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I-81 Corridor Freight Information System

Concept of Operations

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1. INTRODUCTION

1.1. Identification

This document describes the concept of operations (ConOps) for the "GO-81" Corridor Freight Information System (CFIS) [1], which will deliver a suite of capabilities to enhance freight operations safety and efficiency across the length of the I-81 corridor. The corridor, which stretches from East Tennessee through six states to the Canadian border, is a high-volume corridor for trucks. The CFIS will deliver traffic information and support smart truck parking across the corridor by integrating and building on existing systems, and implementing new ones that will support safety and efficiency enhancements in Tennessee, Virginia, West Virginia, Maryland, Pennsylvania and New York. The GO-81 program is a multi-faceted US Department of Transportation (USDOT) initiative being developed under the Multi-Modal Corridor Operations Management (MCOM) program.

1.2. Document Overview

The GO-81 concept came about as a result of a concerted effort on the part of the I-81 Corridor Coalition to address freight safety concerns on the corridor. Past research and analysis efforts revealed that commercial vehicles comprised a large percentage of the vehicles traveling the corridor—reaching as high as 40 percent of total vehicle traffic in sections between Central Pennsylvania and West Central Virginia. This stretch of the corridor also experiences the highest levels of congestion and the greatest frequency of crashes. This document contains the vision, goals, objectives and guiding principles for a system.

The vision for the GO-81 CFIS is:

> *The GO-81 vision is to become the national model for applied truck information systems that integrates existing I-81 corridor data on travel times, incidents, and weather and adds real-time information on truck parking. GO-81 will also define a business model that will guide other corridors on how to implement a similar public-private partnership and thus speed deployment of a national freight information system.*

From a planning perspective, the Coalition and its member jurisdictions envision having access to a consistent information set that allows them to more effectively identify current planning needs related to freight movement. This will provide an analytical foundation upon which to establish investment priorities that are logical, practical, and that reflect MAP-21 national goals for efficient freight movement. The first portion of the work plan addresses this component through a combination of innovative and time-tested multi-modal freight planning actions. This effort will:

- develop a comprehensive picture of demand, origins and destinations for freight movements;

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1 The term "CFIS" is used throughout this document for simplicity.

- assess the degree to which existing truck parking facilities can meet the needs of the trucking community;
- formulate a picture of the portions of the corridor that warrant public investment to better facilitate efficient Goods movement;
- identify specific opportunities where diversion of freight from truck to rail can benefit all users of the corridor; and,
- reflect current data on freight movement.

The remaining components of the GO-81 project address the operational component of our vision. The CFIS will provide freight trucks and State DOTs with an affordable means to extract the maximum productivity from operations on the corridor. For example, if an incident occurs along the corridor, CFIS will:

- notify truck drivers and dispatchers of the incident;
- provide additional detail upon demand (i.e., location, severity, likely delay effects, etc.);
- inform them of options, such as alternate routes, truck stops and rest stops nearby (including available parking, services and fuel prices); and,
- provide navigation to the option of their choosing.

Incidents could include traffic congestion, weather events, crashes or other events that would result in travel delays. The ultimate goal is to provide the trucking community with targeted, high-quality information that can boost efficiency, reliability, and safety. Once deployed, CFIS will provide a cohesive, integrated access point to information necessary for truckers to enhance efficiency while simultaneously making the corridor safer and more reliable for all users. To make this possible, the GO-81 CFIS will incorporate data elements into a decision-making tool that is easy to access, and can be delivered inexpensively.

The I-81 Corridor Coalition and its partners intend to apply a number of key principles in the design and implementation of GO-81:

- ***Leverage Proven Technology.*** GO-81 is not a research project, but a pilot deployment. As such, it is structured as a public-private partnership that will integrate proven systems and leverage advancements in data communications to deliver an affordable solution that can be easily transferred to other corridors.
- ***Take Full Advantage of Multiple Modes.*** In addition to supporting a network of Interstate routes, the I-81 corridor benefits from rail freight capacity that parallels much of its length. GO-81 will actively seek specific, tangible and viable opportunities to divert traffic to this network, thus improving the overall efficiency of the corridor.
- ***Improve Regional and National Economic Competitiveness.*** This scale helps generate transportation benefits and GO-81 is built around a six-state, 855 mile multi-modal corridor.
- ***Plan for Self-Sufficiency.*** The Coalition member jurisdictions and our partners in the business community recognize that success depends upon a long-term commitment to deliver the services described in this proposal. We will prepare a business model that aims to minimize the need for ongoing public financial support.

- ***Support Planning Consistent with MAP-21.*** The GO-81 work plan calls for developing a model for how a multi-state corridor can meet MAP-21 goals. This will be a joint effort with FHWA.

The purpose for this document is to communicate a concept for the GO-81 CFIS that bridges the gap between users' needs and visions and developers' technical specifications. This concept is detailed in this ConOps document and it reflects the quantitative and qualitative system characteristics of the GO-81 CFIS from the users' and operators' perspectives organized by potential applications. The initial activities within this task are related to the extraction of user needs associated with the four programs identified for initial focus.

The structure of this ConOps is based on the Institute of Electrical and Electronics Engineers (IEEE) Standard *1362-1998 IEEE Guide for Information Technology, System Definition, Concept of Operations (ConOps) Document*. Consistent with this Standard, this ConOps document consists of the following sections:

- Section 1 provides an overview of the project scope and an introduction to the ConOps document.
- Section 2 provides an overview of the current system. This is used as the basis for analyzing the needs and capabilities to be considered in the system.
- Section 3 discusses the user needs, the process followed to identify and define them, and the justification for the definition of this concept.
- Section 4 describes the proposed concept, including its scope, operational environment, operational policies and constraints, major system services, and interfaces to external systems and subsystems.
- Section 5 provides a set of scenarios developed to illustrate the system's support for the needs defined in Section 4, as delivered using the conceptual system described in Section 5. Each scenario includes a brief textual description of the scenario.
- Section 6 provides a summary of the operational, organizational, and developmental impacts of the proposed system.
- Section 7 discusses the improvements provided by the proposed system, its disadvantages and limitations, and any alternatives or trade-offs considered.
- Section 8 lists the documents used as background information or as a source of user needs.

The intended audience for this ConOps includes: USDOT, transportation managers (including State and local DOTs), enforcement officers, vehicle manufacturers, information service providers, fleet managers, motor carrier companies; state agencies involved with commercial vehicle safety, application developers, implementers, operators, and maintainers.

1.3. System Overview

The "CFIS" portal is a collection of tools, methods, and standards that together have the potential to transform the way commercial vehicle operators, transportation system managers, truck parking service providers and other authorized users access, apply, and manage information. The CFIS and the components that will be developed under its umbrella will effectively do three major 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 both to electronically identify corridor traffic conditions and commercial vehicle parking capacity 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 foundational element of the CFIS is the establishment of open standards-based connectivity to the variety of systems that are currently in place at the Federal, State, and local levels within government and current and future commercial systems, as well as new and emerging systems related to network performance and truck parking availability. This connectivity is essential to the timely and ubiquitous information exchange that underpins the CFIS, and its ability to enable system users the flexibility to implement additional capabilities suited to their needs.

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

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

The common characteristic for all three major elements is a focus on enhancing the user experience by streamlining access to information, improving decision-making, and providing a means for delivering new capabilities. An overarching element of this vision is that CFIS must fit into and support an information exchange environment that allows for the rapid movement of a variety of different real-time data sets. This is essential to meet the performance requirements inherent in the delivery of the capabilities envisioned for commercial vehicle operations. Sections 4 and 5 of this document discuss the proposed CFIS in detail.

2. CURRENT SYSTEM OR SITUATION

The safe, efficient operation of commercial motor vehicles is a national priority for several reasons. First, the safety of the nation's motoring public is, and will remain, the primary concern of transportation agencies at all levels. As such, significant effort is being made to reduce both the likelihood and severity of crashes involving trucks. These efforts include the revision of hours-of-service rules, and the nationwide effort to ensure that truck drivers have access to adequate rest facilities. Given the volume of trucking activity on the I-81 corridor, this national priority is echoed among the members of the six-state I-81 Corridor Coalition.

These high truck volumes also reflect the importance of commercial freight transportation across not only the Coalition member states, but the entire eastern half of the U.S. It is estimated that the corridor sees as many as 26,000 trucks per day, and annual truck vehicle-miles exceed 8 million.[2] These trucks are moving goods that support economies up and down the entire east coast of the U.S., and in Canada. The I-81 corridor is an essential artery in the nation's commercial bloodstream.

As with any facility that spans multiple jurisdictions—and in particular, one that stretches for more than 850 miles—it is challenging for users to obtain important operational information. Mechanisms currently in place for promoting and providing for safe and efficient commercial vehicle operations across the length of the corridor are limited. Each State member maintains a 511 Traveler Information System, but none are integrated with the other jurisdictions' systems. The result is that truckers must reach out to multiple systems to gather information for any trip that moves through more than one State. Additionally, there are currently no provisions for drivers to gain access to information about the location and availability of commercial truck parking facilities.

3. BACKGROUND, OBJECTIVES, AND SCOPE

The US Department of Transportation (USDOT) works with trucks in a number of ways. The FHWA gathers and makes available to states various sources of data on network performance, funds important research and development projects, supports the deployment and operation of intelligent transportation systems (ITS), and promotes the sharing of lessons learned across the U.S. These functions are complemented by the National Highway Traffic Safety Administration (NHTSA), which sets and enforces safety performance standards for motor vehicles and motor vehicle equipment, and the Federal Motor Carrier Safety Administration (FMCSA) works closely with State-level enforcement agencies and motor carriers to identify processes, procedures, and mechanisms to evaluate over the road operations and ensure that motor carriers engaged in interstate commerce are safe and legal.

State agencies serve the commercial vehicle community in many capacities, including: 1) collecting and disseminating traveler information through traffic management centers and 511 traveler information systems, 2) managing incident detection and clearance activities, 3) building and maintaining rest stop facilities and 4) conducting commercial vehicle credentialing and safety inspection services to ensure the safety of the roadways within their boundaries.

2 Interstate 81 Multistate Corridor Study, VDOT, 2013. Note: Study used 2007 Freight Analysis Framework (FAF3) results.

Local agencies conduct planning activities to establish infrastructure funding needs and priorities and influence the types and locations of businesses that serve the commercial trucking industry.

The current system consists of a layered collection of systems, automated tools, and methods that provide decision-makers with enhanced and expanded access to information derived from historical safety and compliance data. This information provides the ability for enforcement agencies to conduct vehicle screenings and determine which vehicles require closer inspections and measurements.

Figure 1 depicts the wide variety of systems currently used for commercial vehicle operations management and compliance verification activities, and for the capture and dissemination of information related to government agency operations.

Most notable among the characteristics of the current environment is the preponderance of one-to-one linkages between users and the various system elements. This trait typically manifests itself in the multiple steps that a user must undertake to locate, extract, interpret, and apply the data and information necessary to make operational decisions—whether the user is a motor carrier employee or a representative from a government agency. Each of the individual systems depicted in the diagram have been designed and implemented to perform specific functions, often independent of the function of the others. The result is a collection of functional elements that require the user to engage in a significant number of separate decision-support activities. Additionally, several key operational elements (i.e., truck parking facilities and infrastructure facilities) have at best limited connection both within and between states.

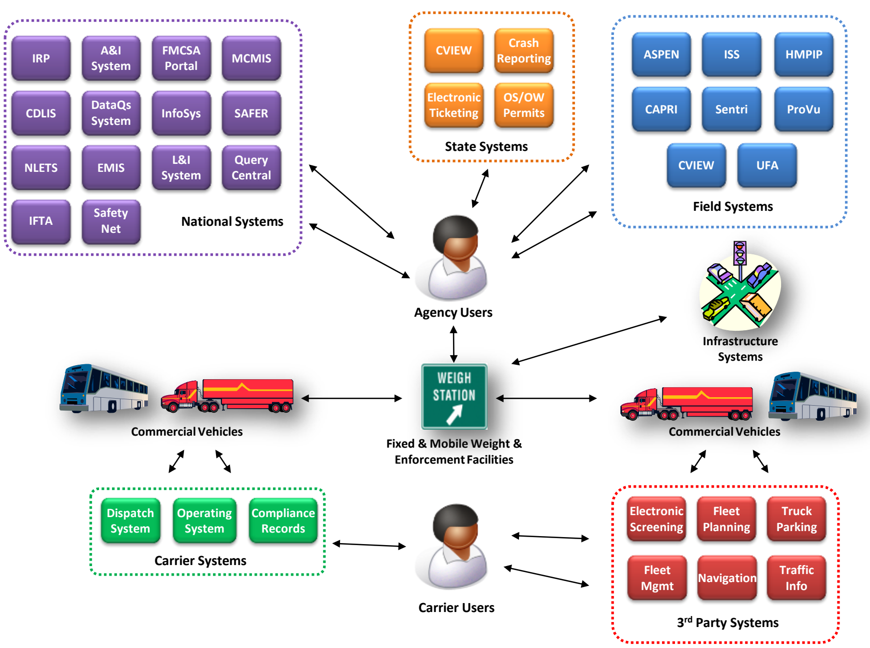


Figure 1 Overview of Current Commercial Vehicle Information Systems

Since the early 1990's, the USDOT has been engaged in various technology development and deployment efforts aimed at improving the quality of data collected and distributed for commercial vehicle operations. These efforts include significant projects undertaken as part of the Dynamic Mobility Applications (DMA) program, such as Freight Advanced Traveler Information System (FRATIS). Projects related to FRATIS have taken on several different forms, but all have in common a focus on capturing and delivering high-quality, timely information that enables motor carrier personnel—drivers specifically—to make informed decisions about routing, departure times and rest periods.

Even with these enhancements in place, much remains to be done to improve freight operations safety and efficiency. New data sources are being identified and new applications are begin developed that offer value. However, integration of datasets is still a considerable challenge, particularly across jurisdictional boundaries and operational channels. CFIS is intended to be a significant step forward by combining traffic information, roadway condition information, truck parking information and routing information into an integrated decision support system for drivers.

The current nature of system-to-system connectivity presents barriers to the broad implementation and use of other value-added functionality. There is a need for a single point of access to give the driver all the information needed for a timely decision. This initiative is highly-dependent upon the application of open architecture and a many-to-many systems connectivity approach to achieve its objectives. The establishment of individual system-to-system connections is neither practical nor capable of producing the level of cooperative operations and information sharing necessary to deliver these capabilities. A broader, open architecture-based model is essential to provide a single point of access.

These systems, as well as new and emerging systems to deliver truck parking information, are not in any way connected to any other systems currently in use. Nor, in many cases, are infrastructure systems such as 511 traveler information systems or advanced traffic management systems. While they may remain separate as they mature and evolve, there is a need to examine how efforts to connect vehicles and the infrastructure can be leveraged to deliver these services in a manner that makes them accessible and reliable to the largest possible number of users in the shortest period of time possible.

Finally, the current system is characterized by the significant presence of human-in-the-loop activities. In other words, much of what happens related to the movement of information and the execution of decisions based upon it is highly dependent upon manual intervention. In the current system, users are as often information exchange intermediaries as they are appliers of decision logic based upon that information. Essentially, these users must perform data integration via manual means. The user must find it, fuse it into meaningful information, and interpret it to make decisions. More effective information support systems are needed to correct this situation.

4. I-81 USER REQUIREMENTS

4.1. User Webinars

The user requirements for the Corridor Freight Information System (CFIS) were captured using two methods in order to get full participation from the I-81 users. The first method included the use of two webinars that presented the CFIS concept and asked potential users to participate in a survey using a survey technology that is embedded in WebEx. Although the webinars were well organized by the research team there was little participation with the users in the webinars. The following email was sent to over 100 participants as a invitation to participate in the webinar.

> "As an I-81 Coalition Stakeholder you are invited to participate in two webinars that are focused on capturing user requirements that are needed to support the development of the GO I-81 Corridor Freight Information System (CFIS) Concept of Operations. The webinars are scheduled for Wednesday October 21st and Thursday October 22nd at 2 PM ET. CFIS will provide the essential tools to improve safety and efficiency across the I-81 corridor. These user requirements sessions will be the first step in developing a system that will help the freight users by providing access to information about highway incidents, weather, congestion, alternate routing, and truck parking from a single system that uses real time information across the corridor.
>
> The planned GO-81 Corridor Freight Information System (CFIS) will build on previous proven technologies and lessons learned in other parts of the country. CFIS will consist of an implementation of integrated information systems that exist today and can be deployed readily within the corridor to support improving efficiency and safety. These systems will provide the I-81 stakeholders travel information in order for operation managers and drivers to make real-time decisions about where to stop for rest and when to travel in order to avoid delays caused by incidents, weather, or congestion.
>
> Capturing the user requirements in the webinar will include a polling process that is available in WebEx. Online participates will be given a set of questions with a multiple choice of answers. Participants will be available to choose the best answer to support the user requirement. Participants may also enter alternate responses to the questions in a chat box available in the WebEx session. The responses will be accumulated and prioritized based on the selection of the answers from the stakeholders. A summary report will be sent to the participants within two weeks to provide the attendees an additional opportunity to comment on the responses.
>
> This email will be followed by two calendar invitations titled "CFIS User Requirements Session 1 and 2" containing the link and instructions to access the WebEx and the audio conference line for the GO I 81 User

> Requirements Webinar. Please select the session you would like to attend and accept the invitation. If you have any questions about the webinar please email Randy Butler at randy.butler@parsons.com. We look forward to your participation and feedback in these sessions."

In order to improve the results the I-81 coalition research team developed a survey of the same questions asked to participants in the webinars and forwarded them to the same I-81 users that were invited to the webinars. The following is the email that was sent to the participants in order to gain additional feedback on user requirements.

> "Dear *named I 81 user*:
>
> We could use some heroes. As you are probably aware, the I-81 Corridor Coalition is leading a study, which will establish a model consolidated freight information system (CFIS). We intend to pilot this system on I-81 before its possible deployment in other parts of the country. In order that we have the input from the planners, designers, and engineers of the highway, we are asking for the input of various persons in the departments of transportation of the six states traversed by I-81. By responding, you will not only be helping to establish critical system usage criteria, but also making sure that the resulting system is germane to the greatest number of freight movers.
>
> Attached is a link to a short survey (25 questions) which should take about 5 to 10 minutes to complete. In addition, there is a link to a short presentation, which goes into more detail about the project. We are also soliciting input from the various trucking association members along the corridor and will merge the results to tweak and define the design of the system. I thank you in advance for your help, as this input is vitally important to proper design and function. This survey will only be open until November 7 so that we may complete our work by the end of the year."

4.2. User Surveys

The follow up action by the research team lead to a response rate of over 60% of the participants. The same survey was sent to a group of government agency employees and the second group was comprised of state trucking associations. The focus was to capture the responses from both the public and private sectors. This assured the research team that we were getting a good distribution of answers from sectors. The following tables contain the questions and responses from each sector. In some questions there were considerable differences in opinion.

