functionality for each of the study's three operational scenarios has remain unchanged over the course of this project and the operational flows developed for each of the SRI scenarios as part of the State of the Practice Report[1] remain an accurate summary of the "target" functionality for SRI. Further, it was determined that the "target" functionality of all three of the operational scenarios could be supported by existing or soon to be deployed technologies. Despite the fact that the "target" functionality can be deployed, a number of operational (O), institutional (I), and technical (T) gaps currently are and likely will continue to limit the ability of the SRI functionality to deliver its intended benefits. Table ES-1 summarizes the gaps impacting the SRI operational scenarios, the gaps between the SRI Prototype (P) and the "target" functionality, and the recommendations to all of the identified gaps. The gaps documented in this report have been identified based on the project team's analysis of prior project documents, as well as their 20 years of experience working with the ITS/CVO program, including the planning and/or deployment of advanced roadside technologies in more than two dozen States.

It also is recommended that U.S. DOT continue to focus on supporting the integration of operational scenarios. Most work currently being done by States and vendors is focused on optimizing the implementation of each operational scenario and not the integration of functionality across scenarios. Given the number of identified gaps, which continue to impede the realization of each scenario's full potential, this approach is well founded. In the long term, however, research and funding should be focused on demonstrating that that all three components of SRI functionality (mainline electronic screening, virtual weigh stations, commercial parking systems) could be integrated for delivery to users via a single technology platform (e.g., Connected Vehicle). This is not to say that U.S. DOT should select a single technology for SRI. Rather, U.S. DOT should simply demonstrate that a technology (or series of technologies) is capable of supporting all aspects of SRI simultaneously as was originally envisioned by the program.

In the short term, the SRI Prototype could be an opportunity to demonstrate how standard an on-board vehicle communication platform could be used as a conduit to integrate mainline screening, virtual weigh station, and commercial truck parking functionality. The Prototype also could be an example of how existing infrastructure (e.g., commercial parking systems, mainline screening facilities) and data sources (SAFER), as opposed to new and/or proprietary systems, can be leveraged to achieve the SRI vision.

[1] U.S. DOT, *Smart Roadside Initiative Gap Analysis State of the Practice—Advanced Roadside Technologies for Commercial Vehicle Safety,* February 2014.

Table ES-1. Summary of Gaps Identified and Recommendations

Identified Gaps	Operational Scenario Affected	Recommendation
O1. All commercial vehicles cannot be identified at highway speeds because of the voluntary nature of the screening programs.	Electronic Mainline Screening	There are several options available to U.S. DOT to support the electronic identification of all commercial vehicles at the roadside. First, stakeholders have requested that FMCSA mandate the use of a Universal Truck ID technology on all commercial vehicles in support of mainline electronic screening. While a viable technical solution, it is unlikely that the required cost/benefit analysis for a rulemaking would support the mandating of such a technology on all commercial vehicles. The benefits associated with identifying additional commercial vehicles at the roadside are derived not by the identification of vehicles but rather from the ability to conduct more inspections on "targeted" commercial vehicles. As long as capacity constraints (operational gap O4) limit the number of inspections that can occur at most fixed sites, it is unlikely that the benefits associated with the technology would warrant mandating it. The second alternative available to U.S. DOT is to leverage the DSRC infrastructure being developed as part of the Connected Vehicle program. As noted in the *Integrating Smart Roadside Initiative into the V2I Component of the Connected Vehicle Program* document produced by task 3.2 of this project, the Connected Vehicle technology and standards can directly support this aspect of SRI. If U.S. DOT elects to require this technology on all commercial vehicles, its deployment will address this gap without requiring a stand-alone cost/benefit analysis.
O2. Not all States are uploading credential information to the national repository (SAFER).	Electronic Mainline Screening/ Virtual Weigh Station	FMCSA is actively working with States to fully deploy the Commercial Vehicle Information Systems and Networks (CVISN) architecture, including the uploading of credential information to the national Safety and Fitness Electronic Records (SAFER) repository. CVISN deployment grants are available to States to support both the planning and implementation of this functionality. It is recommended that FMCSA continue to provide technical assistance to States that are struggling with their implementation of their CVISN programs. This technical assistance has supported States' identification of alternate solutions for uploading of credential and safety data to SAFER, and supported the development of funding plans to implement the optimal solutions.
O3. Secondary screening decisions can prevent targeted vehicles from being inspected.	Electronic Mainline Screening	Numerous States and vendors are working to integrate secondary screening decisions (e.g., ramp-based screening decisions based solely on weight) with the mainline screening decision through the application of additional technologies (e.g., magnetometers on mainline and ramps, camera-based systems on ramps). FMCSA should actively encourage this work and consider prioritizing this type of project in upcoming grant cycles. FMCSA also should consider complete end-to-end processing when evaluating a proposed roadside screening operational scenario as part of a State's CVISN Program Plans/Top-Level Designs and grant applications to ensure that the scenario is not adversely impacted by secondary screening decisions. If the presence of a secondary screening decision will adversely affect the mainline screening functionality, FMCSA should request/require that States address the issue prior to the scenario being approved. Finally, FMCSA should continue its work to document the safety benefits associated with mainline electronic screening at individual inspection sites so that objective measures of effectiveness can be used to calculate the impacts of these technologies at the roadside.
O4. Human and space constraints can prevent targeted vehicles from being inspected.	Electronic Mainline Screening	It is unlikely that sufficient funding will be available at the Federal or State level to fundamentally improve human or physical capacity at the roadside so that all targeted commercial vehicles can be inspected at the roadside. As such, it is recommended that U.S. DOT and FMCSA continue to actively pursue alternative enforcement scenarios so that some type of intervention can occur against "targeted" commercial vehicles when resource constraints prevent human intervention. These enforcement alternatives could include a Wireless Roadside Inspection (WRI) or follow-up enforcement, such as the sending of warning letters to carriers whose vehicles were found to be operating illegally (e.g., without proper credentials, over weight). In working with numerous States on their design of roadside enforcement strategies, Cambridge Systematics has found little interest among public- and private-sector stakeholders towards "direct" automated enforcement (e.g., issuing citations based on data from roadside technologies), but issuing warning letters may be more acceptable. This concept is very similar to the intervention model currently employed by FMCSA's CSA program. This recommendation will become even more important if all commercial vehicles are able to be identified and screened electronically (i.e., gap O1 is addressed).
O5. Need to determine the business model for a commercial truck parking system.	Commercial Parking Systems	Continue implementation of phase 2 of FMCSA's SmartPark initiative. The draft final report from this effort is scheduled for completion in May 2015. The final report is anticipated at the end of 2015. Compare results from FMCSA's SmartPark research effort with evaluations of deployment activities funded by FHWA's discretionary truck parking funds, in order to determine strengths and weaknesses of the various technologies being deployed by the efforts and to document lessons learned regarding business models that could support this functionality.
I1. Some enforcement personnel continue to have limited faith in roadside screening systems.	Electronic Mainline Screening/ Virtual Weigh Station	There remains skepticism among some roadside enforcement personnel that electronic screening systems are effective at targeting the "right" commercial vehicles for inspection. To address this concern it is recommended that U.S. DOT conduct an objective analysis regarding the effectiveness of electronic screening systems/criteria versus human experience/intuition in identifying the "right" commercial vehicles (e.g., high risk, those operating illegally) for inspection. Without this type of real-world field test, it is unlikely that trust and faith in the systems will improve. It also is imperative that the data being used by the electronic systems is accurate, in order for enforcement personnel to have faith in their recommendations. FMCSA efforts to deploy the CVISN architecture should work to resolve data quality issues.
I2. Competing priorities at roadside can result in targeted vehicles not being inspected.	Electronic Mainline Screening	Similar to the recommendation to O4, it is recommended that WRI and alternative enforcement strategies are the best approach to addressing competing institutional priorities at the roadside. Roadside personnel will always have multiple responsibilities and providing tools to them to ensure that commercial vehicle safety is being addressed while they are focusing on other responsibilities is believed to be a superior approach to modifying the programs that fund roadside personnel.