Table 1 Survey Responses – Questions 1-3

What information do you consider necessary to operate trucks safer and with higher efficiency on I-81? (check all that apply)		
Answer Options	Trucker Response Percent	Agency Response Percent
a. Specific I-81 weather information	47.8%	77.5%
b. Truckers interested in secure parking along I-81	52.2%	42.5%
c. Truckers interested in safe parking along I-81	78.3%	55.0%
d. Current travel speeds on I-81	26.1%	70.0%
e. Current congestion locations on I-81	65.2%	92.5%
f. Notification of alternate routes that may be available to route around congestion and incidents	69.6%	75.0%
g. Truck parking availability in the vicinity of I-81	82.6%	65.0%
h. Predictive arrivals at destination based on network constraints	13.0%	37.5%
Do you believe that a common, national and interoperable information system like Corridor Freight Information System (CFIS) as described in the presentation would provide the following key benefits to trucking operations on I-81? (check all that apply)		
Answer Options	Trucker Response Percent	Agency Response Percent
a. Improved Operating efficiencies	73.7%	83.9%
b. Driver retention	31.6%	12.9%
c. Safer operation	84.2%	87.1%
d. Better information on truck parking, rest stops, and planned highway construction	78.9%	83.9%
e. High Return on Investment	10.5%	32.3%
Which one of the items below do you consider the number one benefit? (choose one answer)		
Answer Options	Trucker Response Percent	Agency Response Percent
a. Improved Operating efficiencies	11.8%	29.0%
b. Driver retention	17.6%	0.0%
c. Safer operation	35.3%	48.4%
d. Better information on truck parking, rest stops, and planned highway construction	35.3%	22.6%
e. High Return on Investment	0.0%	0.0%

Table 2 Survey Responses – Questions 4-6

What truck parking information should be available to truck operators operating on I-81? (check all that apply)		
Answer Options	Trucker Response Percent	Agency Response Percent
a. Location of nearby truck stops and rest areas	70.6%	90.0%
b. Location of alternative truck parking locations	82.4%	86.7%
c. Real time information on parking space availability, available amenities, or resources at the truck facilities	82.4%	96.7%
d. Provide information to the driver just before they enter the rest area or truck stop with the number of spaces occupied and the number of space available	41.2%	66.7%
e. Provide reservations	11.8%	36.7%
f. Provide a forecast of space availability, based on historical information	58.8%	43.3%
What information do you consider the most important to provide truck operators as it relates to providing a safer operational trip over I-81? (check one answer)		
Answer Options	Trucker Response Percent	Agency Response Percent
a. Real Time Truck Parking Information	29.4%	26.7%
b. Congestion Information	64.7%	50.0%
c. Weather Information	5.9%	13.3%
d. Other	0.0%	10.0%
What information available in CFIS do you consider the most important to provide truck operators as it relates to improving efficiency on I-81? (check one answer)		
Answer Options	Trucker Response Percent	Agency Response Percent
a. Current travel speeds on I-81	5.9%	13.8%
b. Real time congestion or traffic jam locations on I-81	41.2%	55.2%
c. Notification of alternate routes that may be available to route around congestion and incidents	41.2%	27.6%
d. Predictive arrivals at destination based on network constraints	5.9%	3.4%
e. Other?	5.9%	0.0%

Table 3 Survey Responses - Questions 7-10

How would you envision CFIS working within a trucking company operations? (check all that apply)		
Answer Options	Trucker Response Percent	Agency Response Percent
a. Website available for a mobile or desktop computer	58.8%	56.7%
b. Integration with current on board devices tied to a trucking organizations information systems	82.4%	76.7%
c. Standalone smartphone application	35.3%	46.7%
d. Standalone tablet/telematics devise application	17.6%	30.0%
What are some of the barriers to the implementation of CFIS system? (check all that apply)		
Answer Options	Trucker Response Percent	Agency Response Percent
a. Carrier return on investment	75.0%	53.3%
b. User training	50.0%	43.3%
c. User adoption	43.8%	56.7%
d. Acquisition of data	25.0%	56.7%
e. Integration of systems	50.0%	63.3%
How should information be disseminated to truck operators on I-81? (check all that apply)		
Answer Options	Trucker Response Percent	Agency Response Percent
a. Variable message signs	73.3%	62.1%
b. CB Radio	20.0%	51.7%
c. Smartphone access through cellular network	66.7%	62.1%
d. Traveler Information Radio	46.7%	44.8%
e. Cell phones to access 511 Trucker Information	46.7%	44.8%
f. On-board computers	53.3%	79.3%
Should a system similar to CFIS be considered as part of new programs eligible under federal funding to promote safety and efficiency for Commercial Vehicle Operators?		
Answer Options	Trucker Response Percent	Agency Response Percent
a. Yes	87.5%	89.7%
b. No	12.5%	10.3%

Table 4 Survey Responses – Questions 11 15

How would an organization justify the investment in the use of CFIS? (check all that apply)		
Answer Options	Trucker Response Percent	Agency Response Percent
a. Return on Investment	46.7%	50.0%
b. Safety improvements	93.3%	85.7%
c. Efficiency improvements	80.0%	82.1%
d. Jason's Law funding from MAP-21	13.3%	28.6%
How might CFIS be implemented and funded within the I-81 operating community? (check all that apply)		
Answer Options	Trucker Response Percent	Agency Response Percent
a. USDOT Grant Funding	87.5%	85.7%
b. Private Funding	43.8%	75.0%
c. State Funding	62.5%	64.3%
What historical information should be stored in CFIS to promote future planning for truck operations on I-81? (check all that apply)		
Answer Options	Trucker Response Percent	Agency Response Percent
a. Historical truck parking activities on I-81 that includes both public and private parking availability	93.8%	76.7%
b. Historical congestion bottlenecks or traffic jam activity on I-81	50.0%	93.3%
c. Historical travel times for trucks on I-81	81.3%	76.7%
d. Other information not shown can be typed in the chat box and identified as with question number	6.3%	3.3%
Are you aware of any systems similar to CFIS existing today?		
Answer Options	Trucker Response Percent	Agency Response Percent
a. Yes	6.3%	16.7%
b. No	93.8%	83.3%
Do truck drivers currently access and use the existing 511 information systems deployed by each state on the corridor? (choose one answer)		
Answer Options	Trucker Response Percent	Agency Response Percent
a. Yes, frequently (please elaborate in chat box)	0.0%	3.4%
b. Yes, occasionally (please elaborate in chat box)	25.0%	13.8%
c. No	18.8%	6.9%
d. Do not know	56.3%	75.9%

Table 5 Survey Responses – Questions 16-17

If truck drivers do not frequently access and use existing 511 information systems, do you know why? (please choose all applicable answers)		
Answer Options	Trucker Response Percent	Agency Response Percent
a. Information is inaccurate	6.7%	5.3%
b. Information is too vague	33.3%	21.1%
c. Information covers too large an area	20.0%	10.5%
d. Information is old or too perishable	13.3%	15.8%
e. System is cumbersome to use	40.0%	52.6%
f. Drivers are not permitted to use phones while driving	66.7%	47.4%
g. Drivers have to access different systems in each state	33.3%	26.3%
h. Other	0.0%	15.8%
What features would be useful in order to make CFIS useful and valuable to truck drivers on I-81? (check all that apply)		
Answer Options	Trucker Response Percent	Agency Response Percent
a. Ability to customize information delivery for current or planned trips	50.0%	77.8%
b. Ability to customize information delivery per personal preferences	28.6%	44.4%
c. Ability to provide duplicate information to dispatcher	64.3%	63.0%
d. Ability to provide information regarding risk of not completing scheduled run	64.3%	22.2%
e. Ability to access safely via smartphone	64.3%	63.0%
f. Ability to access via web browser	21.4%	37.0%
g. Ability to "push" information based on user-defined criteria	35.7%	51.9%
h. Other	0.0%	3.7%

Table 6 Survey Responses – Questions 18 -19

How likely is accurate, timely information about available truck parking spaces to reduce the occurrence of trucks being parked in illegal or unsanctioned locations on I-81? (check one answer)		
Answer Options	Trucker Response Percent	Agency Response Percent
a. Likely to significantly reduce parking in illegal/unsanctioned locations	40.0%	22.2%
b. Likely to somewhat reduce parking in illegal/unsanctioned locations	46.7%	48.1%
c. Unlikely to reduce parking in illegal/unsanctioned locations	6.7%	18.5%
d. Don't know	6.7%	11.1%
How likely is accurate, timely information about current delays and congestion to affect truck driver choices regarding routing and/or departure times for trips on I-81? (check one answer)		
Answer Options	Trucker Response Percent	Agency Response Percent
a. Likely to significantly affect driver choices	46.7%	32.1%
b. Likely to somewhat affect driver choices	46.7%	50.0%
c. Unlikely to affect driver choices	0.0%	7.1%
d. Don't know	6.7%	10.7%

4.3. User Requirements

Table 7 Top 30 User Requirements Identified by I-81 Users

Number	Description of User Requirement From Survey Results	Trucker	Agency	System
1	CFIS must support a safer operation for truck operations on I-81	X	X	
2	CFIS must provide real-time weather information on the I-81 corridor.	X		
3	CFIS must provide information on truck parking, rest stops, and planned highway construction	X	X	
4	CFIS must provide real time information on parking space availability, available amenities, and resources at the truck stop in order to make a reservation	X	X	
5	CFIS must provide information on secure and alternate truck parking locations	X		
6	CFIS must provide accurate, timely information about current delays and congestion to affect truck driver choices regarding routing and/or departure times for trips.	X	X	
7	CFIS must provide notification of alternate routes that may be available to route around congestion and incidents	X	X	
8	CFIS must provide a return on investment for carriers	X		
9	CFIS system must facilitate the integration of data from multiple sources into one or more cohesive, reusable datasets		X	X
10	CFIS must disseminate information to truck operators through variable message signs			
11	CFIS should be considered a new program eligible for federal funding.	X	X	
12	CFIS must include the capability to store historical truck parking activities on I-81 that would include both public and private parking availability with amenities.	X		
13	CFIS must capture the data associated with traffic jams for truck on I-81 for future analysis.		X	
14	CFIS must provide the ability to disseminate information regarding risk of not completing a scheduled run.	X		
15	CFIS must provide the ability to receive data from external systems.			X
16	CFIS must provide the ability to efficiently and effectively exchange data between external systems and users in an expeditious manner.			X

Number	Description of User Requirement From Survey Results	Trucker	Agency	System
17	CFIS applications must be provided the ability to interact in such a manner that allows for timely, efficient, well-informed decisions.			X
18	CFIS must provide protection against unauthorized access to and use of data.			
19	CFIS must allow a vehicle operator to interact with it in a safe manner during vehicle operation.	X		X
20	CFIS must be consistent with the ITS National Architecture and associated standards.			X
21	CFIS must include information capture and processing functionality that meets specific CMV operation's needs (e.g., truck parking)			X
22	CFIS must provide applications data in sufficient time to support decision making it essential that data be captured, processed and communicated quickly enough to allow for timely decisions about routes, parking availability, and other critical data needs.			X
23	CFIS must be provide information regarding risk of not completing a scheduled trip.	X		
24	CFIS must provide accurate, timely information about available truck parking spaces to reduce the occurrence of truck being parked in illegal or unsanctioned locations.	X		
25	CFIS must be able to customize information for shipment delivery for current or planned trips	X		
26	CFIS must be able to provide historical truck travel times on I-81.	X	X	
27	CFIS must support an improvement in efficiency in the trucking industry.	X		
28	CFIS must provide Website available for desktop and mobile computers.	X	X	
29	CFIS implementation must support user training	X		
30	CFIS must provide the location of nearby truck stops and rest stops.			

5. PROPOSED CONCEPT

5.1. Proposed Concept and Scope

This section of the planned concept of operations (ConOps) provides an overview of the desired future state for the Corridor Freight Operations System. A ConOps provides a picture of how a proposed system will function, and what is function will accomplish. It provides a starting point for the creation of the future state of integrating many different available applications and data sources to create a future state based upon stakeholder user needs.

There are three major components used to characterize the future state of CFIS. The vision addresses how the corridor will operate after implementation of the Corridor Freight Information System. The goals provide direction to achieve the vision. The objectives and performance measures identify the changes that are expected to occur and the means by which success can be measured.

A ConOps provides a picture of how a proposed system or as in the case of CFIS a collection of systems will function, and what its function will accomplish. A good ConOps describes the relationships that must exist to bring about the end product to reach the goals of the system.

The scope of the CFIS is to capture data, formulate information that will be used in applications for decision making, and disseminate the output to the user. CFIS will be a decision support system to facilitate travel information about conditions (i.e. weather, congestion, etc.), truck parking information on availability and requested reservations. The planned approach for CFIS will include the following:

- Leverage existing data streams between existing public and private sector systems to create a collaborative systems environment. This approach will minimize the need to build a system from the ground up. This approach will help keep costs low and provide for a higher rate of return on the investment.
- Provide the ability to delivery CFIS on multiple types of devices in order to incentivize the adoption and use of the system.
- Integrate the planned technologies with public sector ITS and sensor information systems that are available in current highway system.

5.2. Operational Policies and Constraints

This section presents draft policies and constraints for consideration with respect to the development and use of CFIS. The main purpose of this section is to identify the risk associated with the development and testing of CFIS prototype application. The IEEE 1362 standard defines "operational policies" as predetermined management decisions regarding the operations of the proposed system. The following is a list of operational polices and constraints that will be initialized to support the testing of a CFIS prototype.

5.2.1. Operational Polices

- The CFIS system shall test the technical viability of 24/7 operations. This level of testing will require system monitoring by potential users to validate the capability.
- The CFIS system shall use existing on-board devices and smartphones to demonstrate economies of scale.
- The CFIS system shall be deployed and tested on the I-81 Corridor.
- The USDOT v2X Program – SAE SSSTD J2735, IEEE Standard 1609 and IEEE Standard 802.11p.
- The CFIS system will present information to users so that users have access to data but are not able to modify data captured by the CFIS system.
- The CFIS system will comply with federal and state data protection laws.
- The CFIS system will comply with driver distraction laws and provide a "lockout mode" for all in-cab devices. The only action that a drive will be able to take with the device is a "one click" action while the vehicle is in motion.

5.2.2. Constraints

The following are the key operational constraints for CFIS deployment and operations:

- The deployment and testing of CFIS must ensure that not component or method deployed within the CFIS framework will result in unsafe operation of a commercial motor vehicle by distracting the driver.
- The deployment and testing of CFIS must ensure that data is secure and protected using the appropriate encryption tools and standard to meet legal and business requirements.
- The deployment and testing of CFIS will require the integration of both public and private data which will require the cooperation of both public and private sector partners.

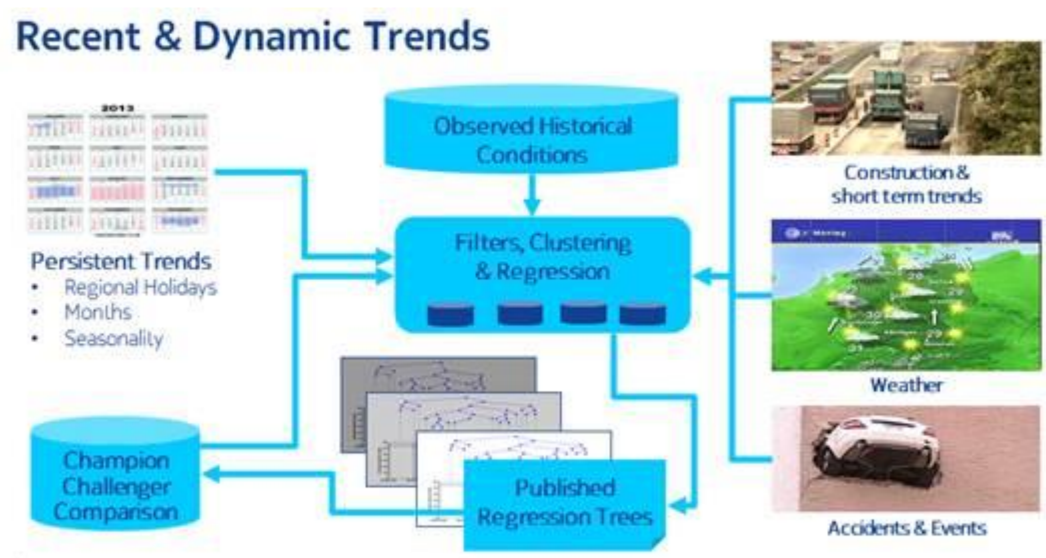
5.3. Operational Environment and Major System Services

5.3.1. HERE Predictive Traffic

HERE's Predictive Traffic Learning Platform is useful for route planning and operations and planning personnel to understand the dynamics of the network. HERE has provided predictive travel times in the real-time feed for over seven years. HERE has built The Learning Platform (TLP), an engine designed to analyze vast amounts of data to decipher key influencers that the best predict future traffic conditions. TLP provides us a smarter way to dissect our traffic data, so that we can better understand why traffic is behaving in a particular way. It provides us the capabilities to distinguish among the various influences that may affect traffic, identify which of those influencers are relevant at the current time and provide a prediction that takes into account those forces that are currently acting on traffic and ignoring those influencers that are not. The base predictive engine analyzes the current traffic in comparison with the historical averages for the time of day and day of the week. The enhanced model considers other influencers such as persistent trends (seasons, holidays, and months), recent trends (construction), and dynamic trends (weather).

HERE Traffic services provide current traffic flow conditions with speed values, as well as historical speed patterns for improved ETAs and more efficient planned routes. Incident data such as accidents, stalled vehicles and road construction enhances the local knowledge while providing additional insights into current road conditions.

The figure below describes the recent and dynamic trends that influence the predictive model.



5.3.2. TSPS Truck Parking System

TSPS has created and built the first proven and scaled Real-time Parking Information Service. The service has been running along 130 miles of I-94 in southwest Michigan for over a year. Truck drivers can proactively plan their routes and make safer, smarter parking decisions by using the real-time truck parking availability information that TSPS makes available to truck drivers and the industry through patented methodologies.

TSPS works directly with the parking operator to deploy sensing equipment that connects to the TSPS Centralized Infrastructure Network to collect data about entries and exits. This data is aggregated and consolidated with 3rd party information within the TSPS Software Platform. It is then distributed through the TSPS website, smartphone applications, and third party applications and data services via an application programming interface.

The following are capabilities that the CFIS Truck Parking System will support:

Problem: Truck Driver wants to find a truck stop with showers and hot food along his route through Pennsylvania.

Capability: Truckers often travel different routes over long distances. Some truckers are very familiar with specific routes that they travel often, but they may not know about the services at all truck stops along the route. Others often drive different routes, and have less knowledge about any one specific area. In order to plan routes effectively, and know where he can obtain needed services, the trucker needs an effective, user-friendly resource that can provide clear information on which truck stops along a given route and have the services he is looking for.

CFIS will provide information about truck stop facilities available at specific points/locations along the highway system. To support truck drivers in understanding what facilities exist along their route, the TSPS information service will provide CFIS access to a database of truck stop attribute information. All APIs are designed to allow CFIS create interfaces to search and deliver information efficiently to the truckers.

Problem: A trucker does not know how much parking is available at a truck stop, so he or she could arrive at a location and find it too full to park.

CFIS Capability: A trucker does not know how much parking is available at a truck stop, so he or she could arrive at a location and find it too full to park. Truckers are generally unable to determine whether a given truck stop parking lot has available parking along the route that they are traveling. They only learn of available space at a particular stop when they arrive. If the stop is full, then they must find parking at a different location. This is a major problem for truckers nearing the end of their hours of service. Truck stops themselves are often grouped together, spaced many miles apart. A trucker arriving at a set of truck stops that are full at the end of her hours of service faces a choice: park nearby illegally or continue on and try the next truck stop down the road, all while battling driver fatigue and the stress of exceeding their hours of service limitations – often at the risk of her job. None of these are attractive options from a public or private perspective. The trucker becomes a hazard to other drivers if they drive while fatigued, and there is no guarantee that the driver will find parking will at the stops ahead. If there was a way in which truckers could obtain advance information on availability, they would be able to make better decisions on where to stop, and understand how far they would need to go.

There is a need to provide accurate and timely information about parking availability at truck stops along the expected route. To provide truck drivers information on truck parking availability, TSPS will install sensing systems, at participating truck stops. This information will be collected by TSPS and made available to CFIS to broadcast to the truckers. The information will inform truck drivers of the real-time parking utilization levels of truck stops along their route. Truckers can then make decisions on where they should park based on the locations that have available parking.

Problem: A trucker may need to stop at a certain truck stop, but will not arrive in time before that stop becomes too full to park.

CFIS Capability: Truck drivers are often in situations in which they need to park at a certain location because of limited times for receiving at their destination. For example, although a trucker may be traveling toward a destination that he could reach at 10:00 PM, the destination only takes shipments during regular business hours. At the same time, the available parking locations near that destination can become quite congested with other truckers parking at the same location for similar reasons. Some truckers with a need to park at a particular location may arrive there after the available parking becomes completely full.

To help truckers with destination-specific needs secure parking in advance, the TSPS information service will provide the ability to make reservations for parking spaces at selected truck stops. The system will allow truck drivers to know in advance where they will park to meet their shipping obligations.

Problem: A trucker plans on being at a truck stop with real-time parking availability in about 4 hours. He would like to know what the parking availability at the truck stop is forecasted to be when he is expected to arrive at the truck stop several hours in the future.

CFIS Capability: Truckers see the value in knowing what the parking availability is in real-time as this offers good information on what the current circumstances are with respect to parking congestion at key truck stops. However, combine this with the ability to see where parking is likely to be available several hours into the future, and the trucker has better information with which to make routing decisions.

To provide truck drivers with information on where truck parking will be available at a future point in time, the TSPS platform will generate a forecast model of parking availability that is timely and accurate. This information will be built empirically from a historical record of accurate real-time parking availability data derived from the installed sensing systems at participating truck stops. The information would inform truck drivers of the expected parking utilization levels at the truck stops at various hours in the future. Truckers could then make decisions on where they think they should park based on the locations that are forecasted to have available parking.

Problem: A trucker needs to find parking in a secure facility due to the high value of his load.

CFIS Capability: Trucking companies often require that loads that are frequent targets of theft be parked in a secure facility. These facilities are typically fenced with active and passive systems in place to ensure a safe place to park. There is a fee to park and reservations are generally required.

The system has information on the location of secure parking facilities. Because there are only a small number of these, truckers need to know their location, how long it will take to arrive, and whether a reservation is required, all of which is available in the TSPS platform.

Truck parking availability information will be captured using sensors at both public and private truck parking facilities. Truck parking availability data will be transmitted to the CFIS, and conversely CFIS, will share information through an API between the CFIS software and the TSPS Real-time Parking Availability Service.

The general overview for collecting truck parking availability data is by counting trucks entering and leaving the truck parking facilities. Video images will be used to verify the accuracy of the data. TSPS will verify the data provided at the truck stops and provide recalibration as needed to provide accurate information.

TSPS will be responsible for disseminating the TSPS truck parking availability information to the different DOTs if they want to display parking information via dedicated truck parking information signs along the I-81 corridor. The DOTs will require specific message formats and protocols for DSRC communications.

TSPS will provide en-route truck parking information via a smart phone application with Interactive Voice Recognition (IVR) capabilities. TSPS will also provide information over their Smart Truck Parking website and value-added services, such as parking reservations, as part of their system.

The TSPS Real-time Parking Information Service is made up of two components, Software Platform and the Infrastructure Network. Together they are responsible for three primary functions:

- The collection of truck parking availability data at public and private truck stops through the TSPS Infrastructure Network. This network is made up of traffic-sensing equipment and cameras, which are installed at targeted sites, collecting information about entries, and exists.
- The aggregation of that data is processed within TSPS Software Platform, where proprietary source code manipulates the counting events into accurate availability information. Consolidators add third-party data relevant to truckers, such as routing information, and more proprietary source code analyzes the data to produce value added services to the truckers. It will combine the data from CFIS to produce real-time and predictive parking information.
- The dissemination of truck parking availability information is enabled through standardized APIs.

The recent Michigan project where TSPS has deployed their Truck Parking System has produced a Benefit-Cost Analysis that shows that for every dollar spent on the TSPS service, there will be a three to five dollar return on the investment from benefits in the following:

- Benefit from reduction in crashes related to commercial driver fatigue;
- Benefit from travel time savings to reduced number of crashes;
- Benefit from travel time savings for commercial drivers; and,
- Benefit from reduced CO2 and other emissions.

5.3.3. Predictive Real Time Weather Information System for the Freight Traveler

A road weather connected vehicle application for freight shippers must accommodate the different information needs of the truck driver. These needs include the ability for the trucking community to make decisions on a variety of other factors, such as highway and bridge restrictions, hours-of-service limitations, parking availability, delivery schedules, and permits the vehicle holds, it is envisioned that the motor carrier firms or their commercial service providers will develop and operate the systems that use the road weather information generated through this concept.

A road weather connected vehicle application would push roadway link-specific information to users' in-vehicle equipment or personal wireless devices. The freight traveler on I-81 would receive road weather alerts and warnings within a short time horizon of adverse conditions being detected by mobile data sources within the I-81 corridor. These conditions may include precipitation types and rates, road surface slickness, and low visibility. Real-time mobile source data would also be combined and processed with forecast information and data from other fixed and remote sensors to provide medium to longer-term alerts and warnings to users. There would be a requirement to integrate the state Road Weather Information System (RWIS) to provide weather alerts and warnings through various onboard or off-board devices to deliver routing and other traveler information services to the freight traveler.

The following are the functional requirements that must be supported by Predictive Real Time Weather Information System:

- CFIS shall allow users to obtain weather conditions for the covered region within ear real-time
- CFIS shall provide temperature for the covered region within near real-time
- CFIS shall provide sky conditions for the covered region within near real-time
- CFIS shall provide precipitation information for the covered region within near real-time
- CFIS shall provide near real-time fog information for the covered region within near real-time
- CFIS shall provide weather-related pavement conditions for the covered region within near real-time
- CFIS shall allow users to obtain weather-related information along the trip path within near real-time for the expected duration of the trip

- CFIS shall provide predicted temperatures along the trip path within near real-time for the expected duration of the trip
- CFIS shall provide predicted sky conditions along the trip path within near real-time for the expected duration of the trip
- CFIS shall provide predicted precipitation along the trip path within near real-time for the expected duration of the trip
- CFIS shall provide predicted fog along the trip path within near real-time for the expected duration of the trip
- CFIS shall provide predicted weather-related pavement conditions along the trip path within near real-time for the expected duration of the trip

5.3.4. Alternative Route Guidance for the Congestion and Incident Avoidance

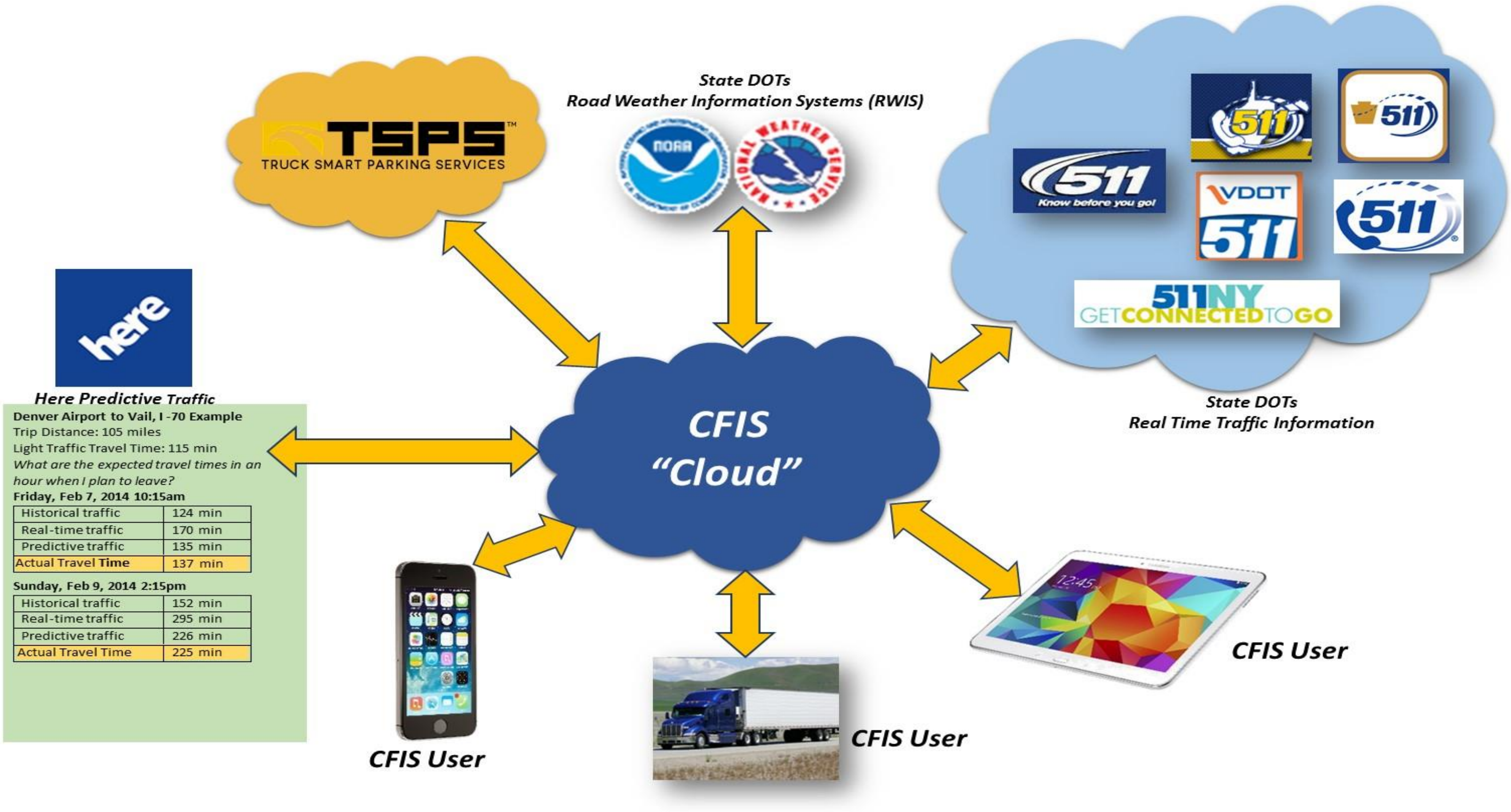
The CFIS system must be able to provide a truck-specific GPS navigation solution that takes into account truck-restricted and prohibited roads to provide driver's safe and reliable navigation around congestion and accidents on roads that are safe for the truck to maneuver. The truck driver will be required to enter the truck’s dimensions that include height, length, width and weight per axel weight. The system shall calculate the optimal route that is both safe and legal, to avoid delays and damage to the truck or trailer.

The following are the functional requirements that the CFIS Alternative Route Guidance must support for the freight traveler:

- CFIS shall notify a user when the current/planned route for a regional truck trip is estimated to coincide with newly discovered or predicted congestion
- CFIS shall provide a notification when the current/planned route for a truck trip is estimated to coincide with newly discovered or predicted congestion
- CFIS shall provide a truck approved alternate route when the current/planned route for a truck trip is estimated to coincide with newly discovered or predicted congestion
- CFIS shall allow users to obtain real-time information for I 81 and related major freight arterials within the covered region and along its borders
- CFIS shall use real-time travel volumes for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region
- CFIS shall use real-time average speeds for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region
- CFIS shall use real-time point-to-point travel time predictive information for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region
- CFIS shall use real-time incident information for incidents on freeways, port and terminal intermodal connectors, and major freight arterials within the covered region

- CFS shall use real-time estimated clearance time for congestion caused by incidents on freeways, port and terminal intermodal connectors, and major freight arterials within the covered region
- CFIS shall use construction information for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region
- CFIS shall use extended arterial outage information for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region
- CFIS shall provide special event traffic information for freeways, port and terminal intermodal connectors, and major freight arterials within the covered region.

5.4. Interfaces to External Systems and Subsystems – I 81 CFIS



6. OPERATIONAL SCENARIOS

This section presents ten scenarios that provide the step by step actions associated with the deployment of Corridor Freight Information System (CFIS) that could significatly improve trucking and freight operations on I-81. The details of the scenarios require the user to make three main actions in order for the application to produce the desired results. The actions will be designed that only required the touching of one button to produce the required results by the truck driver. This design is in compliance with the FMCSA Mobile Phone Restrictions dated May 2012.

6.1. Scenario 1

Scenario 1: ***A trucker has just crossed into the US from Canada and is heading south with a load of Canadian Club whiskey. He has up to six hours of driving time available on this shift. Because of the high value of his load and its attraction to thieves, his employer requires that he park in a secure facility. A trucker needs to find parking in a secure facility due to the high value of his load.***

Use Case Actions, Capability, Data Sources Required, and Outputs to support Scenario User Requirements

Step	Action by User	CFIS Portal Capability	Data Sources Required	Output	User Requirements Supported from Table 7
A	Truck Driver activates a CFIS application in truck before departure that will use the GPS to determine truck location.	CFIS Location Detection Capability using GPS	I-81 GPS Map Data Base	Location of Truck shown on screen	No. 1 No. 2 No. 4 No. 5 No. 9 No. 14 No. 15 No. 16 No. 19 No. 22 No. 27
B	One-Click Action by Truck Driver to activate a query of the CFIS TSPS Truck Parking Data Base to determine available secure truck parking slots in route.	CFIS Location Detection Capability using GPS CFIS Query of TSPS Truck Parking Database with Secure parking locations identified to determine best option to choose for a secure parking location CFIS HERE Predictive Traffic determines route and travel time to location	I-81 GPS Map CFIS TSPS Truck Parking Database with secure parking locations identified. CFIS HERE Truck Predictive Traffic API	Secure Truck Parking Availability and driving time shown to driver for selecting the best option for driver to make reservation.	
C	One Click Action by Truck Driver makes selection of secure parking location.	CFIS provides driver a map display, driving directions, and predictive arrival time	I-81 GPS Map CFIS TSPS Truck Parking Database with secure locations identified. CFIS HERE Predictive Traffic API	Map display, driving directions, number of secure available parking spots, and predictive arrival time	

6.2. Scenario 2

Scenario 2: ***A truck driver with a load of electrical transformers has crossed the border from Canada on I-81 and is heading south for a delivery in Knoxville, TN. He is one hour away from his drive time limit, and needs to find parking, but has not driven this route before and has no idea where he might find parking one hour away. Provide accurate and timely information about parking availability at truck stops along the expected route.***

Use Case Actions, Capability, Data Sources Required, and Outputs to support Scenario User Requirements

Step	Action by User	CFIS Portal Capability	Data Sources Required	Output	User Requirements Supported from Table 7
A	Truck Driver activates a CFIS application in truck before departure that will use the GPS to determine truck location.	CFIS Location Detection Capability using GPS	I-81 GPS Map Data Base	Location of Truck shown on screen	No. 1 No. 4 No. 5 No. 9 No. 14 No. 15 No. 16 No. 17 No. 19 No. 22 No. 27
B	One-Click Action by Truck Driver to activate a query of the CFIS TSPS Truck Parking Data Base to determine available truck parking slots in route.	CFIS Location Detection Capability using GPS CFIS Query of TSPS Truck Parking Database using location to determine best option to choose. CFIS HERE Truck Predictive Travel determines route and travel time to location	I-81 GPS Map CFIS TSPS Truck Parking Database CFIS HERE Predictive Traffic API	Truck Parking Availability and driving time shown to driver for selecting the best option for driver to make reservation.	
C	One Click Action by Truck Driver makes selection of parking from availability.	CFIS provides driver a map display, driving directions, and predictive arrival time	I-81 GPS Map CFIS TSPS Truck Parking Database CFIS HERE Truck Predictive Travel Data Base	Map display, driving directions, number of available parking spots, and predictive arrival time	

6.3. Scenario 3

Scenario 3: ***Driver leaves carrier terminal in Harrisburg, PA headed south to Memphis, TN. Driver notices that the sky is very dark ahead on the trip and wants to make sure weather will not affect the trip. Driver also wants to know that if he must delay where the closest parking location to take rest and avoid the weather.***

Use Case Actions, Capability, Data Sources Required, and Outputs to support Scenario User Requirements

Step	Action by User	CFIS Portal Capability	Data Sources Required	Output	User Requirements Supported from Table 7
A	Truck Driver activates a CFIS application in truck before departure that will use the GPS to determine truck location.	CFIS Location Detection Capability using GPS	I-81 GPS Map Data Base	Location of Truck shown on screen	No. 1 No. 2 No. 4 No. 9 No. 15 No. 16 No. 19 No. 22 No. 27
B	One-Click Action by Truck Driver to activate a query of the CFIS TSPS Truck Parking Data Base to determine available secure truck parking slots in route.	CFIS Location Detection Capability using GPS CFIS Query of Real Time Predictive Weather using API to State DOT RWIS CFIS Query of TSPS Truck Parking Database using location to determine best option to choose	I-81 GPS Map State DOT RWIS TSPS Truck Parking availability	Current and Predicted Weather for current location and forecasted weather on the route.	
C	One Click Action by Truck Driver from menu of weather information choices (temperature, precipitation forecast, pavement conditions, etc.)	CFIS provides driver a map display with weather information displayed based on selection.	I-81 GPS Map State DOT RWIS	Map display with weather information displayed based on selection Location of available truck parking.	

6.4. Scenario 4

Scenario 4: ***A truck loaded with electrical transformers has crossed into the US from Canada is heading down I-81 to Knoxville. The driver has four more hours to drive before he needs to stop to comply with his hours of service. This will mean that he will be stopping at 10:00 pm, and he is concerned that his target truck stop will be too crowded to allow him to park and he would like to make a reservation for a guaranteed spot. Reserve parking space at specified truck stop for a planned time of arrival.***					
Use Case Actions, Capability, Data Sources Required, and Outputs to support Scenario User Requirements					
Step	**Action by User**	**CFIS Portal Capability**	**Data Sources Required**	**Output**	**User Requirements Supported from Table 7**
A	Truck Driver activates a CFIS application in truck before departure that will use the GPS to determine truck location.	CFIS Location Detection Capability using GPS	I-81 GPS Map Data Base	Location of Truck shown on screen	No. 1 No. 2 No. 4 No. 5 No. 9 No. 14 No. 15 No. 16 No. 19 No. 22 No. 27
B	One-Click Action by Truck Driver to activate a query of the CFIS TSPS Truck Parking Data Base to determine available truck parking slots in route.	CFIS Location Detection Capability using GPS CFIS Query of TSPS Truck Parking Database using location to determine best option to choose. CFIS TSPS Truck Parking Reservation Application recommends reservation CFIS HERE Truck Predictive Travel determines route and travel time to location	I-81 GPS Map CFIS TSPS Truck Stop Amenities Database CFIS HERE Truck Predictive Traffic API	Truck Parking Availability shown to driver Summary of Travel Time with alternative options to choose	
C	One Click Action by Truck Driver makes selection of reservation	CFIS provides driver a map display, driving directions, and predictive arrival time	I-81 GPS Map CFIS TSPS Truck Parking Database CFIS HERE Truck Predictive Travel Data Base	Map Display, driving directions, reservation number, slot number, and predictive arrival time.	

6.5. Scenario 5

Scenario 5: *Driver stops for fuel south of Winchester, VA. Once he returns to I-81 going south he is notified by highway message sign that there is a major accident that will delay or the trip by 3 hours. Driver has to make a decision either to park and rest or choose an alternate route.*					
Use Case Actions, Capability, Data Sources Required, and Outputs to support Scenario User Requirements					
Step	**Action by User**	**CFIS Portal Capability**	**Data Sources Required**	**Output**	**User Requirements Supported from Table 7**
A	Truck Driver activates a CFIS application in truck before departure that will use the GPS to determine truck location.	CFIS Location Detection Capability using GPS	I-81 GPS Map Data Base	Location of Truck shown on screen	No. 1 No. 6 No. 7 No. 9 No. 13 No. 14 No. 15 No. 16 No. 19 No. 22 No. 23 No. 25 No. 27
B	One-Click Action by Truck Driver to activate a query of the from CFIS to State DOT 511 traveler information system	CFIS Location Detection Capability using GPS CFIS Query of State DOT 511 system and use API to query potential accidents and congestion. CFIS Query of TSPS truck parking system to determine available truck parking near the driver's current location. CFIS Query HERE Truck Database to determine legal alternate routes.	I-81 GPS Map State DOT event and congestion system HERE Truck Database to determine legal restrictions – contains detailed information on exact areas or roads where legal restrictions apply. HERE Predictive Traffic	Alternate legal route for trucks Planned arrival time based on HERE Predictive Traffic	
C	One Click Action by Truck Driver from menu of possible legal routes and available parking	CFIS provides driver a map display with alternate routes displayed based on selection with predicted travel times. CFIS presents truck parking locations with amenities.	I-81 GPS Map State DOT 511 Travel Information HERE Truck Data HERE Predictive Traffic TSPS available parking database.	Map display with route and drive time information displayed based on selection Location of available truck parking with driving time to parking location.	

6.6. Scenario 6

Scenario 6: Driver leaves Inland Port at Front Royal to make a delivery in Madison, VA. It is a Saturday afternoon in October and the driver would like to know if there are any planned public events that are going to delay his arrival at the Walmart Store in Madison, VA. If there are any events and there is a possible risk of congestion and delays at the event are the driver a choice of alternate routes and the predicted travel time and arrival time at the store.