Identified Gaps	Operational Scenario Affected	Recommendation
I3. Determine whether motor carriers/ commercial drivers will modify their routing in response to information from a truck parking system.	Commercial Parking Systems	Review findings from phase 2 of FMCSA's SmartPark initiative, as well as evaluations of deployment activities funded by FHWA's discretionary truck parking funds.
T1. All commercial vehicles cannot be identified electronically.	Virtual Weigh Station	As noted in response to O1 above, it is recommended that U.S. DOT leverage the Connected Vehicle infrastructure to support identification of all commercial vehicles in support of roadside enforcement activities at both fixed facilities and virtual weigh stations. The Connected Vehicle program, in fact, has already contemplated that its infrastructure could allow other ITS-equipped facilities (e.g., toll booths, rest areas) into VWS-like deployments. This expansion of the VWS network in association with alternate enforcement technologies (e.g., WRI, warning letters) could greatly expand the efficiency and effectiveness associated with roadside enforcement programs. NHTSA's forthcoming decision on whether to require the deployment of 5.9 GHz technology on all commercial vehicles will go a long way in determining whether this technology is a viable option to identify all commercial vehicles electronically. Further, whether existing commercial vehicles would be required to be retrofitted with this technology will determine how quickly this technology could achieve sufficient market penetration to adequately address this required functionality.
T2. Need to determine the best means for disseminating commercial truck parking information to private-sector decision-makers.	Commercial Parking Systems	Review findings from phase 2 of FMCSA's SmartPark initiative, as well as evaluations of deployment activities funded by FHWA's discretionary truck parking funds.
P1. Universal ID is not included in current SRI Prototype.	Electronic Mainline Screening/ Virtual Weigh Station	As noted in the task 3.1 memo of this project, Universal Truck ID is not part of the currently envisioned SRI Prototype. Given that other technologies (e.g., Connected Vehicle) could fulfill this role, this decision likely will not impact the long-term deployment of SRI functionality. If U.S. DOT, however, were to decide not to use the Connected Vehicle infrastructure to support the Universal Truck ID functionality, it may wish to reconsider whether the functionality should be included in the Prototype or subsequent deployment efforts.

Chapter 1. Introduction

The Smart Roadside Initiative (SRI) was designed to break down information silos at the roadside in order to improve motor carrier safety and mobility, as well as the operational efficiency of motor carriers and the public-sector agencies that regulate them. Jointly conceived by the Federal Highway Administration (FHWA), the Federal Motor Carrier Safety Administration (FMCSA), and public- and private-sector stakeholders, SRI looks to build on previous Intelligent Transportation Systems (ITS) research conducted by the United States Department of Transportation (U.S. DOT), as well as existing State and local ITS deployments.

SRI was envisioned to extend and enhance the benefits associated with a myriad of Federal, State, and private-sector programs/technology deployments (e.g., Commercial Vehicle Information Systems and Networks (CVISN), truck size and weight enforcement technologies, Wireless Roadside Inspection, truck parking systems, Connected Vehicle Program (e.g., "FRATIS"), weather information, electronic toll collection systems, carrier-based communication technologies) through additional collaboration, coordination, and data sharing. During the 2008 SRI workshop, stakeholders identified a total of 42 functional capabilities and 22 specific projects within 4 operational environments (urban, multistate/long-haul, intermodal/port, and international border-crossing) that could advance the Smart Roadside vision.

A great deal has changed since the initial SRI vision was developed in 2008. Specifically, technology has become more widely deployed by both public-sector stakeholders and motor carriers. The majority of States have now deployed advanced technologies, such as mainline screening systems and virtual weigh stations, at the roadside to improve commercial vehicle safety and in many cases have begun to deploy second- or third-generation systems that utilize technologies that were just becoming commonplace in 2008 (e.g., license plate readers, U.S. DOT number readers) or were still conceptual at that time (e.g., cellular phones to support electronic screening). The private sector also has embraced the use of technology and has deployed in-vehicle sensors and communication systems more widely in the past five years. Stakeholders in major metropolitan areas (e.g., Southern Florida, Los Angeles, Dallas-Fort Worth) and at State regulatory/enforcement sites also are actively planning technology deployments that integrate enforcement and mobility applications at the roadside. These deployments will make the SRI vision an operational reality.

The Federal landscape also has evolved since 2008. FHWA has advanced the SRI program through the development of the Smart Roadside Concept of Operations (ConOps) and architecture, as well as the development of a Smart Roadside Prototype system. The Connected Vehicle Program also has matured greatly in recent years and what was once solely a research project was actively tested through the Safety Pilot in Michigan. On August 20, 2014, the National Highway Traffic Safety Administration (NHTSA) issued an Advance Notice of Proposed Rulemaking (ANPRM) to initiate "rulemaking that would propose to create a new Federal Motor Vehicle Safety Standard (FMVSS), FMVSS No. 150, to require vehicle-to-vehicle (V2V) communication capability for light vehicles (passenger cars and light truck vehicles (LTV)) and to create minimum performance requirements for

V2V devices and messages."[2] A decision regarding whether to proceed with a similar regulation concerning commercial vehicles is expected.