Use Case Actions, Capability, Data Sources Required, and Outputs to support Scenario User Requirements

<table>
<tr><th>Step</th><th>Action by User</th><th>CFIS Portal Capability</th><th>Data Sources Required</th><th>Output</th><th>User Requirements Supported from Table 7</th></tr>
<tr><td>A</td><td>Truck Driver activates a CFIS application in truck before departure that will use the GPS to determine truck location.</td><td>CFIS Location Detection Capability using GPS</td><td>I-81 GPS Map Data Base</td><td>Location of Truck shown on screen</td><td rowspan="3">No. 1
No. 6
No. 7
No. 9
No. 13
No. 14
No. 15
No. 16
No. 19
No. 22
No. 23
No. 25
No. 27</td></tr>
<tr><td>B</td><td>One-Click Action by Truck Driver to activate a query of the from CFIS to State DOT 511 traveler information system</td><td>CFIS Location Detection Capability using GPS
CFIS Query of State DOT 511 system and use API to query potential events and congestion.
CFIS Query HERE Truck Database</td><td>I-81 GPS Map
State DOT event and congestion system
HERE Truck Database to determine legal restrictions – contains detailed information on exact areas or roads where legal restrictions apply.
HERE Predictive Traffic</td><td>Alternate legal route for trucks

Planned arrival time based on HERE Predictive Traffic</td></tr>
<tr><td>C</td><td>One Click Action by Truck Driver from menu of possible legal routes</td><td>CFIS provides driver a map display with alternate routes displayed based on selection and predicted travel times.</td><td>I-81 GPS Map
State DOT 511 Travel Information
HERE Truck Data
HERE Predictive Traffic</td><td>Map display with route information displayed based on selection of route.</td></tr>
</table>

6.7. Scenario 7

Scenario 7: *A trucker plans on departing along I-81 at 8am. He would like to know what the parking availability at the truck stop is forecasted to be when he is expected to arrive at the truck stops based on his additional travel time needed.* Truckers see the value in knowing what the parking availability is in real-time as this offers good information on what the current circumstances are with respect to parking congestion at key truck stops. However, combine this with the ability to forecast where the trucker will be, based on additional travel time needed along particular road segments know for congestion. This Buffer Time when combined with the average travel time, generates what is called the planning time index.					
Use Case Actions, Capability, Data Sources Required, and Outputs to support Scenario User Requirements					
Step	**Action by User**	**CFIS Portal Capability**	**Data Sources Required**	**Output**	**User Requirements Supported from Table 7**
A	Truck Driver activates a CFIS application in truck before departure that will use the GPS to determine truck location.	CFIS Location Detection Capability using GPS	I-81 GPS Map Data Base	Location of Truck shown on screen	No. 1 No. 6 No. 9 No. 13 No. 14 No. 15 No. 16 No. 17 No. 19 No. 22 No. 23 No. 25 No. 26 No. 27
B	One-Click Action by Truck Driver to activate a query of TSPS software platform will utilized the CFIS Buffer Time tables described in Appendix V	CFIS Location Detection Capability using GPS CFIS Query of CFIS Buffer Time tables as a data feed as described in Appendix V of this document. CFIS Query of TSPS truck parking system to determine available truck parking near based on CFIS Buffer Time planning methodology. CFIS Query HERE Predictive Traffic to determine drive time	I-81 GPS Map Travel by day of week and time of day as described in Appendix V of this document. HERE Predictive Traffic	Parking location based on CFIS Buffer Time table methodology described in Appendix V Planned arrival time based on HERE Predictive Traffic	
C	One Click Action by Truck Driver from menu of possible legal routes and available parking	CFIS provides driver a map display with alternate routes displayed based on selection with predicted travel times. CFIS presents truck parking locations with amenities.	I-81 GPS Map State DOT 511 Travel Information HERE Predictive Traffic TSPS available parking database.	Map display with route and drive time Location of available truck parking with driving time to parking location.	

6.8. Scenario 8

Scenario 8: *A driver is headed south on his first trip down I-81 with a load of alternators from Canada bound for an auto factory in Georgia. He wants to find a truck stop with showers and hot food along his route through Pennsylvania. Provide information about truck stop facilities available at specific points/locations along the highway system.*					
Use Case Actions, Capability, Data Sources Required, and Outputs to support Scenario User Requirements					
Step	**Action by User**	**CFIS Portal Capability**	**Data Sources Required**	**Output**	**User Requirements Supported from Table 7**
A	Truck Driver activates a CFIS application in truck before departure that will use the GPS to determine truck location.	CFIS Location Detection Capability using GPS	I-81 GPS Map Data Base	Location of Truck shown on screen	No. 1 No. 4 No. 5 No. 9 No. 14 No. 15 No. 16 No. 17 No. 19 No. 22 No. 24 No. 27
B	One-Click action by Truck Driver to activate a query of the CFIS Truck Stop Data Base to locate truck stop amenities in route.	CFIS Location Detection Capability using GPS CFIS Query of TSPS Truck Stop Amenities Database using location to determine best option to choose. CFIS HERE Predictive Traffic	I-81 GPS Map CFIS TSPS Truck Stop Amenities Database CFIS HERE Predictive Traffic API	Truck Stop Amenities • Fuel Prices • Showers • Food Summary of Travel Time with alternative options to choose	
C	One-Click action by Truck Driver makes selection.	CFIS provides driver a map display, driving directions, and predictive arrival time	I-81 GPS Map CFIS TSPS Truck Stop Amenities Database CFIS HERE Predictive Traffic API	Map display, driving directions, and predictive arrival time	

6.9. Scenario 9

Scenario 9: *A trucker plans on being at a truck stop with real-time parking availability in about 4 hours. He would like to know what the parking availability at the truck stop is forecasted to be when he is expected to arrive at the truck stop several hours in the future. Provide accurate and timely forecasts of parking availability at future points in time at truck stops along the expected route.*					
Use Case Actions, Capability, Data Sources Required, and Outputs to support Scenario User Requirements					
Step	**Action by User**	**CFIS Portal Capability**	**Data Sources Required**	**Output**	**User Requirements Supported from Table 7**
A	Truck Driver activates a CFIS application in truck before departure that will use the GPS to determine truck location.	CFIS Location Detection Capability using GPS	I-81 GPS Map Data Base	Location of Truck shown on screen	No. 1 No. 2 No. 4 No. 5 No. 9 No. 14 No. 15 No. 16 No. 19 No. 22 No. 27
B	One-Click Action by Truck Driver to activate a query of the CFIS TSPS Truck Parking Forecast Model to determine available truck parking slots in route.	CFIS Location Detection Capability using GPS CFIS Query of TSPS Truck Forecast Model using current location to review historical information to determine best option to choose. CFIS HERE Truck Predictive Travel determines route and travel time to location	I-81 GPS Map CFIS TSPS Truck Parking Database accessing historical information on parking CFIS TSPS Forecast Model CFIS HERE Truck Predictive Travel Data Base	Expected Truck Parking Availability and driving time shown to driver to inform truck driver of the expected parking utilization levels at the struck stops at various hours in the future.	
C	One Click Action by Truck Driver makes selection based on output of CFIS TSPS Forecast Model of parking availability by day and hour.	CFIS provides driver a map display, driving directions, and predictive arrival time	I-81 GPS Map CFIS TSPS Truck Parking Database CFIS HERE Truck Predictive Travel Data Base	Map display, driving directions, number of available parking spots, and predictive arrival time	

7. SUMMARY OF IMPACTS OF THE PROPOSED SYSTEM

CFIS system implementation will support the delivery of data-rich capabilities for truck routing, truck parking, and road network information access. In particular, CFIS will dramatically improve motor carrier efficiency and highway safety through improved information access, timely information delivery, and enhanced decision-making for motor carrier participants. The purpose of the following subsections is to identify potential operational impacts, organizational impacts, and impacts during development so that affected organizations may begin to prepare for CFIS system deployment.

7.1. Operational Impacts

Through the proposed CFIS enterprise level applications, what are now disparate systems will be integrated, and the quantity and quality of data that can be shared among various systems will be expanded significantly. This includes information exchanges between public and private systems and between private systems (truck parking and other support services).

The most likely operational impacts will manifest in less time spent in traffic, fewer instances of drivers needing to park in unsanctioned areas, and improvements in compliance with hours of service (HOS) regulations.

7.2. Organizational Impacts

Few organizational impacts are expected to result from the implementation of CFIS. Drivers already access and use various platforms to receive information about roadway conditions. If anything, CFIS has the potential to reduce the amount of time dispatch personnel must spend locating, analyzing and forwarding information to drivers.

7.3. Developmental Impacts

This section addresses the impacts the CFIS user community will experience while the system is being developed and deployed. During the prototype development phase there will be a need for continuous user testing and feedback due to the concurrent design and development approach. Demonstrations and test activities will need to be conducted using participating vehicles and user forums. The ITS America and State chapter conferences, I-81 Corridor Conferences, and other forums provide an excellent venue for reaching a representative cross-section of the user communities. The information will be limited to the results of the prototype test but a continuing dialogue with the user communities will be important to ensure that potential issues and concerns are identified.

The actual quantity of data that will be generated through the prototype test may be limited. However, to demonstrate the potential benefits of CFIS and to ensure the ongoing support of the motor carrier community, data integrity and quality performance measurements will need to be collected, analyzed, and disseminated during development. Demonstrating data integrity and quality performance will help build the level of confidence users will need to continue with CFIS once the prototype is completed.

8. Supporting Documents

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

IEEE Std. 1362 – IEEE Guide for Information Technology, System Definition, Concept of Operations (ConOps) Document, 22 Dec 1998 (R2007)

Virginia Truck parking Study, Kimley-Horn for VDOT, July 2015.

Jason's Law Truck Parking Survey Results and Comparative Analysis, FHWA Office of Freight Management and Operations, August 2015.

VII Core System Concept of Operations (ConOps), Prepared for USDOT Research and Innovative Technology Administration, 19 Apr 2011

WSDOT Truck Parking Study – Final Report, Washington State Department of Transportation, December 2005

I-95 Corridor Coalition Truck Parking Initiative, Concept of Operations Version 4.0, FHWA, November 24, 2010

I-95 Corridor Coalition Truck Parking Initiative, System Design Version 1.2, FHWA, November 24, 2010

Draft Concept of Operations, Federal Highway Administration Truck Parking Initiative, Improved Parking Information and Reservations for Truckers, FHWA, January 14, 2011

Federal Highway Administration, Economic Development History of I-81 Corridor in Pennsylvania, http://www.fhwa.dot.gov/planning/economic_development/studies/i81pa.cfm

Federal Highway Administration, Economic Development History of I-81 Corridor in Virginia, http://www.fhwa.dot.gov/planning/economic_development/studies/i81va.cfm

Virginia Commonwealth Transportation Board, Virginia's Long-Range Multimodal Transportation Plan, Corridors of Statewide Significance: Crescent Corridor, http://www.vtrans.org/resources/crescent%20corridor%20(i-81).pdf

Crescent Corridor, "The Crescent Corridor Improving Lives and Livelihoods," October 2009, presentation delivered in Philadelphia, Pennsylvania, http://www.dvrpc.org/freight/pdf/2009-10-CrescentCorridor-Smith.pdf

Norfolk Southern, "One line, infinite possibilities," http://midamericafreight.org/wp-content/uploads/Wilson_RailGovernmentRelationsAndPPP.pdf

Virginia Department of Rail and Public Transportation, Kevin page, "I-81 Rail Corridor Project Update," February 20, 2008, presentation http://www.ctb.virginia.gov/resources/cm_5_ns_i-81_rail_corridor_2-11-08.pdf

Norfolk Southern, Crescent Corridor Brochure, http://www.thefutureneedsus.com/images/uploads/crescent-corridor-brochure_1.pdf

Virginia Department of Transportation, "I-81 Corridor Improvement Study, Freight Diversion and Forecast Report," http://www.virginiadot.org/projects/resources/freight.pdf

New York State Department of Transportation, "The I-81 Corridor Study," July 2013, https://www.dot.ny.gov/i81opportunities/repository/I-81Corridor-Study.pdf

Cambridge Systematics, "Feasibility Plan for Maximum Truck to Rail Diversion in Virginia's I-81 Corridor," April 15, 2010, http://www.drpt.virginia.gov/media/1141/i-81-freight-rail-study-final.pdf

Cambridge Systematics, "Interstate 81 Multistate Corridor Study," 2012, http://www.camsys.com/pubs/Interstate_81_Multimodal_Corridor_Study_FINAL.pdf

CSX, "Practical Steps for Highway to Intermodal Rail Conversion in Your Supply Chain,"

http://csxcanada.shepherddev.com/sites/default/files/pdf/CSXT%20Intermodal%20Six%20Steps%20White%20Paper.pdf

APPENDIX I - LITERATURE REVIEW OF EXISTING TRUCK PARKING AND PLANNING STUDIES BY STATES AND OTHERS ALONG THE CORRIDOR

I-81 Corridor Improvement Study, Freight Diversion and Forecast Report, Appendix to the Tier 1 Environmental Impact Statement

Author: Virginia Department of Transportation

Study Objective

The objectives of the study were to develop a more complete understanding and profile of freight movements in the I-81 corridor; analyze and review the growth of freight movements in the corridor; forecast travel demand for the year 2035; examine the potential for freight diversion to rail in the I-81 corridor if rail improvements occur in Virginia; determine the potential freight diversion that would result if tolls were put on I-81.

How the Study was Conducted

To estimate the diversion potentials the Intermodal Transportation and Inventory Cost Model (ITIC) was used. "This model was developed by the Federal Highway Administration's (FHWA) Office of Policy Studies and the Federal Railroad Administration (FRA). The model is continually refined by a steering group of rail and truck experts under the FHWA. Most of the data required for the model (except for rail variable costs, highway and rail distances between origins and destinations, and drayage distances) are readily attainable. The ITIC model was used by the United States Department of Transportation and others to estimate diversions for various truck size and weight, rail and intermodal scenarios. In this study, the model was run using commodity flows from the Transearch™ database, and rail cost data from the Surface Transportation Board (STB). Assumptions used in the models come from extensive consultation with the FHWA, STB, the Virginia Department of Rail and Public Transportation (DRPT), Norfolk Southern Railroad and others."[3]

The study area is defined as the 325-mile stretch of I-81 in Virginia. At the beginning of the study previous studies were used to gather base year forecasts and the results of earlier studies of diversion and toll impact modeling. Existing data sources and mode choice models were identified.

Two surveys were conducted to collect data from truck drivers, shippers and carriers to analyze truck movement characteristics in the I-81 corridor and to gather more detailed information about the companies in the corridor, including what goods it moved in the I-81 corridor.

Forecasts of 2035 truck movements in the I-81 study were developed using a wide variety of sources including VDOT traffic counts, Regional Economic Models, Inc. (REMI) Economic and Demographic forecasts, 1997 Vehicle Inventory and Use Survey (VIUS), Virginia Statewide Transportation Model, National Transportation Statistics, and the 1998 VDOT Freight Flow

3 Virginia Department of Transportation, "I-81 Corridor Improvement Study, Freight Diversion and Forecast Report," p. ES-1.

Database. The 2035 forecasts were developed using the Truck Trip Analyzer (TTA) developed by Jack Faucett Associates. A variety of economic growth rate forecasts were developed by the REMI model and these were applied to existing traffic counts using the TTA model. The end result is an annual forecast through 2035 for freight movements in the study area measured in commodity tonnages and truck trips.

The freight diversion analysis assumed that diversions to rail would occur for two reasons. The first was the degradation of truck service because of increased congestion or added costs in the form of tolls. The second was improvements in rail infrastructure resulting in improved service speeds and reliability and lower costs from more and improved intermodal service within the confines of Virginia.

The ITIC mode shift model was refined with available data and used to develop truck trip diversion estimates for four rail improvement concepts and one no build concept. The four build concepts are

- Rail Concept 1 – Star Solutions' Proposal – rail improvements from Manassas to Front Royal; 10 percent improvement to rail speeds and two percent improvement to transit time reliability.
- Rail Concept 2 – Piedmont Line Improvements – rail improvements from Danville to Manassas, extensive improvements to Front Royal and the West Virginia Line; One key feature is that it employs the Canadian Pacific (CP) Expressway technology which is an improvement to existing trailer-on-flatcar (TOFC) intermodal service; 25 percent improvement in rail speeds, five percent improvement to transit time reliability, and a 75 percent improvement to load/unload times at intermodal terminals.
- Rail Concept 3 – Norfolk Southern RR Pilot Intermodal Program – modified version of Concept 2 with more investment in improvements; maximum improvement in rail speeds, 7.5 percent improvement in transit time reliability, and a 75 percent improvement in load/unload times at intermodal terminals.
- Rail Concept 4 – Steel Interstate – Rail Solutions advocacy group proposing major upgrade of NS Shenandoah Line, turning it into a dual track, high speed rail line, grade separated from all road crossings, capable of carrying intermodal freight and passenger trains at average speeds of 60 to 80 mph; 10 percent improvement in transit time reliability, 75 percent improvement in load/unload times at terminals.

Study Outcome

The results of the freight to rail diversion analysis were:

- No build would result in 107,200 diverted truck trips, 0.5 percent of all truck trips
- Rail Concept 1 would result in 147,100 diverted truck trips, 0.7 percent of all truck trips
- Rail Concept 2 would result in 606,400 diverted truck trips, 2.9 percent of all truck trips
- Rail Concept 3 would result in 744,800 diverted truck trips, 3.5 percent of all truck trips

- Rail Concept 4 would result in 1,244,500 diverted truck trips, 5.8 percent of all truck trips

Geographic and Economic Assessment of Trucking and Warehousing In South-Central Pennsylvania, Part 1: Economic Assessment and Impacts

Authors: Kurt Fuelhart and Paul Marr, Geography and Earth Science Department, Shippensburg University, June 2006

Study Objective

The purpose of this study was analyze the economic impact of trucking and warehousing on the southern I-81 corridor in south-central Pennsylvania. Franklin and Cumberland Counties, PA form the study region for the analysis.

How the Study was Conducted

The components of the trucking and warehousing industries in the region are detailed in the first section. This included Federal definitions of the industry and a description of how the industry fits into the national economy. Finally the analysis hones in on Franklin and Cumberland Counties in Pennsylvania. The focus is on concentrations of either industry and their share of things like employment in the area.

The second part of the study provides context for the economic impact by describing the socio-economic variables such as population, employment/unemployment, industrial infrastructure, and wages/earnings. This analysis showed that the study area had been hit hard by industrial restructuring that led to a loss of manufacturing jobs and a growth in retail and service jobs. The manufacturing jobs have been replaced in recent years with the development of significant growth in truck transportation and warehousing and storage industries. The two counties in the study area are better off in terms of jobs and wages than Pennsylvania as a whole.

The final section uses Input-Output analysis to quantify the contributions of the trucking and warehousing industries to the region. IMPLAN Pro modeling software and IMPLAN's proprietary 2002 economic data was used. The first step was to determine the base impact of trucking and warehousing in the counties. Next a multiplier analysis was conducted using IMPLAN to determine the effect the trucking and warehousing industries have on other sectors. IMPLAN has two types of multipliers, one much more conservative than the other. Multipliers were developed for twenty industries for output, employment and value added.

Using these multipliers an impact scenario of the total loss of the truck transportation and the warehousing sectors in Franklin and Cumberland Counties was developed. It is assumed that the two-county region will lose, through direct, indirect, and induced effects, all employment in the truck transportation and warehousing & storage sectors. This another way of measuring the value to a region of certain sectors.

Study Outcome

Truck transportation and warehousing and storage combined account for 7.9 percent of regional output, 7.93 percent of regional employment, 8.5 percent of regional employee compensation/proprietary income, and 7.5 percent of total regional value added. Due to indirect and induced effects, the industries combined affect up to 28,000 jobs and about $1.2billion in value added to the region.

Interstate 81 Corridor Improvement Study, Tier 1 Record of Decision, FHWA-VA-EIS-05-04-t1F

Author: Federal Highway Administration, Virginia Division, June 6, 2007

This report summarizes agreement between the Federal Highway Administration and the Virginia Department of Transportation to follow a tiered decision-making process for the I-81 Corridor Improvement Study. This agreement defines the decisions to be made and approvals to be granted at specific milestones of the tiered NEPA process, and defines the study approach and elements to be included in each stage of the tiered analysis.

Preliminary Truck Parking Inventory of the Interstate 81 Corridor: A cataloging of Commercial Truck Stop and Public Rest Areas

Authors: George Pomeroy and Gus Frederick, Shippensburg University for the I-81 Corridor Coalition, December 14, 2012

<u>Study Objective</u>

This report is not so much a study as it is a compilation of an I-81 corridor truck parking inventory. It includes public area and private major chain commercial truck stops. It does not include independent truck stops, park and ride areas, or emergency parking/pull over areas.

<u>How the Study was Conducted</u>

The data was collected in the fall of 2012 using commercial road atlases, Google Earth, truck stop websites and state DOT websites. A section is provided with idea to update the list to include overlooked truck stops.

<u>Study Outcome</u>

Tables were compiled by state for the number of facilities by type and number of parking spaces. A separate table was compiled of major commercial chain truck stops. A fourth table included all public rest areas in the corridor.

Virginia Truck Parking Study

Author: Kimley-Horn, prepared for VDOT, July 2015

Study Objective

The primary purpose of the study was to identify the frequency of trucks parking on ramps near interchanges, rest areas, and welcome centers. The second objective was to determine where parking is needed.

How the Study was Conducted

The study was carried out between September 2013 and June 2014. Stakeholder5s were the major source of data. The first step was the stakeholders identifying areas of parking challenges in Virginia. Each of the stakeholder groups were surveyed. A regional approach was taken that included the entire state.

Study Outcome

Truckers surveyed felt that there was a shortage of truck parking, there was no information about where available parking spaces are locate. Parking facilities were already over-capacity when truckers arrive, and most shippers and receivers are not flexible enough to allow trucks to park in their staging areas. Further more than 70 percent of truckers surveyed felt that overnight parking is a personal safety concern. They also pointed out that the changes in the Hours of Service regulations have changed their requirements for parking facilities. Truckers also said that many of Virginia's parking facilities are functionally obsolete – designed and built for smaller trucks.

The Regional study showed that he Northern Virginia Region has a deficit of 1,069 parking spaces, with I-66 leading with a deficit of 542 spaces, followed by I-95 north of Richmond with a deficit of 463 spaces and US 29 north of Charlottesville lacking 64 spaces.

The study also listed some of the issues causing the shortage of parking spaces. These included growing congestion, both highway and rail; high land acquisitions; truckers' diverse parking needs; characteristics of some of the regional freight hubs such as the Hampton Roads.

A set of recommendations were made in the report:

- Recommendation 1 – Partner with private industry and local governments to increase capacity and related improvements
- Recommendation 2 – Provide accurate and real-time information about truck parking supply and availability in Virginia.
- Recommendation 3 – Improve the Safety, effectiveness and supply of truck parking spaces at State-owned facilities

Economic and Transportation Impact of Warehousing on Rural Pennsylvania

Authors: Paul Marr, Scott Srzyzga, George Pomeroy, Department of Geography/Earth Science, Shippensburg University, and James Biles, Department of Geography, Indiana University – Bloomington, for The Center for Rural Pennsylvania. November 2008

Study Objective

The research had five goals:

- Provide a comprehensive analysis of the warehousing and trucking industries by examining industry trends, labor issues, technology requirements, community issues, and policy and tax issues.
- Present a geographic inventory of warehousing and trucking facilities throughout Pennsylvania counties in relation to transport infrastructure, intermodal facilities, and other socio-economic and land use characteristics.
- Develop an economic/sectoral assessment of warehousing and trucking throughout rural Pennsylvania at the county level to determine the economic contribution of warehousing and trucking. Also establish economic multipliers to provide policymakers with a sense of how future changes in employment in warehousing and trucking will impact local economies.
- Assess labor, location and infrastructure impacts/needs of warehousing and trucking.
- Develop policy considerations.

How the Study was Conducted

The definition of terms was first laid out. The research focused on big-box, retail warehousing and distribution facilities because as demand for additional capacity and physical size increases, so does the demand for larger lots. This results in new construction in rural areas where land is cheaper. The increase in truck volumes creates challenges for many municipalities. Employment counts were used as proxies for economic activity.

A geographic Information System was used to characterize warehousing ad trucking facilities by their various locations at various scales. Other geospatial data sets were added to delineate interstates and highways, traffic volumes were mapped, and other land was mapped by use and cover type. Interstate accessibility was estimated using straight line distance from the warehouse to the closest interstate.

Study Outcome

In a national comparison Pennsylvania

- employed the second largest number of people in warehousing and storage;
- is tied with Kentucky with the highest concentration of general and refrigerated warehousing and storage;
- ranks 20th in long distance trucking; and,

- ranks ninth for logistics services

Looking at Pennsylvania

- Cumberland County employs the most people and ranks second in warehousing and storage employment; and,
- Cumberland County employs the most people in trucking.

Overall, Pennsylvania gained 21,194 net warehousing and storage jobs between 2001 and 2006 (BLS, 2001- 2006); rural counties gained 7,066 net jobs and urban counties gained 14,128 net jobs. Overall, Pennsylvania lost 4,780 net trucking jobs between 2001 and 2006. Rural counties lost 458 net trucking jobs and urban counties lost 4,322 net trucking jobs.

Examining the economic impacts show that:

- Overall, warehousing in Pennsylvania generated nearly $1.8 billion in direct wages and proprietary income. In turn, this direct income produced $2.6 billion in additional wages and earnings as it rippled through the state's economy.
- Rural Pennsylvania generated 25 percent of all direct wages and income associated with warehousing activities, and it received 20 percent of all indirect and induced effects.
- Every dollar of wages and proprietor income earned by truck transportation in rural Pennsylvania generated $2.48 worth of additional income statewide; nearly 72 percent of these direct, indirect and induced (multiplier) effects remained in rural Pennsylvania while the other 28 percent leaked into urban areas.
- Each additional warehousing job created in rural Pennsylvania results in 1.82 additional jobs and in urban Pennsylvania results in 1.52 jobs statewide. Each additional trucking job created in rural Pennsylvania and urban Pennsylvania generates 3.00 and 2.50 new job opportunities, respectively, statewide.

SmartPark Technology Demonstration Project

Authors: Von Lopez-Jacobs, John Ellerbee, Michael Hoover for the Federal Motor Carrier Safety Administration (FMCSA), USDOT

<u>Study Objective</u>

The objective of Phase I of the SmartPark project was to demonstrate the functionality and usefulness of a commercially available or near-term technology designed to gather real-time parking availability information. Phase I evaluated various vehicle detection units capable of collecting parking availability data and communicating that information to drivers. SmartPark addresses FMCSA's goals of enhancing truck safety by better matching parking space supply and demand using Intelligent Transportation System (ITS) technology. Such technology could be effective on a broad scale and could be used to better align the high demand for truck parking with existing resources.

<u>How the Study was Conducted</u>

Phase I was a field operational test (FOT) to determine the accuracy and reliability of a technology for counting truck parking space availability. Three combinations of different technologies were subjected to field testing to ascertain their feasibility for determining truck parking space availability in real time: side (SID) scanners, overhead (OH) scanners, and light curtains (CURs), each combined with Doppler radar. The functionality and usefulness of a technology can be quantified in several steps. The first step is to define what accuracy is in relation to said technology—that is, determining the occupancy of a parking lot. The second step is to compare the accuracy of varying combinations of the laser scanner and CUR technologies to determine an optimal combination.

The SmartPark system evaluated in this study consisted of two types of components which are described below and shown in Figure A-I-1:

- Detection equipment: the detection units being demonstrated and validated, including the gantries and structures to support it.
- Verification tools: technologies and installations to support the inspection, verification, and evaluation of system performance, including communications to the site, closed circuit television (CCTV) cameras, and the project Web site.

A suitable site was selected for the test using the following criteria:

- The test site must be a private or public truck parking area with a controlled ingress and egress from a major arterial road or highway.
- The site must be suitable for use with the detection technologies identified.
- There must be documentation of complaints about inadequate parking, need for a truck appointment or reservation system, illegally-parked trucks, or trucks queuing up to enter the site.
- There must be at least one adjacent truck parking area within 35 miles of the proposed site, capable of being accessed from the same road, with a controlled ingress and egress, and suitable for use with the identified technology.

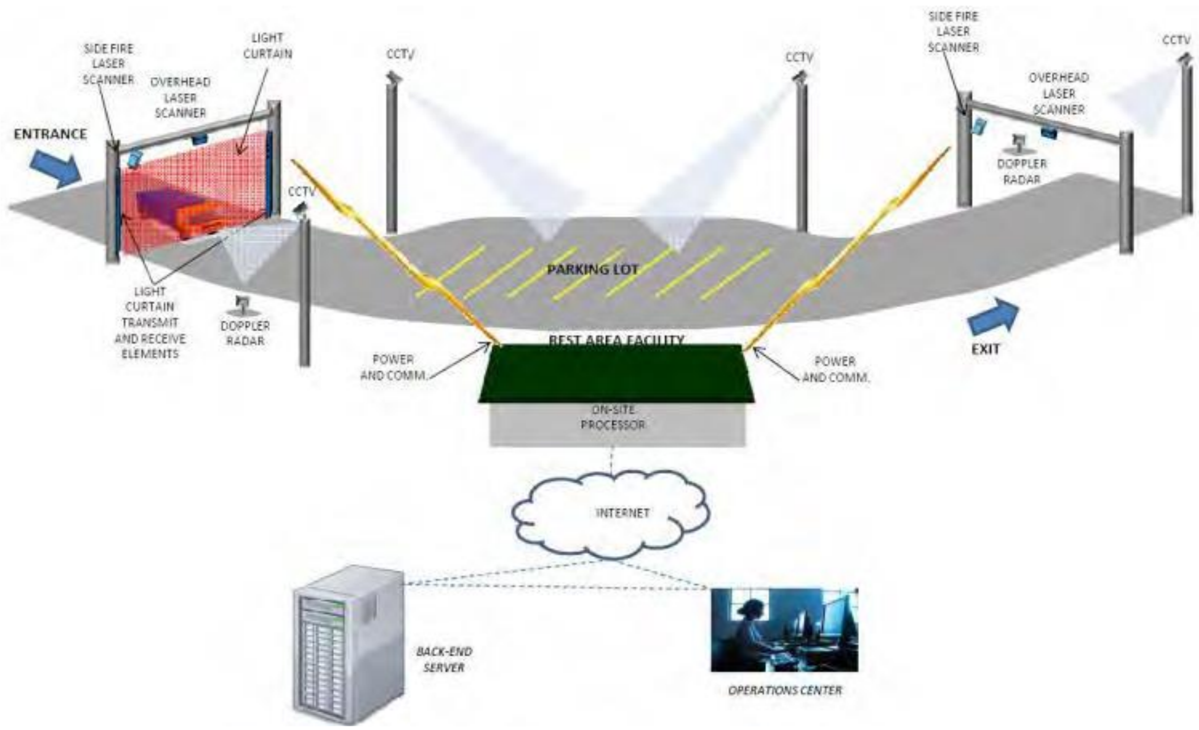


Figure A-I- 1 Flowchart. SmartPark system overview

As displayed in Figure A-I-1, a vehicle enters the parking area, is detected by one of the ingress detectors, and then proceeds to a parking space. Once detected, the ingress detector communicates via fiber optics to the rest area facility equipment room, where the onsite processor analyzes the detection, classifies the vehicle, and communicates with the Web site to indicate that a vehicle has entered the lot. Using this information, the SmartPark system determines how many vehicles are currently in the lot, and thus determines the number of spaces that are available. A series of seven CCTV cameras monitors the activity in the lot in order to verify lot count accuracy. The CCTV cameras can be viewed remotely from any Web browser, provided the user has proper authentication credentials.[4]

Once the technology was in place the six month testing period started. The goal of the testing was to demonstrate functionality and usefulness of the detector technologies and to gather data regarding the performance of each of the detector units. During the testing period the team performed troubleshooting, verified the vehicle detection accuracy, and verified and measured system performance. A series of performance requirements by which to measure the accuracy and performance of the project components was established and are contained in Table A-I-1.

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[4] Von Lopez-Jacobs, John Ellerbee, Michael Hoover, SmartPark Technology Demonstration Project, Federal Motor Carrier Safety Administration (FMCSA), USDOT , p.24.

Table A-I- 1 SmartPark Phase I Performance Requirements

Performance Requirement	Description
Performance Requirement 1	The system shall maintain the parking area occupancy count to better than 95-percent accuracy.
Performance Requirement 2	Classification consistency; the ingress and egress detectors must be consistent in classification with each other to a level of 95 percent.
Performance Requirement 3	The system shall provide parking availability information at a minimum of 99.5 percent of the time.

In addition, an expanded list of specific requirements were developed as the project progresses:

- A means of automatically detecting parking space status, by monitoring both ingress and egress.
- A central database to maintain parking status and reservation information.
- Controlled access to dedicated parking areas.
- Other required functions:
  - The system must be able to count and classify vehicles entering and exiting the facility.
  - It must be easy to install and maintain.
  - It must operate unattended 24 hours per day, 7 days per week.
  - It must operate in all weather and ambient lighting conditions.
  - It must maintain a count of the available parking spaces in the facility and provide this count to authorized remote users.
  - It must provide a means for authorized users to remotely monitor the parking facility to determine the accuracy of the system.
  - It must allow authorized users to reset the count of available parking remotely.
  - It must maintain a log of vehicle entrance and exit events and system errors.
- A set of three primary performance requirements (PRs) were developed to measure and evaluate the performance of the various detection systems. To be successful the technology tested must meet all three PRs list in the Table below[5].

[5] ibid, p.2.

During the test data was collected both automatically using the technology and manually for further verification. The research team viewed video surveillance footage and performed in person counts to verify the systems' ability to accurately keep track of ingress and egress and to properly class vehicles by their size and type.

Study Outcome

The most optimal configuration of technologies is a SID scanner combined with Doppler radar at both the ingress and egress points of the selected truck parking area. Other findings and recommendations pertain to the trade-off between accuracy and the frequency of ground-truth correction, qualitative reporting of truck parking availability to address uncertainty when the parking area is nearly full, required time for stabilizing the system, use of a vehicle classification scheme that reduces the number of vehicle classes, increased bandwidth in data transmission, and enhanced surveillance and monitoring with closed circuit television (CCTV) cameras.

The team also encountered some issues which had to be resolved, often manually, including

- Vehicle obstruction while trying to use video to conduct verification counts – a counter had to monitor large trucks which were obstructing the spaces next to them and check the space when the larger vehicle moved.
- Clarity of spaces – the view from the video cameras overlapped in some instances and it was difficult to determine if a space had already been counted from another camera view – the suggested solution is to mark the pavement outlining parking places with a more easily distinguishable feature or color.
- Nighttime visibility impaired the resolution of some of the cameras, particularly in low light and shadowy conditions – the data was corroborated in the daylight and corrections made.

The Minnesota Interstate Truck Parking Study

Author: Wilbur Smith Associates and the Center for Transportation Research and Education at Iowa State University for the Minnesota Department of Transportation (MnDOT)

Study Objective

The Minnesota Interstate Truck Parking Study was undertaken to help MnDOT develop the information necessary to support decisions regarding future approaches to the truck parking issues in Minnesota. The issues examined by the study effort include determining what the state's role should be in the provision of truck parking; which provisions of long term truck parking will provide the greatest support to the state's economy, and what actions will provide the greatest impact on traffic safety, while taking maximum advantage of effective technology and available federal programs.

How the Study was Conducted

The Minnesota Interstate Truck Parking Study examined the supply and demand of public and private commercial vehicle parking along Minnesota's three primary interstate corridors: I-90, I-35, and I-94. The study was conducted through three primary tasks:

- An inventory of Minnesota's Interstate Truck Parking Supply: This inventory established the basis for the collection of data regarding truck parking demand by time of day.
- Truck Parking Demand Analysis: Data compiled on parking facilities was then given to a field data collection team for use during facility site visits.
- Survey Results of Trucking Company Practices and Attitudes Regarding Truck Parking: Vehicle information was turned over to researchers who contacted the motor carrier companies responsible for the trucks observed to find out more about why their drivers were parked in a particular location, and the nature of their stop.

In addition to the motor carrier survey conducted for Task 3, the project team was required to identify the demand for truck parking among the state's parking facilities. During the summer months of July through August field staff collected information about the demand for parking in public and private facilities along the identified Minnesota Interstate routes. Once this data was summarized, the team worked with the Mn/DOT Rest Area Program Manager to identify a measure that would effectively identify facilities that had reached, or were over capacity during the busiest hours of the day. Therefore, over capacity was defined as those facilities that observed more trucks parked than there were spaces to accommodate them. Finally, the project team identified the degree of the problem at each rest area based on whether the rest area was over capacity 15 (yellow color), 25 (orange color), or 50 (red color) percent of the time. The project team also analyzed the truck parking demand at private parking facilities.

Study Outcome

The study found that 20 facilities were identified to have significant capacity issues during the busiest time of day. Specific attention should therefore be given to facilities that are over capacity more than 50 percent of the time. These facilities would best benefit from additional investment or capacity additions. There are five rest area facilities on Minnesota's interstates that are at or over capacity at least 50 percent of the time. The project team produced maps showing the supply and demand on public rest area facilities, with indications of how often public rest area parking facilities for commercial vehicles are filled to capacity during week-night hours.

ITS Action Plan: Study regarding secure parking places for trucks and commercial vehicles, telematics-controlled parking and reservation systems

Authors: Cornelia Petz, Celine Lyoen, Karin Kim Lim for the European Commission

Study Objective

The objective of this study is to provide support on the subjects of secure parking places for trucks and commercial vehicles, and on telematics-controlled parking and reservation systems. The study was addressing the following issues:

- over-crowding of some truck parking areas at specific peak times leading to dangerous parking (e.g. on motorway slip roads or dangerously within sites) and driving beyond statutory driver stop time limits
- extensive freight crime leading to large economic losses
- increasing market requirements for a higher level of truck parking service in certain market segments (e.g. high value goods, dangerous goods, long-distance trucking)

How the Study was Conducted

ITS-based road safety and security applications have proved their effectiveness, but the overall benefit for society depends on the scale of their deployment. The study was structured around two tasks:

- Synchronization of past and ongoing activities in the field of Intelligent Secured Truck Parking
- Analysis and propositions for a harmonized information system at a European level. This task focused on seamless cross-border information systems to display the occupancy of Truck Parking Areas (TPA).

Study Outcome

Key information for building a financial business model is scarce. Limited information is available on the implementation and operational costs of TPA information and reservation services, and research on the willingness to pay for TPA remains sketchy. What is clear is that truck drivers would welcome better information on TPAs and in a second step the option to make reservations. The willingness to pay for occupancy information by truck drivers is however very low.

Member states and lower level public authorities appear to be reluctant to invest in TPA. The key issue in the establishment of a TPA information service is the collection of occupancy data. Though the counting systems should run unattended, commitment from a local party, i.e., TPA operator, for basic maintenance and calibration is required to guarantee continuous operation. TPA operators are reluctant to invest in counting systems. The implementation and operational costs are substantial while the perceived benefit to the operator is limited. Public TPA operators are more concerned with expanding the TPAs capacity than adding services.

Another key issue in the deployment of TPA reservation services is the lack of a common standard for handling reservation requests. Such a standard is neither available nor under development. Several private initiatives have developed a platform that offers a TPA reservation service, in-vehicle and in back-office systems. All services rely on proprietary IT implementations, which can in the future severely restrict interoperability. As demonstrated by HighwayPark, a private initiative, truck drivers are willing to pay for reservation services. Insurance companies also derive a direct benefit from customers that make reservations at secure TPA. By balancing the interests of the truck drivers, TPA operators and insurance companies it should be possible to develop a viable business model for TPA reservation services by private parties.

APPENDIX I

APPENDIX II TRANSPORTATION DATA COLLECTED FROM THE I-81 CORRIDOR

Data Requested from each State	Virginia DOT	Tennessee DOT	Maryland DOT	West Virginia DOT	Pennsylvania DOT	New York DOT
Overall traffic counts	RITIS*	TN supplied this data in Shapefiles	RITIS	RITIS (has some gaps)	RITIS	2012 available online
Truck traffic	RITIS	TN supplied this data in Shapefiles	RITIS	RITIS (has some gaps)	RITIS	2012 available online
Known performance measures and historical results	RITIS has some performance summaries, also received some corridor wide performance metrics from VDOT	Not Available	RITIS – Has some performance summaries	RITIS (has some gaps) has some performance summaries	RITIS has some performance summaries	Not Available
Accident statistics	RITIS	TDOT supplied this data in Shapefiles	RITIS		RITIS	RITIS
Delay statistics	RITIS	Not Available	RITIS	RITIS (has some gaps)	RITIS	Not Available

**Regional Integrated Transportation Information System (RITIS)* http://www.cattlab.umd.edu/?portfolio=ritis

APPENDIX III – STUDY OF TRUCK PARKING AVAILABILITY ON I-81

Inventory of Truck Parking Facilities on the I-81 Corridor

The project team completed a 3-day drive along the I-81 corridor to observe, collect, and validate data points collected from several sources of truck parking area information. This included TSPS own database, the HERE website, a 2012 inventory completed by Shippensburg University, and online trucking sites. Corrections, updates, or supplementary information related to this report are welcomed and appreciated.

The following tables catalog the truck parking in both summary and detailed fashion. Table A-III-1 notes the total number of truck parking areas by type, Table A-III-2 lists and details the private truck stops, and Table 4 lists and details the public rest areas along the I-81 corridor.

Table A-III-1 Total Truck Parking Areas

State	I-81 Mileage	Private	Public	Total
NY	184	4	4	8
PA	233	17	10	27
MD	11	3	0	3
WV	26	0	3	3
VA	325	20	12	32
TN	76	6	4	10

There are a total of 6599 private truck parking spaces and 570 public truck parking spaces along the I-81 corridor based on this project’s definition of truck stop. If all truck stops are included, then the total becomes 7511 private and 570 public truck parking spaces.