To support the continued advancement of the SRI program, U.S. DOT commissioned this SRI Gap Analysis project, in order to:

- Document the currently available and emerging roadside technologies for commercial vehicle operations (CVO);
- Analyze the functionality being developed as part of the Smart Roadside Prototype;
- Document the "target" SRI functionality; and
- Identify operational, institutional, and technical gaps that would hinder the deployment of the SRI "target" functionality.

Purpose of This Document

The purpose of this report is to document the "target" functionality for the Smart Roadside Initiative, as well as the operational, institutional, and technical gaps that currently impede the deployment of three of its operational scenarios (electronic mainline screening, virtual weigh stations, and truck parking systems). Specific attention is given to gaps that exist between the "target" functionality and the current design of the Smart Roadside Initiative Prototype. Recommendations to address these gaps also are presented. This document is the final piece of analysis associated with the SRI Gap Analysis project. It integrates information from the project's State of the Practice report, which summarized the States' current deployment of advanced roadside technologies, with findings from the project's assessment of private-sector technology usage, review of U.S. DOT's SRI Prototype project, and assessment of how the Vehicle-to-Infrastructure component of the Connected Vehicle program could support SRI functionality.

In addition to this introduction, the document contains three technical sections. Each section is focused on one of the operational scenarios being studied by this project: Mainline Electronic Screening (section 2); Virtual Weigh Stations (section 3); and Commercial Parking Systems (section 4).

This document is a combination of two other documents that were envisioned at the outset of this project and represent the final project deliverable from task 3, as well as the deliverable for task 4. The project team, in association with U.S. DOT, determined that a single combined document for these two tasks would prove to be a more useful document for stakeholders.

Functional Areas Studied

In order to systematically analyze the "target" functionality and potential gaps that exist, this report continues to analyze SRI functionality across five core functional elements. These functional elements include:

[2] 79 FR 161 (August 20, 2014).

- **Identify—**Accurately identifying commercial vehicles, motor carriers, and/or commercial vehicle drivers while the vehicle remains in motion.
- **Select, Check, and Verify—**This functional area has two distinct applications across the operational scenarios. Within the mainline screening and VWS scenarios, activities in this functional area determine which commercial vehicles should be targeted for a roadside inspection based on dimensional/performance data collected at the roadside (e.g., weight, height, brake performance) and credential and safety data (e.g., credential status, safety scores). Within the truck parking scenario, activities in this functional area are designed to determine the real-time availability of truck parking at a facility.
- **Control—**Managing the movement of commercial vehicles through a facility.
- **Collection and Payment—**Electronically collecting payment of fees at a site.
- **Analysis—**Analyzing site operational data to modify site or enforcement operations.

These functional areas are the same ones used to organize the stakeholder input during the 2008 Smart Roadside Workshop. These functional areas also were used as the framework for analysis in this project's State of the Practice Report.

Chapter 2. Electronic Mainline Screening

The "target" functionality for mainline electronic screening has remained unchanged since the concept was initially introduced in the early 1990s as part of U.S. DOT's Intelligent Transportation Systems for Commercial Vehicle Operations (ITS/CVO) program. As described in the State of the Practice report (task 2) from this project, Electronic Mainline Screening systems use technology to improve the operational efficiency of fixed enforcement facilities. As part of this scenario:

- Commercial vehicles are identified electronically while in motion at highway speeds;
- The vehicle identification information is used to query data sources in order to verify the credential status and safety history for the specific vehicle and its associated motor carrier; and
- The credential status and safety history information (along with other real-time inputs, such as vehicle weight from in-road sensors) is used to determine whether a vehicle should be targeted for roadside enforcement (e.g., inspected) or allowed to bypass an enforcement facility.

The screening decision (i.e., pull in, bypass) is communicated to the driver of the commercial vehicle via an in-vehicle device or via roadside signage. The operational scenario is designed to allow the nation's limited number of roadside enforcement personnel to target commercial vehicles that are known to be operating illegally (e.g., overweight, without proper credentials, in violation of an out of service order) or that have a history of poor safety performance (e.g., poor safety score[3]). This scenario (and its associated technologies) is detailed in figure 2-1.

Gap Analysis

All of the "target" functionality for mainline electronic screening is supported by existing technologies and architectures. That said, a number of operational and institutional gaps prevent stakeholders from realizing the full benefits associated with the "target" functionality. There also is a gap between the "target" functionality and the SRI Prototype project that currently is underway. The identified gaps are summarized in table 2-1 and detailed on the following pages.

[3] States use a variety of safety scores in their screening algorithms to evaluate a motor carrier's safety performance. These scores include FMCSA's Inspection Selection System (ISS), and FMCSA's Performance Registration Information System Management (PRISM) Motor Carrier Safety Improvement Program (MCSIP).

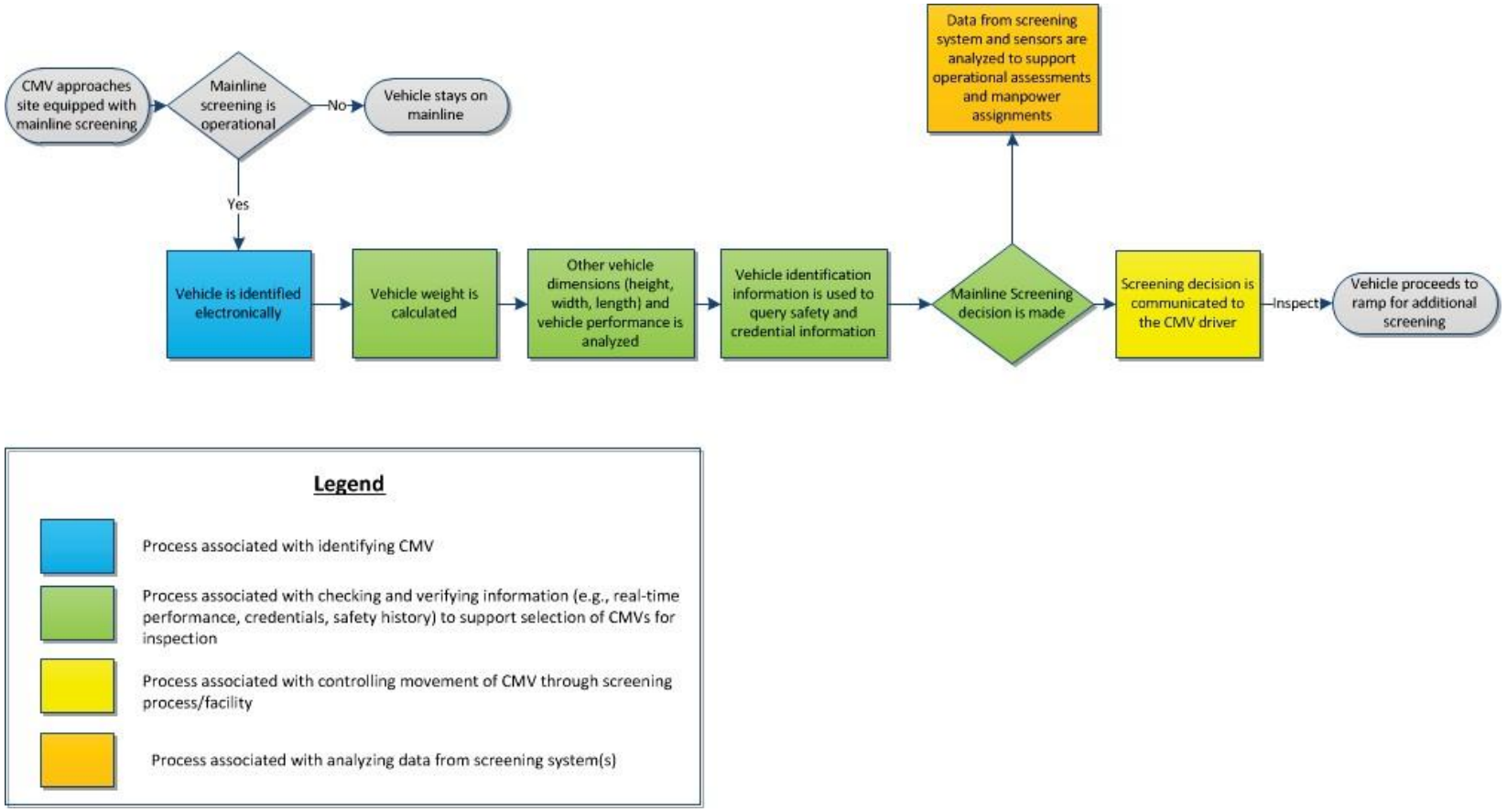

Figure 2-1. Flowchart. Mainline screening "target" functionality
(Source: Cambridge Systematics, Inc., based on observations taken at mainline screening facilities, including Martin County, Florida; Lordsburg, New Mexico; Fort Lewis, Washington; and SeaTac, Washington)

Table 2-1. Gaps Identified Between "Target" Electronic Mainline Screening Functionality and Existing or Planned Deployments, including SRI Pilot Project

	Gaps			
Functional Components	**Operational (O)**	**Institutional (I)**	**Technical (T)**	**SRI Prototype (P)**
Identify	O1. All commercial vehicles cannot be identified at highway speeds because of the voluntary nature of the screening programs.			P1. Universal ID is not included in current SRI Pilot.
Select/Check/ Verify	O2. Not all States are uploading credential information to the national repository (SAFER).	I1. Some enforcement personnel continue to have limited faith in screening systems/ recommendations. I2. Competing priorities at roadside can result in targeted vehicles not being inspected.		
Control	O3. Secondary screening decisions can prevent targeted vehicles from being inspected. O4. Human and space constraints can prevent targeted vehicles from being inspected.			
Collect/Pay				
Analyze				

The identified key operational gaps include:

- **O1. Inability to identify *all* commercial vehicles for screening purposes—** Public-sector stakeholders continue to request the ability to identify all commercial vehicles as part of the mainline screening process. While transponders and Commercial Mobile Radio Systems (CMRS) technologies are capable of supporting this requirement, their deployment currently is not required on all commercial vehicles and a State's ability to screen a commercial vehicle with 100 percent accuracy therefore is limited to carriers that elect to voluntarily enroll in a screening program. Numerous States and vendors have deployed alternate technologies (e.g., camera-based license plate readers) that have the potential to identify all vehicles (that have license plates) but operational considerations (e.g., lighting, shadows, weather, dirt, damaged license plate) reduce these technologies' effectiveness.
- **O2. Not all States are uploading credential information to the national repository (SAFER) for use at the roadside—**As part of the nationwide deployment of U.S. DOT's Commercial Vehicle Information Systems and Networks (CVISN) program, all States will be uploading their commercial vehicle interstate registration and interstate fuel tax data into the national Safety and Fitness Electronic Records (SAFER) system. Through the CVISN architecture, the information uploaded to SAFER is made available for download/use by all other participating CVISN States. The end result of this activity will be that accurate and up-to-date vehicle registration and fuel tax information from all jurisdictions will be available at the roadside to support mainline screening. This cross-jurisdictional sharing of data is critical to the electronic mainline screening operational scenario because it allows screening systems to effectively screen vehicles from any jurisdiction as they pass an enforcement facility. As of November 2014, 38 States are uploading interstate vehicle registrations to the SAFER repository and 36 States are uploading interstate fuel tax data. Until all jurisdictions upload their content to SAFER, the "target" functionality of enabling the screening of all commercial vehicles at the roadside cannot be realized.
- **O3. Secondary screening decisions can prevent targeted vehicles from being inspected—**In addition to the mainline screening decision, many fixed inspection sites have secondary (e.g., ramp-based) screening points. Optimally, these secondary screening points are fully integrated with the mainline screening system and the targeting decision made on the mainline is carried forward and factored into the ramp screening decision. In many cases, however, these secondary screening points are not integrated with the mainline screening decision and at times are based solely on weight. In these cases, a commercial vehicle that was targeted for inspection on the mainline is directed onto an inspection site's ramp where it is weighed and then (if legally loaded) allowed to proceed back to the mainline before being observed by enforcement personnel. As such, this secondary screening point fundamentally prevents the "target" functionality from performing as intended.
- **O4. Human and space constraints can prevent targeted vehicles from being inspected—**Resource constraints (human and physical) impact the realization of the desired outcomes associated with the "target" mainline screening functionality. Many enforcement facilities only have a limited number of

certified inspectors on duty at any given time. In some cases only a single inspector is on duty at a site. Further, sites also have a limited amount of physical space in which commercial vehicles can be inspected. If the number of commercial vehicles that are targeted for inspection at a site exceeds the capacity of inspectors or the facility itself, targeted vehicles will not be inspected. In cases where only a single inspector is on duty, that individual may be occupied for approximately an hour while conducting a Level 1 inspection, which will mean that all other targeted vehicles passing the site during that hour will be allowed to proceed past the inspection facility without any roadside intervention. This gap, in combination with O3 and I2, combine for as low as two percent of targeted commercial vehicles being inspected at some sites.[4]