Table A-III-2 Details Private Truck Parking Areas

STATE	HWY_ADDRESS	STREET_ADDRESS	CITY	ZIP	PROVIDER	LAT	LON	SPACES
NY	I-81 Exit 2 W NB/3 SB (US 11)	735 Upper Court St	Binghamton	13904	TA	42.100861	-75.841255	110
NY	I-81 Exit 2 W NB/3 SB	2 Industrial Park Dr	Binghamton	13904	Loves	42.102207	-75.835014	100
NY	I-81 Exit 34 (NY 104 E)	2023 State Route 104	Parish	13131	Ezze Truck Stop	43.457897	-76.115623	100
NY	I-81 Exit 25/I-90 Exit 36	107 7th North St	Liverpool	13088	Pilot	43.086449	-76.165207	80
PA	I-76 (PATP) Exit 226 N (I-81 Exit 52 W)	1201 Harrisburg Pike	Carlisle	17013	Petro	40.233109	-77.14048	450
PA	I-81 Exit 178 B	98 Grove St	Dupont	18641	TA Petro	41.329929	-75.743149	350
PA	I-81 Exit 52 A NB/52 SB (US 11 N)	1501 Harrisburg Pike	Carlisle	17013	Flying J	40.234028	-77.120972	284
PA	I-78 Exit 10 (PA 645)	2212 Camp Swatera Rd	Frystown	17067	Flying J	40.463989	-76.339012	250
PA	I-81 Exit 5	10835 John Wayne Dr	Greencastle	17225	TA	39.783482	-77.711746	160
PA	I-81 Exit 77 (PA 39)	7848 Linglestown Rd	Harrisburg	17112	TA	40.353348	-76.725708	125
PA	I-81 Exit 219 (PA 848)	1623 Oliver Road	New Milford	18834	Flying J	41.82336	-75.682144	125
PA	I-81 Exit 100 (PA 443)	482 Suedberg Rd	Pine Grove	17963	Pilot	40.533718	-76.431541	120
PA	I-76 (PATP) Exit 226 (US 11 N)	1165 Harrisburg Pike	Carlisle	17013	Loves	40.231026	-77.144333	100
PA	I-81 Exit 77 (PA 39)	7833 Linglestown Rd	Harrisburg	17112	Wilco Travel Plaza	40.353539	-76.727516	100
PA	I-81 Exit 90	22 Old Forge Rd	Jonestown	17038	Loves	40.450394	-76.514214	90
PA	I-81 Exit 219 (PA 848)	2174 State Rd 848	New Milford	18834	Liberty	41.823669	-75.678612	90
PA	US 22-322 (1/4 mi E of US 11-15)	30 Benvenue Rd	Duncannon	17020	Pilot	40.404945	-77.009956	86
PA	I-81 Exit 175 NB/175 B SB (PA 315)	417 State Hwy 315	Pittston Township	18640	Pilot	41.314816	-75.755264	75
PA	I-81 Exit 217	5076 State Route 545	Harford	18823	Liberty	41.786819	-75.684135	75
PA	I-81 Exit 217	5085 State Route 547	Harford	18823	Liberty	41.787033	-75.684219	60
PA	I-81 Exit 104	10 Molleystown Rd	Pine Grove	17963	Raceway	40.590488	-76.407768	50
MD	I-81 Exit 5 B (Halfway Blvd W)	11546 Hopewell Rd	Hagerstown	21740	AC&T	39.629959	-77.785378	200
MD	I-70 Exit 24 (MD 63)	11633 Greencastle Pike	Hagerstown	21740	Pilot	39.633244	-77.80825	100
MD	I-81 Exit 5 B	16921 Halfway Blvd	Hagerstown	21740	Pilot	39.629726	-77.785271	95
VA	I-77-81 Exit 80 (US 52)	139 Factory Outlet Dr	Fort Chiswell	24360	Flying J	36.944096	-80.94677	300

STATE	HWY_ADDRESS	STREET_ADDRESS	CITY	ZIP	PROVIDER	LAT	LON	SPACES
VA	I-81 Exit 29	12433 Maple St	Glade Spring	24340	Petro	36.770168	-81.780861	270
VA	I-64-81 Exit 195 (US 11 S)	2516 N Lee Hwy	Lexington	24450	TA Petro	37.831821	-79.37838	250
VA	I-81 Exit 273 (VA 703)	218 Conicville Blvd	Mt Jackson	22842	Liberty	38.760197	-78.629906	185
VA	I-77-81 Exit 77 (S)	3249 Chapman Rd	Wytheville	24382	Flying J	36.936333	-80.993355	177
VA	I-81 Exit 291	1014 Mt Olive Rd	Toms Brook	22660	Pilot	38.966602	-78.439079	174
VA	I-81 Exit 243 (US 11 S)	3355 S Main St	Harrisonburg	22801	Harrisonburg Travel Center	38.403927	-78.910088	150
VA	I-81 Exit 323 (VA 669)	1530 Rest Church Rd	Clear Brook	22624	Flying J	39.291222	-78.087486	140
VA	I-81 Exit 150 A (US 11-220 N)	2905 Lee Hwy	Troutville	24175	Pilot	37.388603	-79.901756	130
VA	I-77 Exit 41 (I-81 Exit 72)	1025 Peppers Ferry Rd	Wytheville	24382	TA	36.965702	-81.069077	115
VA	I-64-81 Exit 213 (NB)/213 A (SB)	3541 Lee Jackson Hwy	Staunton	24401	Pilot	38.021103	-79.143372	100
VA	I-81 Exit 291 (VA 651)	1015 Mt Olive Rd	Toms Brook	22660	Loves	38.966385	-78.439194	100
VA	I-81 Exit 251	3634 N Valley Pike	Harrissonburg	22802	Pilot	38.484	-78.815	98
VA	I-81 Exit 273	227 Conicville Blvd	Mount Jackson	22842	Sheetz	38.760441	-78.630722	85
VA	I-81 Exit 101	5150 State Park Rd	Dublin	24084	Lancers Travel Plaza	37.08585	-80.649292	80
VA	I-81 Exit 128 (VA 603)	5151 Northfork Rd	Elliston	24087	Lancer Truck Stop	37.233276	-80.23925	80
VA	I-81 Exit 84 (VA 651)	145 Major Grahams Rd S	Max Meadows	24630	Loves	36.952061	-80.882195	75
VA	I-81 Exit 86	5722 E Lee Hwy	Max Meadows	24360	I-81 Travel Plaza	36.966068	-80.852798	60
VA	I-77-81 Exit 77 (N)	1318 E Lee Hwy	Wytheville	24382	Pilot	36.937771	-80.99247	50
VA	11268 US 460	11268 W Lynchburg-Salem	Montvale	24122	Exxon Travel Stop	37.38171	-79.72802	50
TN	I-81 Exit 36 (CR 172 N)	195 Van Hill Rd	Greeneville	37745	TA	36.326393	-82.835274	200
TN	I-81 Exit 4	3624 Roy Messer Hwy	White Pine	37890	Pilot	36.109501	-83.338531	110
TN	I-81 Exit 4	3663 Roy Messer Hwy	White Pine	37890	WilcoHess	36.107986	-83.333221	95
TN	I-40 Exit 412 (Deep Springs Rd)	1058 Deep Springs Rd	Dandridge	37725	Loves	36.01078	-83.53199	60
TN	I-40 Exit 417 (TN 92 N)	505 Patriot Dr	Dandridge	37725	Pilot	36.038418	-83.443802	50
TN	I-81 Exit 36 (CR 172 N)	300 Vanhill Rd	Greeneville	37743	TA	36.327187	-82.836098	40

Table A-III-3 Details Public Truck Parking Areas

STATE	REST AREA	ROUTE	MUNICIPALITY	COUNTY	LAT	LON	SPACES
NY	Preble	I-81N	Pratt Corners	Cortland	42.715402	-76.145746	59
NY	Whitney Point	I-81S	Manningville	Broome	42.375074	-75.994444	29
NY	Orleans	I-81N	Calcium	Jefferson	44.082065	-75.915284	11
NY	Watertown	I-81S	Honeyville	Jefferson	43.90209	-75.984621	8
PA	NHS Rest Stop or Truck Facility 27	I-81S	Penn	Cumberland	40.147776	-77.316315	23
PA	NHS Rest Stop or Truck Facility 23	I-81N	Penn	Cumberland	40.132711	-77.342433	23
PA	NHS Rest Stop or Truck Facility 44	I-81S	Great Bend	Susquehanna	41.983735	-75.748497	16
PA	NHS Rest Stop or Truck Facility 28	I-81S	East Hanover	Dauphin	40.375259	-76.677129	15
PA	NHS Rest Stop or Truck Facility 29	I-81S	Rice	Luzerne	41.130807	-75.963774	15
PA	NHS Rest Stop or Truck Facility 24	I-81N	East Hanover	Dauphin	40.373285	-76.67647	15
PA	NHS Rest Stop or Truck Facility 25	I-81N	Dorrance	Luzerne	41.10217	-75.960891	15
PA	NHS Rest Stop or Truck Facility 47	I-81N	Antrim	Franklin	39.736298	-77.725845	13
PA	NHS Rest Stop or Truck Facility 43	I-81S	Lenox	Susquehanna	41.673992	-75.682218	6
PA	NHS Rest Stop or Truck Facility 26	I-81N	Greenfield	Lackawanna	41.603743	-75.647213	6
WV	Inwood Welcome Center NB	I-81N	Ridgeway	Berkeley	39.320836	-78.070672	19
WV	Falling Waters Welcome Center SB	I-81S	Marlowe	Berkeley	39.58702	-77.848069	18
WV	Marlowe Weigh Station SB	I-81S	Marlowe	Berkeley	-77.847244	-39.586001	0
VA	Abingdon Truck-Only Safety Rest Area North	I-81N	Abingdon	Washington	36.684062	-82.029558	48
VA	Ironto Safety Rest Area North	I-81N	Ironto	Montgomery	37.239716	-80.225025	22
VA	New Market Safety Rest Area North	I-81N	New Market	Rockingham	38.614002	-78.705893	18
VA	New Market Safety Rest Area South	I-81S	New Market	Rockingham	38.616814	-78.705737	15
VA	Radford Safety Rest Area South	I-81S	Radford	Montgomery	37.098936	-80.52114	14
VA	Radford Safety Rest Area North	I-81N	Radford	Montgomery	37.09852	-80.523613	14
VA	Mount Sydney Safety Rest Area North	I-81N	Mount Sidney	Augusta	38.24998	-78.954318	13
VA	Winchester Safety Rest Area/Welcome Center	I-81S	Wincester	Frederick	39.242869	-78.115876	11
VA	Fairfield Safety Rest Area South	I-81S/I-64	Fairfield	Rockbridge	37.87521	-79.309059	10
VA	Mount Sydney Safety Rest Area South	I-81S	Mount Sidney	Augusta	38.251621	-78.955273	9
VA	Troutville Safety Rest Area South	I-81S	Troutville	Botetourt	37.468652	-79.811815	7
VA	Smyth Safety Rest Area South	I-81S	Smyth	Smyth	36.883911	-81.385924	6
TN	NHS Rest Stop or Truck Facility 12	I-81N	Pine Grove	Greene	36.336846	-82.80507	26

STATE	REST AREA	ROUTE	MUNICIPALITY	COUNTY	LAT	LON	SPACES
TN	NHS Rest Stop or Truck Facility 15	I-81S	Dandridge	Jefferson	36.0531	-83.2115	22
TN	NHS Rest Stop or Truck Facility 13	I-81S	Pine Grove	Greene	36.350255	-82.768289	22
TN	NHS Welcome Center, I-81	I-81		Sullivan	36.3541	-82.1449	22

APPENDIX IV - LESSONS FROM THE ROAD

The TSPS project team drove the I-81 corridor, from north to south. They stopped off at several truck stops along the way, to observe the facilities, observe their usage, and talk with truckers. In addition, the project team has conducted its own in-person "clipboard" survey with over 100 truckers at truck stops during other projects. The surveys covered parking patterns and experiences, how trips are planned, what communication devices they carry, the overall value of having advance information about space availability and the ability making reservations, and their willingness to pay for these services.

There were several lessons learned from this exercise:

- Independently Owned versus Major Truck Stop Operators
- There are actually more independently owned and operated truck stops then there are ones owned by the major truck stop operators (TA, Loves, Flying J), an observation borne out by data.

Centralized Network

Truckers all believed that an app that would show them where parking is available along their routes would represent a great benefit to their quality of life

Origin/Destination Information

The truckers were skeptical about providing their origin/destination information to another party, especially a governmental agency. They all have some form of routing information system in their trucks already.

Check-in Capability

It was mentioned and observed that the truckers will meet up at specific truck stops if it is not too far off their optimal route or drive time. An ability to allow their select "friends" to know where they are planning on stopping or have stopped would be a great feature. This would be analogous to the popular, GPS-driven "check-in" feature on Facebook and would give drivers yet another, social-interaction based reason to make use of the app.

Rating Truck Stops

Truckers reported that they communicate amongst themselves about what they do and do not like about different truck stops. The ability to "block" certain truck stops that a trucker decides he does not like is a suggested feature. The reverse is also suggested; the ability to "like" favorite truck stops and have that factor into the suggested parking availability would be an attractive feature, again analogous to features in popular social networking sites.

Expansion of Corridor

Based on our experience and lessons learned on the successful deployment of the Michigan I-94 corridor, we believe that the distribution along this 100 mile corridor helped achieve the following project goals:

- Enhance highway safety by providing timely and reliable truck parking availability information.
- Maximize user acceptance of the system for truck parking decisions.

Figure A-IV-1 Xxx

If we extrapolate this out over the I-81 corridor, which is 855 miles, that would equate to 43 public and 127 private truck stops.

<u>Off-the-Grid Availability</u>

Access to safe and convenient parking areas for trucks is essential for a robust freight transportation network along the I-81 corridor. Nationally, there is a large and growing problem with truck parking along the national highway system and other freight corridors of statewide and national significance. The FMCSA regulates Hours of Service for drivers and mandates rest periods for them - at least 10 hours per day after every 14 hour shift or risk fines and disciplinary action.

It has been documented that drivers face two main issues when seeking safe and convenient resting options: there is no real-time information regarding parking availability, and there are not enough safe and convenient parking options where needed. TSPS will support CFIS to solve the first issue, by providing CFIS with the data feed to disseminate real-time parking availability information to the truckers.

It should be noted, that TSPS Software Platform can also handle “Off-the-Grid” locations along the I-81 corridor. These are locations that are not classified as truck stops under the definitions defined in this proposal. Below, are several options that TSPS identified during its road trip down the I-81 corridor. Off-the-Grid can also include big box retailers, which many were seen directly adjacent to the corridor.

Recommendations

TSPS believes that the I-81 Coalition must view this project with a multistage approach. Simply, seed the network in Stage 1 and continue to grow the network for more value for all stakeholders.

Stage 1: An initial "light dusting" of the I-81 corridor, which will support the real-time parking availability and reservation capabilities of the system at 9 truck parking facilities along I-81 which connects six states from Tennessee to the Canadian border – a total of 855 miles. This first stage represents Phase 3 of the GO-81 Corridor Freight Information System Pilot Project, which is "Implement a Pilot Project."

Stage 2: The TSPS system should be expanded based on lessons learned during Stage 1 and from other TSPS successful deployments. TSPS has recommends an additional x private and x public truck stops along the I-81 corridor based on other successful deployments.

Stage 3: The final TSPS would recommend the eventual expansion to other locations and arteries off the I-81 corridor. Anyone of the major arteries would be a beneficial place to start expansion.

I-81 begins in east Tennessee, with connections to I-40 and points west including I-75 and the Atlanta region. In Kingsport, Tennessee, I-81 crosses I-26 providing a route to the Port of Charleston. In Virginia the road crosses Interstates 64 and 66 providing access to the Hampton Roads Ports, the Virginia Inland Port, and Washington DC. From Virginia, I-81 continues on through West Virginia and into Maryland and intersects with I-70 and connections to manufacturing and agricultural markets west of the Appalachians as well as direct access into Baltimore, MD and the Port of Baltimore. In Pennsylvania, Interstate 76 (Pennsylvania Turnpike) provides access to Philadelphia as well as Midwestern population centers, including Cleveland and Pittsburgh. Further north, Interstates 83 and 78 provide access into the cities of Baltimore and New York as well as the Port of Baltimore and the NY/NJ Ports. Interstate 80 crosses I-81 in Hazleton, PA, and is a critical East-West freight connection providing access to markets throughout the United States. In New York State a major connection is Interstate 90 (NY Thruway) with links to the Great Lakes Ports, western markets, Boston Massachusetts, and the Port of Boston. Interstate 81 terminates at the Thousand Islands Bridge where it crosses into Ontario, Canada.

Overall, the TSPS software platform and infrastructure network is designed to enable expansion to additional locations along and beyond the I-81 corridor. This plan will be updated periodically to reflect potential modifications to the system, based on internal lessons learned and stakeholder feedback.

Alternative Truck Parking Areas

TSPS has identified some other options that can be used as truck parking areas for I-81 in future phases.

<u>Ontario</u>

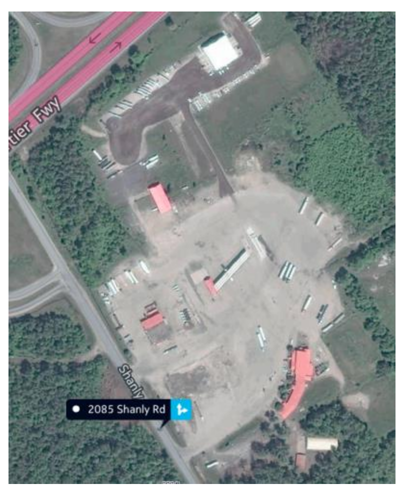
The TSPS project team drove the I-81 corridor starting from the US/Canadian border in the Thousand Islands. This is where a trucker would exit the Hwy 401 onto Hwy 137 in Canada to cross over into the US and join up to the northern end of I-81. As you can see from the pictures in Figure 21 there is minimal truck parking available at the border crossings. Therefore, installing the TSPS system at a truck stop either north or south on Hwy 401 from the border crossing could be beneficial for easing congestion onto I-81.

Further investigation would have to be made into which direction from the border, north or south, is more beneficial based on which way the truckers are entering or leaving the crossing.

Border Crossing Canada

Border Crossing US

There is a 730 Truck Stop north of the border that would be a good selection. More investigation has to be done on the total number of spots and amenities. They have only two entrances making the TSPS installation straightforward.



There is a Husky Truck Stop north of the border that would be a good selection. More investigation has to be done on the total number of spots and amenities. They have only two entrances making the TSPS installation straightforward.

New York

There is a rest stop in Orleans with 11 spots right before the border crossing.

Note: There are a number of "Text Stops" along I-81 in New York. These locations have shoulder parking for both trucks and cars. They are on both the North and southbound sides.

More work should be given into the potential use of these locations in the future. This is the only one that will be documented as an example.

Figure A-IV-2 Pictures of Ontario

APPENDIX V - FRAMEWORK FOR FREIGHT PLANNING AND PERFORMANCE MEASUREMENT

Background

Performance measures are a growing management tool for transportation planners and operators. The basic goal of the performance measures proposed here is to find locations along I-81 that are likely to create delays for long-haul truckers. Delays generate two economic problems:

- Decreased reliability makes the I-81 Corridor a less attractive business location relative to other freight corridors, and
- Unexpected delays mean drivers are more likely to need to find unplanned places to stop. This is a more common problem given the new hours of service regulations that limit the number of hours truck drivers can drive between breaks.

This information will also provide value as general management information for state DOT planners and managers regarding operations and investment. This will provide information that can help justify and prioritize investment of scarce dollars. They also make it possible to track the effect of improvements in roadway reliability.

Methodology

Two measures of delay are proposed: 1) a bottleneck index that identifies locations where unexpected delays are likely and 2) a buffer index that measures the additional time needed to provide a truck driver with assurance of not being late. These two measures are related.

The bottleneck index provides a direct measure of problems and their location. It is calculated as part of the RITIS traffic information system maintained by the University of Maryland. While RITIS covers most of I-81, the system currently does not have access to traffic data for the states of New York and Tennessee.[6] The buffer time measures reliability, but for a stretch of roadway rather than identifying specific locations that tend to generate traffic delays. The approach called for here focuses first on the bottleneck index and then uses the buffer time to cover route segments where the bottleneck index is not available (locations that do not have access to the University of Maryland's RITIS program).

First some basic definitions:

Buffer Time: This is the most common measure of travel time reliability. It measures the amount of additional travel time needed to be on time for 95 percent of the trip along a particular road segment (say along I-81 between Syracuse, New York and Harrisburg, Pennsylvania). When combined with the average travel time, this generates what is called

6 RITIS also misses a few short segments in Virginia. Not all state DOTs have decided to purchase the RITIS package of performance measures and analytic tools.

the planning time index. For example, a 95 percent confidence level would provide enough time to ensure arriving before the appointed time at least 19 out of 20 trips. For example, a buffer time of 20 minutes for a trip that normally takes 20 minutes means that a traveler should allow 40 minutes in order to risk being late only five percent of the time.