The identified institutional gaps associated with mainline electronic screening include:

- **I1. Some enforcement personnel continue to have limited faith in screening systems/recommendations**—Some roadside enforcement personnel continue to doubt that electronic screening systems are effective at targeting the "right" carrier and/or vehicle for inspection. These individuals believe that their years of experience better equip them to make screening decisions and therefore often disregard the targeting recommendation made by the screening system. As long as this sentiment exists, the benefits associated with the "target" functionality likely will not be realized.
- **I2. Competing priorities at roadside can result in targeted vehicles not being inspected—**Roadside staff often are funded by a diverse array of sources, including Motor Carrier Safety Assistance Program (MCSAP), National Highway Transportation Safety Administration grants, and State funds. The funding source paying for a staff member's time on a given day often dictates that individual's focus for that day. For instance, if an individual is being funded by a seat belt enforcement grant his/her focus on that day will be exclusively on the enforcement of seat belt regulations. As such, the funding source supporting an individual on a given day can influence whether targeted vehicles will be inspected or not.

The singular gap associated with the SRI Prototype and the "target" mainline electronic screening is the lack of Universal Truck Identification functionality. As noted above, stakeholders continue to request the ability to identify all commercial vehicles as part of their roadside electronic screening processes. As was reported in the task 3.1 memorandum associated with this project, however, the Universal Truck ID functionality currently is not planned to be part of the Prototype.

Recommendations to Address Gaps

All of the gaps impacting the electronic mainline screening functionality can be overcome. Table 2-2 summarizes the recommendations that address each of the identified gaps.

[4] Roadside data observed by Cambridge Systematics in support of a currently unreleased safety analysis conducted for FMCSA.

Table 2-2. Recommendations to Address Electronic Mainline Screening Gaps

Identified Gap	Recommendation
O1. All commercial vehicles cannot be identified at highway speeds because of the voluntary nature of the program.	There are several options available to U.S. DOT to support the electronic identification of all commercial vehicles at the roadside. First, stakeholders have requested that FMCSA mandate the use of a Universal Truck ID technology on all commercial vehicles in support of mainline electronic screening. While a viable technical solution, it is unlikely that the required cost/benefit analysis for a rulemaking would support the mandating of such a technology on all commercial vehicles. The benefits associated with identifying additional commercial vehicles at the roadside are derived not by the identification of vehicles but rather from the ability to conduct more inspections on "targeted" commercial vehicles. As long as capacity constraints (operational gap O4) limit the number of inspections that can occur at most fixed sites, it is unlikely that the benefits associated with the technology would warrant mandating it. The second alternative available to U.S. DOT is to leverage the DSRC infrastructure being developed as part of the Connected Vehicle program. As noted in the Integrating Smart Roadside Initiative into the V2I Component of the Connected Vehicle Program document produced by task 3.2 of this project, the Connected Vehicle technology and standards can directly support this aspect of SRI. If U.S. DOT elects to require this technology on all commercial vehicles, its deployment will address this gap without requiring a stand-alone cost/benefit analysis.
O2. Not all States are uploading credential information to the national repository (SAFER).	FMCSA is actively working with States to fully deploy the CVISN architecture, including the uploading of credential information to the national SAFER repository. CVISN deployment grants are available to States to support both the planning and implementation of this functionality. It is recommended that FMCSA continue to provide technical assistance to States that are struggling with the implementation of their CVISN programs. This technical assistance has supported States' identification of alternate solutions for uploading of credential and safety data to SAFER, and supported the development of funding plans to implement the optimal solutions. While most States are actively working to deploy CVISN functionality, the voluntary nature of the program could make this gap difficult to eliminate completely without a substantive change to the program if a State were to simply elect to leave the CVISN program. If this issue were to arise, FMCSA's primary recourse would be to educate the State about the benefits of the program (e.g., safety benefits, productivity benefits, availability of funding for future ITS deployments) in an attempt to re-engage them. If this were unsuccessful, broader program and/or legislative changes (e.g., tie other funding sources to CVISN participation) might be required to compel a State to participate; although it is unclear if these additional methods could be realistically enacted.
O3. Secondary screening decisions can prevent targeted vehicles from being inspected.	Numerous States and vendors are working to integrate secondary screening decisions (e.g., ramp-based screening decisions based solely on weight) with the mainline screening decision through the application of additional technologies (e.g., magnetometers on mainline and ramps, camera-based systems on ramps). FMCSA should actively encourage this work and consider prioritizing this type of project in upcoming grant cycles. FMCSA also should consider complete end-to-end processing when evaluating a proposed roadside screening operational scenario as part of a State's CVISN Program Plan/Top-Level Design and grant application to ensure that the scenario is not adversely impacted by secondary screening decisions. If the presence of a secondary screening decision will adversely affect the mainline screening functionality, FMCSA should request/require that States address the issue prior to the scenario being approved. Finally, FMCSA should continue its work to document the safety benefits associated with mainline electronic screening at individual inspection sites so that objective measures of effectiveness can be used to calculate the impacts of these technologies at the roadside.

Identified Gap	Recommendation
O4. Human and space constraints can prevent targeted vehicles from being inspected.	It is unlikely that sufficient funding will be available at the Federal or State level to fundamentally improve human or physical capacity at the roadside so that all targeted commercial vehicles can be inspected at the roadside. As such, it is recommended that U.S. DOT and FMCSA continue to actively pursue alternative enforcement scenarios so that some type of intervention can occur against "targeted" commercial vehicles when resource constraints prevent human intervention. This recommendation will become even more important if all commercial vehicles are able to be identified and screened electronically (i.e., gap O1 is addressed). These enforcement alternatives could include a Wireless Roadside Inspection (WRI) or follow-up enforcement, such as the sending of warning letters to carriers whose vehicles were found to be operating illegally (e.g., without proper credentials, over weight). In working with numerous States on their design of roadside enforcement strategies, Cambridge Systematics has found little interest among public- and private-sector stakeholders towards "direct" automated enforcement (e.g., issuing citations based on data from roadside technologies) but issuing warning letters may be more acceptable. This concept is very similar to the intervention model currently employed by FMCSA's CSA program.
I1. Some enforcement personnel continue to have limited faith in screening systems/ recommendations.	There remains skepticism among some roadside enforcement personnel that electronic screening systems are effective at targeting the "right" commercial vehicles for inspection. To address this concern it is recommended that U.S. DOT conduct an objective analysis regarding the effectiveness of electronic screening systems/criteria versus human experience/intuition in identifying the "right" commercial vehicles (e.g., high risk, those operating illegally) for inspection. Without this type of real-world field test, it is unlikely that trust and faith in the systems will improve. It also is imperative that the data being used by the electronic systems is accurate, in order for enforcement personnel to have faith in their recommendations. FMCSA efforts to deploy the CVISN architecture should work to resolve data quality issues.
I2. Competing priorities at roadside can result in targeted vehicles not being inspected.	Similar to the recommendation to O4, it is recommended that WRI and alternative enforcement strategies are the best approach to addressing competing institutional priorities at the roadside. Roadside personnel will always have multiple responsibilities and providing tools to them to ensure that commercial vehicle safety is being addressed while they are focusing on other responsibilities is believed to be a superior approach to modifying the programs that fund roadside personnel. The new version of roadside Aspen inspection software will enable enforcement personnel to flag the reason (e.g., screening system) that an inspection was conducted. This will allow closer tracking of how often screening systems are being used to target inspections. If this data suggests that the screening systems are not being used widely to target inspections, U.S. DOT and stakeholders could explore the best way to resolve this issue (e.g., set standards for use of technology, education).
P1. Universal ID is not included in current SRI Prototype.	As noted in the task 3.1 memo of this project, Universal Truck ID is not part of the currently envisioned SRI Prototype. Given that other technologies (e.g., Connected Vehicle) could fulfill this role; this decision likely will not impact the long-term deployment of SRI function-ality. If it is decided, however, that the Connected Vehicle infrastructure will not be used to support the Universal Truck ID functionality, U.S. DOT may wish to reconsider whether this functionality should be included in the SRI Prototype or subsequent deployment efforts in order to demonstrate that Universal ID of commercial vehicles is possible.

Chapter 3. Virtual Weigh Station

Virtual weigh stations (VWS) are remote facilities that allow commercial vehicles to be identified, screened, and targeted for inspection in an area where there is no fixed enforcement facility. VWS typically consist of four key operational components:

- Real-time identification of a commercial vehicle;
- Real-time weighing of a commercial vehicle;
- Integration of real-time data (e.g., weight, safety, credential) into screening decisions; and
- Communication of data to enforcement personnel in real time.

The key difference between mainline screening sites and VWS is that the screening decision at VWS sites are communicated to enforcement personnel positioned at the roadside downstream from the VWS. These enforcement personnel are responsible for stopping and inspecting the targeted commercial vehicle. Figure 3-1 illustrates the "target" functionality associated with this operational scenario.

Gap Analysis

As with electronic mainline screening, all of the "target" functionality for the virtual weigh station operational scenario is supported by existing technologies. There are, however, a number of operational, institutional, and technical gaps that are preventing the functionality from delivering all of its intended benefits. A number of gaps affecting VWS also impacted mainline electronic screening. These common gaps include:

- O2. Not all States are uploading credential information to the national repository (SAFER);
- O4. Human and space constraints can prevent targeted vehicles from being inspected;
- I1. Some enforcement personnel continue to have limited faith in screening systems/recommendations; and
- P1. Universal ID is not included in current SRI Pilot.

The details associated with these gaps can be found in section 2 of this report. Details regarding the technical gap that is unique to VWS can be found on the following pages.