Bottleneck Index: This measures the severity of bottlenecks based on queue length in miles; duration of queue in minutes; and volume of traffic affected. Results are then totaled for a given corridor or jurisdiction. The University of Maryland CATT Lab defines bottlenecks based on locations where the average speed falls 40 percent below the reference speed (usually set as the speed limit) for more than five minutes and that generate queues that are more than 0.5 kilometers (0.3 miles) in length. There must be at least ten minutes with no bottlenecks in order to identify the start of a second bottleneck. These data identify key problem areas and can be used to track improvements.[7]

Bottleneck Index

The bottleneck index identifies all the locations along a particular stretch of I-81 that have experienced a bottleneck delay during a specific time period. Each individual bottleneck includes information on:

- Starting TMC[8] and nearest interchange.
- Length of bottleneck in minutes.
- Length of bottleneck in miles – this makes it possible to identify the full region affected by this particular delay.
- Severity of delay – based on difference between normal traffic and the average speed during the bottleneck.
- An impact factor, calculated by multiplying the duration of the bottleneck in minutes by the length in miles by the number of occurrences.

Rather than search for individual bottlenecks, a more useful approach calls for summarizing bottleneck activity during a particular time period (say the first quarter of 2014). This will identify clusters of bottlenecks that occur in the same location.

Step 1: County by county analysis. This takes a regional approach in preparing summary information regarding the location and severity of bottlenecks. This is easily done on a county by county basis for those states that have access to RITIS. RITIS contains an option that makes it possible to aggregate data by county.

7 For a video tutorial on the technique, see http://vpp.ritis.org/suite/screencast/

8 There are 293 TMCs located along I-81 in each direction (586 in total). Most are associated with a particular interchange. TMCs represent specific road segments that have been agreed upon by firms in the traffic information business in order to have a consistent way to report speed and travel time information. TMC stands for traffic message channel.

As an example, this analysis was carried out for the eight counties along I-81 in Pennsylvania (see Figure A-V-1). Table A-V-1 shows the results of this analysis for northbound traffic and Table A-V-2 shows the results for southbound traffic, both during the first quarter of 2014. These tables contain:

- General nature of county – urban areas such as Scranton (Lackawanna County) and Harrisburg (Dauphin County) tend to generate bottlenecks due to traffic congestion.
- Distance (length of I-81 in the county)
- Sum of Average Duration (minutes) of bottleneck
- Sum of Average Maximum Length (miles, average max length of bottleneck)
- Occurrences (total number of times this bottleneck occurred during the time period in query)
- Sum of Impact Factors (see definition above)
- Events/Incidents (number of events or incidents that occurred during the bottleneck and in the geographic area of the bottleneck.)[9]

The most severe delays in the northbound direction as measured by the impact factor were found in Dauphin County (Harrisburg) and Luzerne (suburban area near Scranton), followed by Schuylkill and Cumberland counties. Southbound results were similar, with Luzerne County number one followed closely by Cumberland, Schuylkill and Franklin counties. Northbound the longest delays in time were in Dauphin County, the longest delays in distance were in Cumberland County, and the largest number of delays were in and around Scranton (Lackawanna and Luzerne Counties). Southbound results were similar, although Lackawanna County had the longest delays in terms of miles. During the first quarter of 2014, northbound delays were much worse than southbound.

9 RITIS makes it possible to track details regarding each incident. Not all incidents are recorded and the incidents in the RITIS data base may not necessarily have caused the bottleneck).

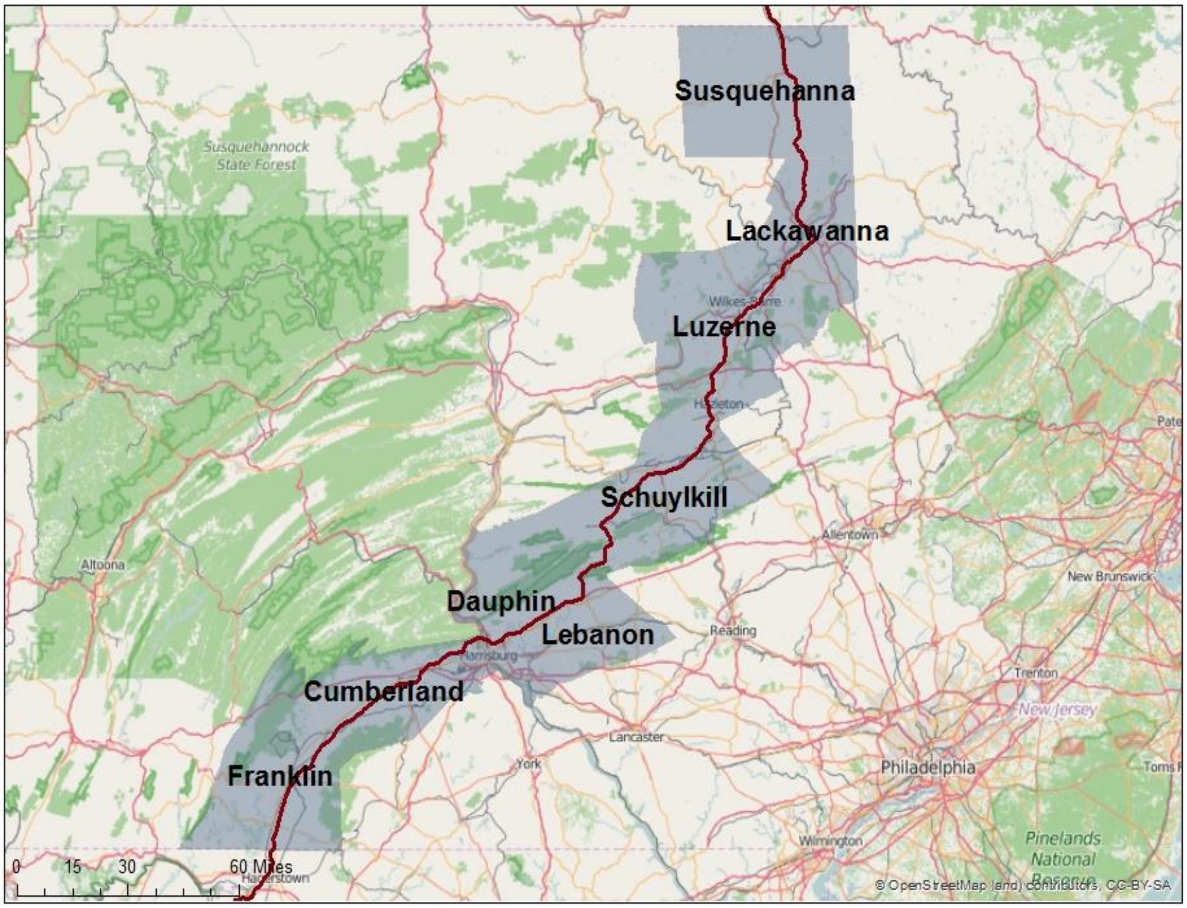


Figure A-V-1 Pennsylvania Counties along I-81

Table A-V-1 Bottleneck Data by County for Pennsylvania Northbound, 1st Quarter of 2014

County	Description	I-81 Distance (miles)	Sum of Ave Duration (min)	Sum of Average max length (miles)	Number of occurrences	Sum of impact factor	Number of incidents
Susquehanna	Rural	31.0	269	29.1	288	43,212	11
Lackawanna	Scranton	24.1	718	108.8	461	67,649	78
Luzerne	Suburban	39.9	1,381	228.4	459	212,969	220
Schuylkill	Rural	47.5	1,033	189.6	367	180,018	203
Lebanon	East of Harrisburg	9.8	816	149.1	69	113,847	203
Dauphin	Harrisburg	15.7	1,776	226.2	131	219,833	416
Cumberland	South of Harrisburg	40.5	1,021	241.2	231	166,652	412
Franklin	Rural	24.1	927	190.4	188	82,838	177

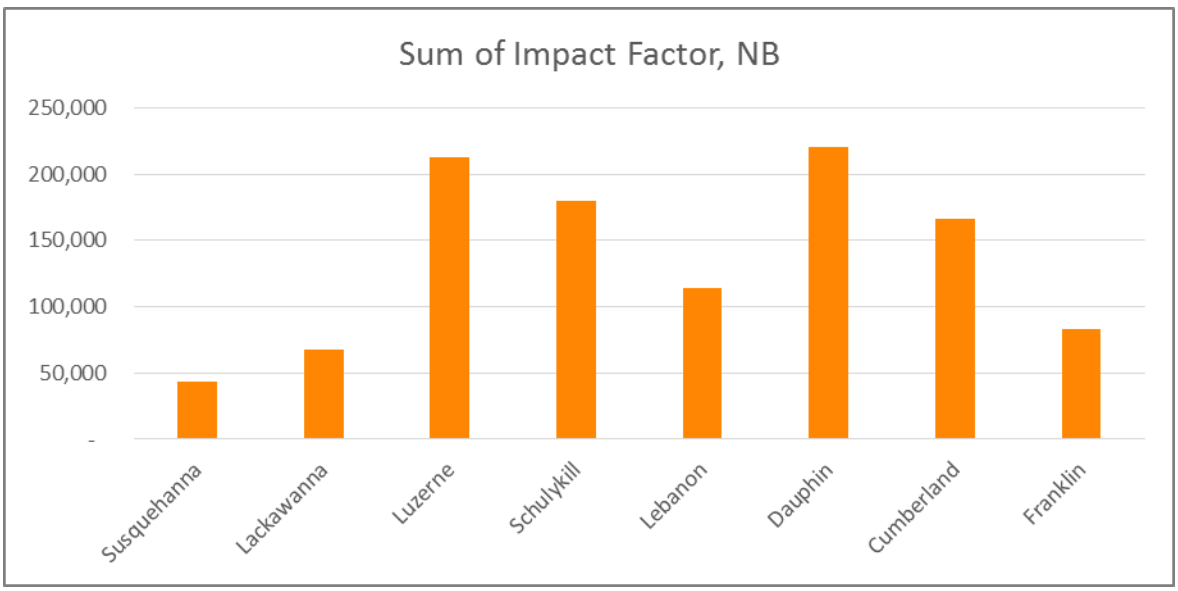


Figure A-V-2 Sum Of Impact Factor Northbound

Table A-V-2 Bottleneck Data by County for Pennsylvania Southbound, 1st Quarter of 2014

County	Description	I-81 Distance (miles)	Sum of Ave Duration (min)	Sum of Average max length (miles)	Number of occurrences	Sum of impact factor	Number of incidents
Susquehanna	Rural	31.0	352	58.1	279	21,144	36
Lackawanna	Scranton	24.1	978	164.8	485	92,244	131
Luzerne	Suburban	39.9	919	150.8	674	117,794	129
Schuylkill	Rural	47.5	602	109.7	396	107,385	68
Lebanon	East of Harrisburg	9.8	758	88.9	101	47,533	185
Dauphin	Harrisburg	15.7	1,081	139.3	178	54,967	313
Cumberland	South of Harrisburg	40.5	619	90.5	186	116,464	94
Franklin	Rural	24.1	831	141.6	163	102,982	237

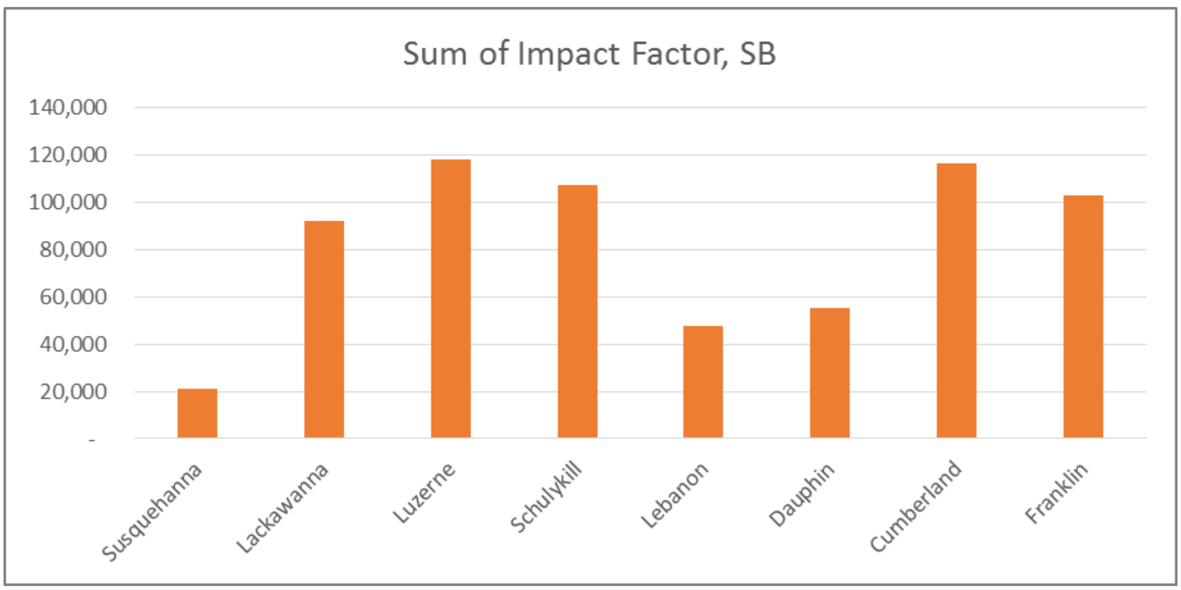


Figure A-V-3 Sum of Impact Factor Southbound

Step 2: Identify specific bottlenecks. Once a county with significant problems is selected, the results can identify specific locations in that county. This will allow planners and managers to focus on consistent problem areas and seek to identify possible solutions. Rather than using the summary table for each county, detail on individual bottlenecks in each county can be displayed. Table A-V-3 shows the top 15 bottlenecks in Cumberland County for both northbound and southbound traffic during the first quarter of 2014.

These are listed from north to south and show the rank of each bottleneck based on the impact factor of all the bottlenecks that occurred at this location. Many bottlenecks are quite long and may begin beyond the borders of the county (one averages 84 miles, starting north of Harrisburg and covering all of Cumberland County). This is shown in the last column.

Table A-V-3 Top 15 Bottlenecks in Cumberland County during the First Quarter of 2014

RITIS Rank	Location	Direction	Average duration	Average max length (miles)	Occurrences	Impact factor	Originates in Cumberland? [Y/N]
2	I-81 N @ PA-54/EXIT 131	NORTHBOUND	3 h 41 m	84.1	3	55,761	N
3	I-81 N @ PA-39/EXIT 77	NORTHBOUND	2 h 31 m	41.63	8	50,284	N
14	I-81 N @ US-322/EXIT 70	NORTHBOUND	42 m	16.75	4	2,814	N
4	I-81 N @ US-322/US-22/EXIT 67	NORTHBOUND	1 h 53 m	36.96	5	20,885	N
10	I-81 N @ PA-944/WERTZVILLE RD/EXIT 61	NORTHBOUND	52 m	13.35	6	4,166	Y
7	I-81 N @ PA-581/EXIT 19	NORTHBOUND	59 m	9.95	16	9,391	Y
8	I-81 N @ PA-114/EXIT 18	NORTHBOUND	48 m	4.33	39	8,107	Y
15	I-81 N @ US-11/EXIT 52	NORTHBOUND	28 m	2.15	43	2,587	Y
9	I-81 N @ PA-174/EXIT 29	NORTHBOUND	35 m	5.51	23	4,433	Y
11	I-81 S @ PA-114/EXIT 18	SOUTHBOUND	1 h 1 m	4.12	16	4,025	Y
13	I-81 S @ PA-465/EXIT 44	SOUTHBOUND	43 m	5.7	12	2,942	Y
12	I-81 S @ PA-233/EXIT 37	SOUTHBOUND	30 m	6.65	15	2,991	Y
5	I-81 S @ PA-174/EXIT 29	SOUTHBOUND	54 m	17.29	16	14,943	Y
6	I-81 S @ PA-696/EXIT 24	SOUTHBOUND	1 h 5 m	18.01	12	14,047	N
1	I-81 S @ PA-997/EXIT 20	SOUTHBOUND	2 h 34 m	26.42	18	73,248	N

Not all bottlenecks are equal. Indeed the worst three bottlenecks that affected Cumberland county in the first quarter of 2014 (two northbound and one southbound) accounted for about two thirds of all the delay impact. Five of the six bottlenecks that lasted more than an hour on average originated outside the county – another sign of the regional nature of traffic delays along the I-81 Corridor. Four bottlenecks averaged more than 20 miles long (this occurred 34 times) and eight were more than 10 miles long (72 times).

Figure A-V-4 shows where these bottlenecks occurred. The location to the far north, is the long bottleneck that ended up covering I-81 through Harrisburg and then most of Cumberland County. This super delay occurred three times in the first quarter of 2014. Some shorter bottlenecks occurred close to 40 times during this 90 day time period – almost every other day.

Figure A-V-4 Location of Bottlenecks in Cumberland County during the First Quarter of 2014

Buffer Time and Planning Index

These measures provide for each TMC 1) the relative likelihood of delay (the index) and 2) the length of additional time required to be sure of not being delayed – 95 percent probability. The required degree of certainty can be varied. The extra time required for each individual TMC can be added based on an individual route of interest. An example is shown for I-81 in Cumberland and Franklin Counties in Pennsylvania and Washington County in Maryland (Figure A-V-5) using the RITIS application..

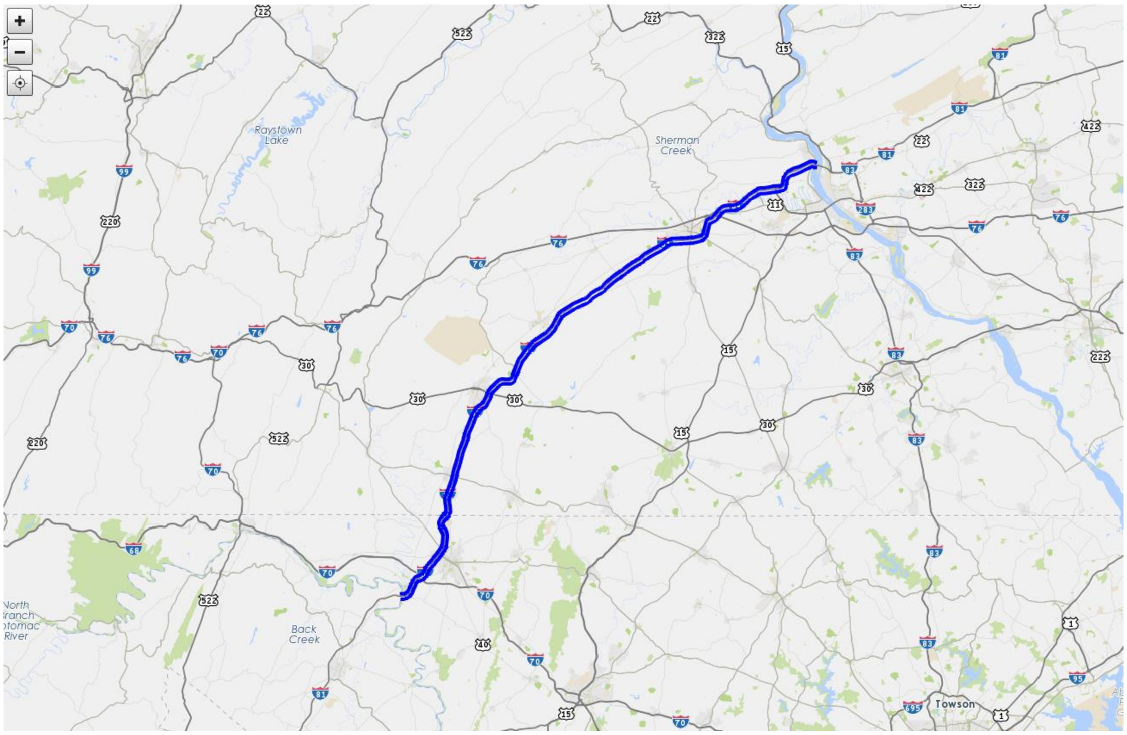


Figure A-V-5 Route along I-81 from Harrisburg through Maryland

Table 8 shows the planning time index itself and the additional minutes (buffer time) required in order to meet the 95 percent criteria for different days of the week and time during the day for travel along I-81 between Harrisburg, PA and the MD/WV state line (two counties in Pennsylvania and one in Maryland). Table A-V-4 uses data from the first quarter of 2014 that is exclusively truck speed data. Remember, the planning index is a ratio that shows the additional time required beyond the base speed. Thus, a ratio of 2.0 says that drivers should allow twice as much time in order to be assured to get through this region on time. A ratio of 1.24 (for Fridays during the afternoon peak) says they should allow 24 percent more time or 9.8 minutes beyond normal travel times for this part of I-81.