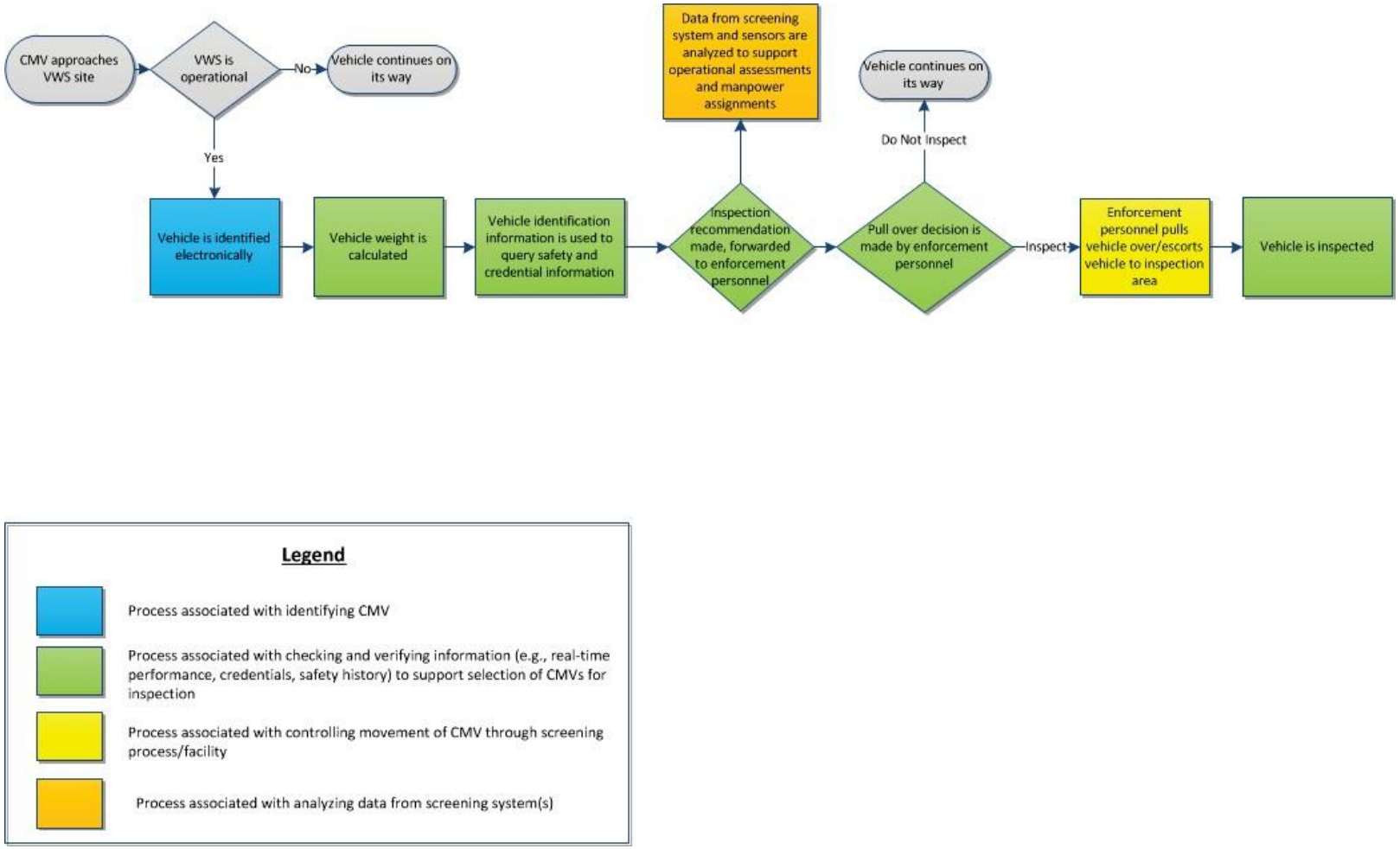

Figure 3-1. Flowchart. Virtual weigh station "target" functionality
(Source: Cambridge Systematics, Inc., based on observations taken at actual virtual weigh station facilities, including Jenkins Creek, Alabama and Wildwood, Florida)

Table 3-1. Gaps Identified Between "Target" Virtual Weigh Station Functionality and Existing or Planned Deployments, including SRI Pilot Project

	Gaps			
Functional Components	**Operational (O)**	**Institutional (I)**	**Technical (T)**	**SRI Prototype (P)**
Identify			T1. All commercial vehicles cannot be identified electronically.	P1. Universal ID is not included in current SRI Pilot.
Select/Check/ Verify	O2. Not all States are uploading credential information to the national repository (SAFER).	I1. Some enforcement personnel continue to have limited faith in screening systems/ recommendations.		
Control	O4. Human and space constraints can prevent targeted vehicles from being inspected.			
Collect/Pay				
Analyze				

The technical gap associated with the VWS operational scenario is related to the identification of all commercial vehicles while they remain in motion. Most VWS deployments use camera-based systems with optical character recognition (OCR) to identify commercial vehicles while they remain in motion. While the accuracy of camera-based/OCR systems has improved in recent years, they still cannot identify 100 percent of commercial vehicles accurately due to a number of environmental factors (e.g., lighting, shadows, dirt/mud/snow obscuring the license plate, damaged license plates). A number of States have sought to employ other technologies (e.g., CMRS) to overcome the inherent issues with camera-based systems but use of these technologies are voluntary in nature and therefore do not support identification of all commercial vehicles for the operational scenario.

Recommendations to Address Gaps

All of the gaps impacting the VWS functionality can be overcome. Table 3-2 summarizes the recommendations that address each of the identified gaps.

Table 3-2. Recommendations to Address Virtual Weigh Station Gaps

Identified Gap	Recommendation
O2. Not all States are uploading credential information to the national repository (SAFER).	See table 2-2.
O4. Human and space constraints can prevent targeted vehicles from being inspected.	See table 2-2.
I1. Some enforcement personnel continue to have limited faith in screening systems/recommendations.	See table 2-2.
T1. All commercial vehicles cannot be identified electronically.	As noted, in response to O1 above, it is recommended that U.S. DOT leverage the Connected Vehicle infrastructure to support identification of all commercial vehicles in support of roadside enforcement activities at both fixed facilities and virtual weigh stations. The Connected Vehicle program, in fact, has already contemplated that its infrastructure could allow other ITS-equipped facilities (e.g., toll booths, rest areas) into VWS-like deployments. This expansion of the VWS network in association with alternate enforcement technologies (e.g., WRI, warning letters) could greatly expand the efficiency and effectiveness associated with roadside enforcement programs. NHTSA's forthcoming decision on whether to require the deployment of 5.9 GHz technology on all commercial vehicles will go a long way in determining whether this technology is a viable option to identify all commercial vehicles electronically. Further, whether existing commercial vehicles would be required to be retrofitted with this technology will determine how quickly this technology could achieve sufficient market penetration to adequately address this required functionality.
P1. Universal ID is not included in current SRI Prototype.	See table 2-2.

Chapter 4. Commercial Parking Systems

Truck parking systems are an emerging operational scenario focused on providing truck drivers and/or dispatchers with real-time or near real-time information regarding the location and availability of commercial vehicle parking. This scenario typically includes:

- Technology to monitor and calculate the number of available truck parking sites at a parking facility; and
- A means to distribute this parking availability information to truck drivers and/or dispatchers.

Gap Analysis

The primary technical gap that previously impacted the commercial vehicle parking systems operational scenario was the (in)ability to accurately identify the number of available commercial vehicle parking spaces at a facility. This gap, however, was overcome through research being conducted for FMCSA. After a pilot test that compared the performance of three distinct technologies/configurations, FMCSA has determined that "Doppler radar combined with a side laser scanner" best meets the operational requirements of this operational scenario.[5] As such, this technology is being advanced to phase 2 of testing, which will:

- Link two truck parking areas in order to demonstrate the concept of whether truckers can be diverted from an area that is full to an area that is unfilled;
- Demonstrate real-time dissemination of truck parking space availability information based on utilization;
- Demonstrate a truck parking reservation system;
- Forecast future truck parking availability from past use; and
- Develop a business plan for deploying SmartPark.[6]

[5] Federal Motor Carrier Safety Administration, *SmartPark Technology Demonstration Project*, October 2013.

[6] FMCSA webinar, "FMCSA's SmartPark and Using Expanded CVISN Grants for Deployment." November 20, 2014.

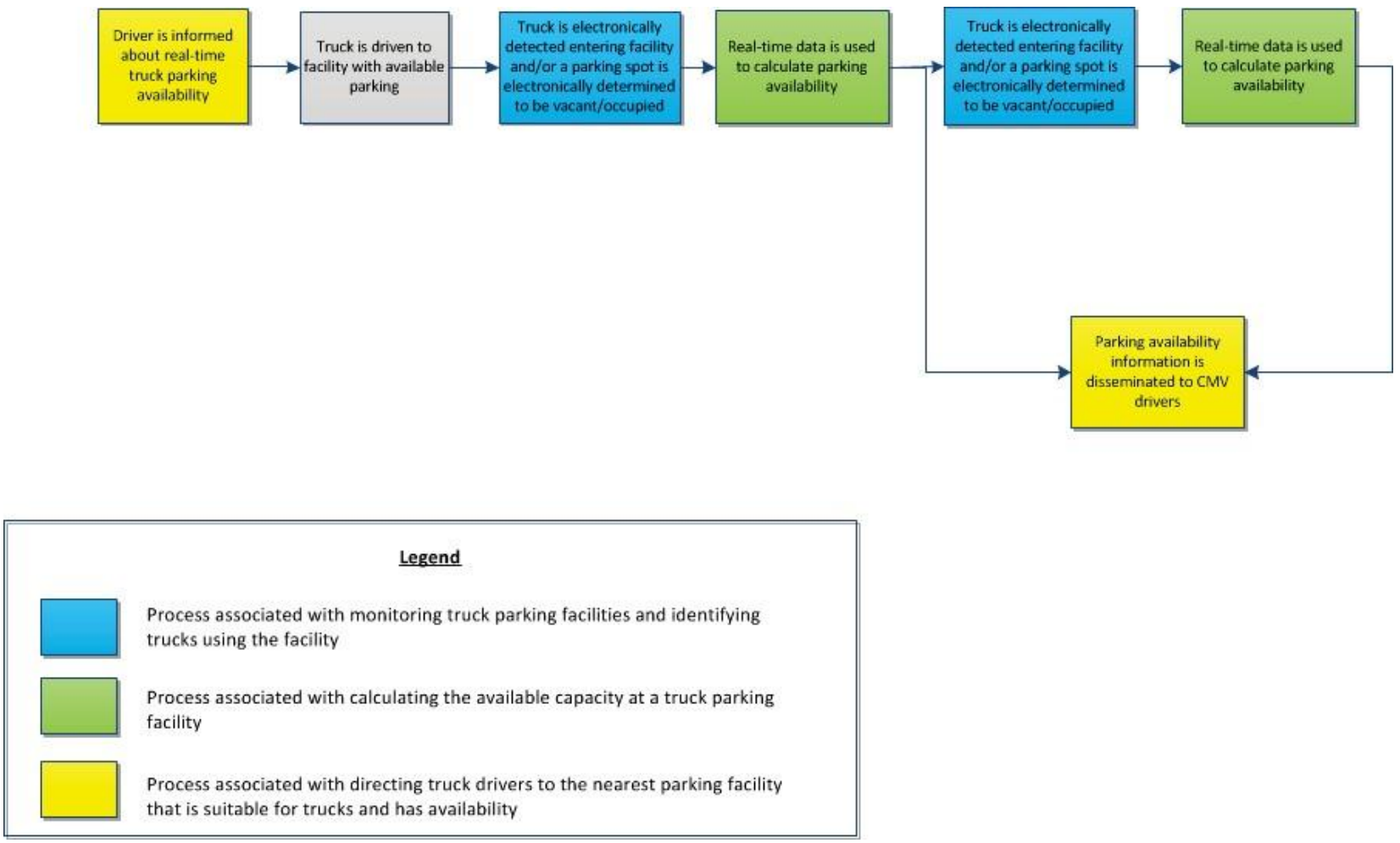

Figure 4-1. Flowchart. Automated commercial parking "target" functionality
(Source: Cambridge Systematics, Inc., based on observations taken at the New Buffalo Welcome Center in Michigan)

Table 4-1. Gaps Identified Between "Target" Commercial Parking Systems and Existing or Planned Deployments, including SRI Pilot Project

	Gaps			
Functional Components	**Operational (O)**	**Institutional (I)**	**Technical (T)**	**SRI Prototype (P)**
Identify				
Select/Check/ Verify				
Control		I3. Determine whether motor carriers/commercial drivers will modify their routing in response to information from a truck parking system.	T2. Need to determine the best means for disseminating commercial truck parking information to private-sector decision-makers (e.g., dispatchers, commercial drivers).	
Collect/Pay	O5. Need to determine the business model for a commercial truck parking system.			
Analyze				

All of the gaps associated with commercial truck parking operational scenario are associated with the dissemination and long-term operation of the system(s). In particular the gaps include:

- **O5. Need to determine the business model for a commercial truck parking system—**While commercial vehicle operators have expressed a desire for truck parking information, it remains to be seen whether they are willing to pay for this information or associated value-added services (e.g., reservations to hold a space). If the industry is unwilling to pay for this information, public-sector agencies may be required to underwrite the funding and long-term operation of these systems. Until the business model is determined, the operational scenario likely will not gain widespread deployment.
- **I3. Determine whether motor carriers/commercial drivers will modify their routing in response to information from a truck parking system—**The willingness/ability of motor carriers to leverage information from commercial parking systems will be a critical factor in determining whether these systems deliver their intended safety and operational benefits. In particular, it currently is

unknown how far from their originally planned route a carrier/driver will be willing to deviate, in order to take advantage of available parking.

- **T2. Need to determine the best means for disseminating commercial truck parking information to private-sector decision-makers (e.g., dispatchers, commercial drivers)—**A wide variety of technologies (e.g., web site, smart phone application, direct integration with routing and dispatch software) could support the dissemination of truck parking availability information. Which of these technologies is most efficient and effective remains to be determined.

Recommendations to Address Gaps

Phase 2 of FMCSA's SmartPark initiative is addressing the outstanding gaps associated with the "target" functionality for the commercial parking operational scenario. The findings from this research, which should be available in draft form in May 2015 (final version available in late 2015), should guide future deployments of commercial parking systems. Evaluations of the ongoing FHWA-funded truck parking deployments also will provide insight into the future of truck parking systems (technologies and business models) in the United States. U.S. DOT likely will want to compare the findings from the FMCSA and FHWA activities and determine if lessons learned can be drawn across these efforts.

Further, it is recommended that U.S. DOT continue to focus on supporting the integration of functionality across operational scenarios. Most work currently being done by States and vendors is focused on optimizing the implementation of each operational scenario and not the integration of functionality across scenarios. Given the number of identified gaps, which continue to impede the realization of each scenario's full potential, this approach is well founded. In the long term, however, research and funding should be focused on demonstrating that a single technology platform (e.g., Connected Vehicle) could support all of the SRI operational scenarios/applications. In the short term, the SRI Prototype could be an opportunity to demonstrate how standard an on-board vehicle communication platform could be used as a conduit to integrate mainline screening, virtual weigh station, and commercial truck parking functionality. The Prototype also could be an example of how existing infrastructure (e.g., commercial parking systems, mainline screening facilities) and data sources (SAFER), as opposed to new and/or proprietary systems, can be leveraged to achieve the SRI vision.

U.S. Department of Transportation
ITS Joint Program Office-HOIT
1200 New Jersey Avenue, SE
Washington, DC 20590

Toll-Free "Help Line" 866-367-7487
www.its.dot.gov

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