Table A-V-4 Planning Time Index

Northbound						
	Planning time index			Buffer Time (minutes)		
	All Day Average	AM Peak (6-9am)	PM Peak (4-7pm)	All Day Average	AM Peak (6-9am)	PM Peak (4-7pm)
Monday	1.38	1.68	2.24	18.6	38.9	76.5
Tuesday	1.34	1.67	1.34	16.0	38.1	15.9
Wednesday	1.29	1.38	1.31	12.7	18.6	13.6
Thursday	1.38	1.4	1.98	18.8	19.8	58.2
Friday	1.25	1.29	1.24	10.4	13.2	9.8
Saturday	1.26	1.3	1.24	11.1	14.0	10.1
Sunday	1.28	1.26	2.02	12.9	11.4	62.5
Weekends	1.27	1.28	1.47	11.7	12.4	25.3
Weekdays	1.3	1.41	1.28	13.6	20.5	11.7
All Days	1.29	1.36	1.29	13.0	17.7	12.9
Southbound						
	Planning time index			Buffer Time (minutes)		
	All Day Average	AM Peak (6-9am)	PM Peak (4-7pm)	All Day Average	AM Peak (6-9am)	PM Peak (4-7pm)
Monday	1.32	1.67	1.47	15.0	38.0	24.9
Tuesday	1.34	1.31	1.38	15.6	13.7	18.4
Wednesday	1.3	1.33	2.6	13.3	15.4	99.6
Thursday	1.35	1.52	1.58	16.7	28.0	31.7
Friday	1.25	1.26	1.27	9.9	11.2	11.0
Saturday	1.25	1.4	1.23	10.3	20.2	9.4
Sunday	1.31	1.26	2.78	14.1	10.9	112.7
Weekends	1.28	1.26	1.46	12.0	10.7	24.6
Weekdays	1.31	1.35	1.33	13.5	16.6	15.1
All Days	1.29	1.32	1.33	12.8	14.7	15.4

Application

These data measure the travel time risks along I-81. Thus they can be used by trucking firms and logistics companies to assess the extra time needed to assure an on-time arrival. Just as the analysis shown here focused on specific counties, individual firms could generate data that are relevant for their specific routes and customers.

The bottleneck data provides geographically specific information regarding where and when to expect unplanned delays. The RITIS bottleneck index also shows the relative severity of these events and the frequency of occurrence. The buffer time and planning index analysis is not as precise in terms of location. Plus the results are averaged over time. But they also highlight areas with a higher risk of delay and provide estimates of the extra margin required to assure an on-time delivery.

The bottleneck data also provide state DOT and county transport planners with information regarding the location and severity of traffic problems. That is, they identify locations where a focus on reducing bottlenecks will provide a noticeable return in terms of reliability. This means that they can help set priorities for investment. The RITIS package also estimates the congestion costs for trucks and travelers in general. This is valuable information in terms of generating benefit-cost ratios or rates of return on investment. These data do not identify the specific problem that has created the delay, nor do they highlight the best solution.

These data, however, do make it possible to monitor changes over time in order to assess the impact of improvements that the DOT or county officials may have taken. This is important information as part of performance analysis and asset management.

The bottleneck data can help identify locations where it may be best for truckers to consider alternative places to stop for rest. Table A-V-5 shows how far a truck could travel in eight hours heading south from Harrisburg for different departure times. Rest times are not included in the eight hours. Based on average conditions, there is little difference between the expected distances. But, if the company (and driver) want to have a high probability of reaching their destination on time, they should use the buffer index information. This reduces the expected distance within eight hours driving time by between 56 miles (noon departure) and 72 miles (6 PM departure). In sum, the "cost" of a high probability of arriving on time ranges between 12 and 15 percent. This also has implications for where the driver will need to find a rest stop of truck stop.

Table A-V-5 Travel Distances from Harrisburg, PA Southbound in Eight Hours of Driving Time

(First Quarter of 2014)

Schedule	Distance based on average travel time	Distance with 95% assurance	Difference (miles)	Difference (percent)
8 AM start	478.4 miles	416.2 miles	- 62.2 miles	-13.0 percent
Noon start	479.5 miles	423.1 miles	- 56.4 miles	- 11.8 percent
6 PM start	473.4 miles	401.8 miles	- 71.6 miles	- 15.1 percent

The results can support economic development efforts. They provide a consistent measure of expected delays. The results can be compared with competing corridors – say I-95. The analysis regarding travel distances with and without assurance of arriving on time (Figure A-V-6) shows that trucking companies traveling on I-81 south of Harrisburg face a 12-15 percent margin in order to adjust for traffic uncertainty. This shows the tangible economic value in reducing bottlenecks. Adding an additional 50-70 miles to a day's travel has a significance impact on the market area that can be served from I-81. These results could be compared with similar reliability penalties for other corridors – say I-95 heading south from Philadelphia.

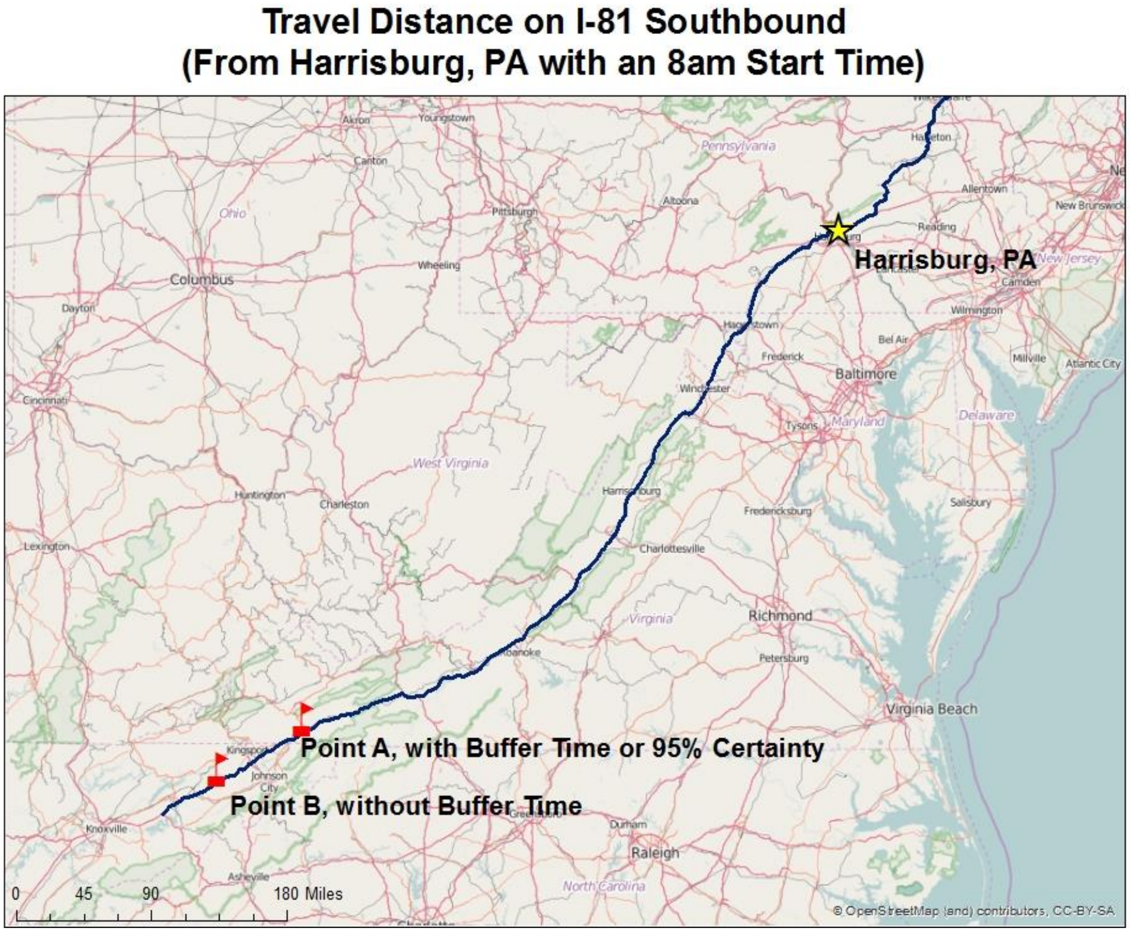


Figure A-V-6 Travel Distance on I-81 Southbound (From Harrisburg, PA with an 8am Start Time)

APPENDIX VI - ALTERNATIVE RAIL OPTION FOR I-81

Background

Freight transportation is a really a purchased service agreement made between shippers or receivers and carriers and/or third party logistics (3PL) companies. Purchasing decisions are usually based on multiple factors including: cost, speed, reliability, service quality, in-transit visibility, ability to adapt to changing needs while in transit, and safety and security, and more often in today's tight truck market, the ability to provide the needed capacity. Ideally, shippers/receivers would be mode agnostic, not caring which mode of transportation was used, as long as their service criteria were met.

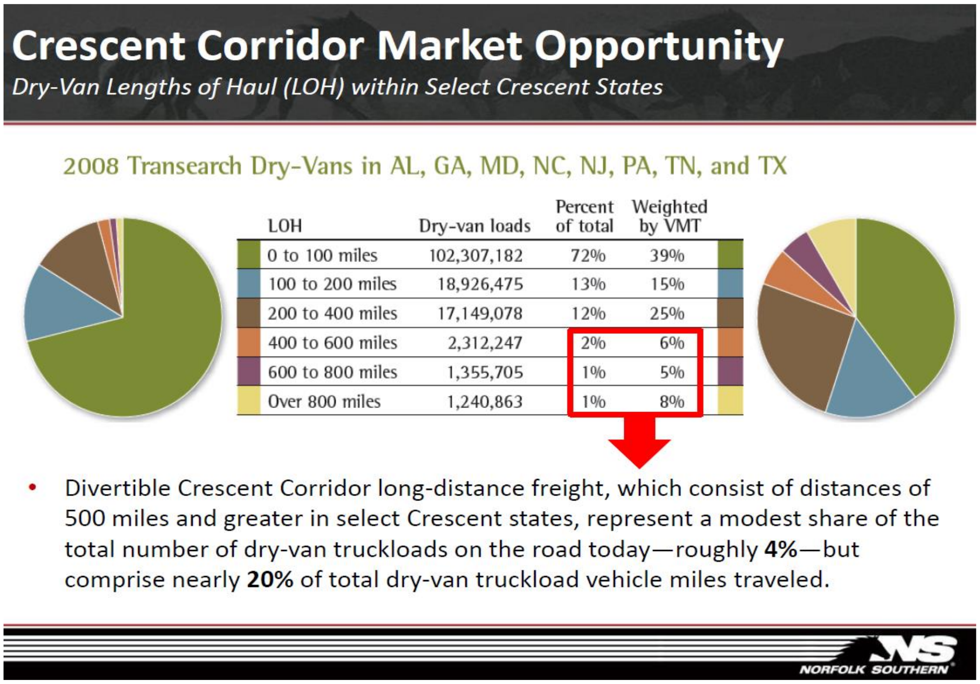
Interstate 81 is the most truck intensive corridors in the U.S. and the truck traffic is growing faster than the national average.[10] In a history of the economic development of Interstate 81 the Federal Highway Administration (FHWA) called the I-81 Corridor "one of the most strategically important north-south trucking routes."[11] Furthermore, the FHWA study points out that the roadway was originally designed to carry trucks, but it was assumed that only 15 percent of the vehicular traffic would be trucks. "Statistically, on some segments, one in three vehicles would be classified as a heavy commercial vehicle."[12] Securing funding to expand the capacity of I-81 has been difficult. Given the escalating growth of traffic in the corridor moving freight out of trucks and onto the rail makes good economic sense.

Norfolk Southern's (NS) Crescent Lines run roughly parallel to the corridor and are not near capacity making them an excellent alternative to the growing level of truck traffic on I-81. During the last decade numerous studies of the traffic diversion possibilities have been undertaken and concluded that there is enough divertible traffic that could be siphoned off to rail.[13] NS estimated that their market share of long distance dry van truckloads could be about four percent of the total moves or about 20 percent of the truck vehicle miles[14] (see Figure A-VI-1)

Recognizing the diversion potential CSX and NS have entered into public-private partnerships and have invested heavily in adding and upgrading track, removing

10 Go-81, "I-81 Corridor Freight Information System (CFIS) FHWA Grant Application," http://www.ctb.virginia.gov/resources/2014/may/reso/Resolution_Attachment_Agenda_Item_3_Appendix_C.pdf, p.4.
11 FHWA, "Economic Development History of the I-81 Corridor," http://www.fhwa.dot.gov/planning/economic_development/studies/i81pa.cfm.
12 Ibid.
13 See for instance, Norfolk Southern's "Norfolk Southern and the Crescent Corridor along Interstate 81," http://www.ship.edu/uploadedFiles/Ship/I81/Presentations/Wilson_NorfolkSouthern_11_10.pdf; VDOT's "Feasibility Plan for Maximum Truck to Rail Diversion in Virginia's I-81 Corridor," http://www.drpt.virginia.gov/media/1141/i-81-freight-rail-study-final.pdf; VDOT's "Freight Diversion and Forecast Report," http://www.virginiadot.org/projects/resources/freight.pdf.
14 Ibid. Norfolk Southern's "Norfolk Southern and the Crescent Corridor along Interstate 81," p. 15.

impediments to double stack containers, and building intermodal terminals and other infrastructure in the states that I-81 serves.



LOH	Dry-van loads	Percent of total	Weighted by VMT
0 to 100 miles	102,307,182	72%	39%
100 to 200 miles	18,926,475	13%	15%
200 to 400 miles	17,149,078	12%	25%
400 to 600 miles	2,312,247	2%	6%
600 to 800 miles	1,355,705	1%	5%
Over 800 miles	1,240,863	1%	8%

Figure A-VI-1 Norfolk Southern's Diversion Estimates

In a diversion feasibility study prepared by Virginia Department of Transportation (VDOT) and the Virginia Department of Rail and Public Transportation (DRPT), it was estimated that approximately 2.5 million trucks annually had potential for diversion.[15] In 2013 when NS opened its new Franklin County Regional Intermodal Center in Pennsylvania it was projected that the terminal, along with the other NS terminals in the state, could divert as many as 800,000 long-haul truck moves in Pennsylvania by 2020[16].

The Interstate 81 corridor has a rail network that provides service to intermodal facilities along its 855 miles. The primary Class I railroads running north-south are NS' Crescent Lines, which parallel I-81 from east Tennessee up to Harrisburg, Pennsylvania and then east to the NY/NJ Ports and north through New York. There are several other Class I rail lines that feed traffic onto I-81 including CSX's National Gateway Line and NS's Heartland

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[15] VDOT's "Feasibility Plan for Maximum Truck to Rail Diversion in Virginia's I-81 Corridor," http://www.drpt.virginia.gov/media/1141/i-81-freight-rail-study-final.pdf, p.13.

16 Norfolk Southern, "Norfolk Southern's new Pennsylvania rail-truck terminal speeds freight and benefits the environment,) Jan.31. 2013, http://www.nscorp.com/content/nscorp/en/news/norfolk-southerns-new-pennsylvania-rail-truck-terminal-speeds-freight-and-benefits-the-environment.html.

Corridor Line. In addition there are numerous smaller railroads operating within the I-81 corridor. The map in Figure A-VI-2 shows the rail lines and the intermodal terminals which provide service to the I-81 corridor.

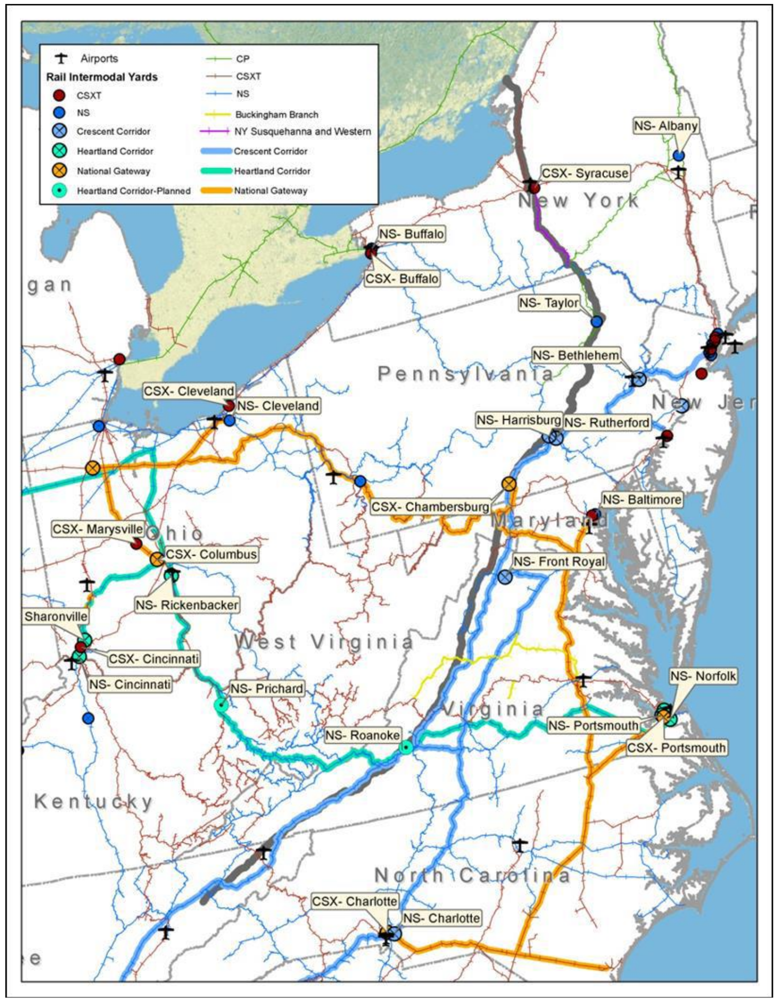


Figure A-VI-2 Map of Rail Lines Serving I-81

The Harrisburg area is one of NS's three primary intermodal hubs. The Harrisburg Intermodal Yard (Lucknow Terminal) and Rutherford Yard, have both grown in activity as transfer points where rail freight from distant locations in the Midwest and South is transferred to trucks and regional rail lines for distribution within the northeastern U.S.

The Virginia Port Authority operates an "inland port" in Fort Royal on I-66 near its junction with I-81. Containers are imported at marine terminals in the Hampton Roads area and transported via NS to the Virginia Inland Port, from there they are trucked to distribution centers in the I-81/Shenandoah Valley and to destinations in Pennsylvania and in the Ohio River Valley.

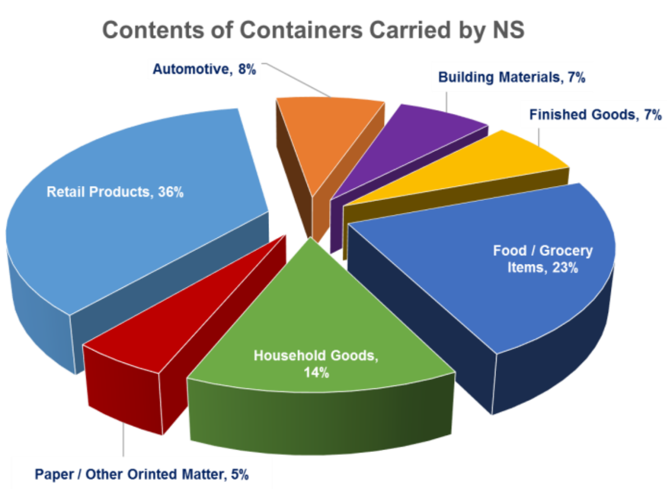
Trucking accounts for more than 80 percent of the freight traffic moving in the I-81 corridor despite the presence of rail options.[17] NS made and is continuing to make significant

17 Virginia Commonwealth Transportation Board, Virginia's Long-Range Multimodal Transportation Plan, Corridors of Statewide Significance: Crescent Corridor, page 2-2, http://www.vtrans.org/resources/crescent%20corridor%20(i-81).pdf.

investment in its Crescent Lines because it believes that there is significant potential for growth in rail service because[18]:

- the long haul intermodal services along I-20, I-40, I-75, I-85 and I-81 Corridors are largely undeveloped;
- there is significant highway congestion along many portions of these routes; and,
- there is existing intermodal and motor carrier interest in developing services in this corridor.

In its analysis NS estimated that almost 60 percent of the goods moved by intermodal rail in the corridor are retail products and food and grocery Items. (See Figure A-VI-3). 2014 shipment data from Parson's Real-Time Freight Intelligence (RTFI) shows that the truck loads moved in the I-81 corridor comprise the same types of goods – 35 percent is food or food products; 17 percent is chemicals, mostly household chemicals and pharmaceuticals; 7 percent is automotive and vehicle components and parts; 6 percent is electrical equipment, appliances and components; and 16 percent is mixed freight, which is generally consumer goods, such as clothing, toys, and electronics. This similarity in goods carried increases the possibility of diversion.



Source: "Norfolk Southern and the Crescent Corridor along Interstate 81," Norfolk Southern, p.28

Figure A-VI-3 Commodities Carried on Norfolk Southern's Crescent Corridor Intermodal Trains

The growing congestion on the I-81 corridor and the numerous chokepoints, that not only hinder the timely movement of freight, but also lead to higher accident rates, are an impetus to move some of the current traffic and much of the future traffic from highway to rail. Many states in the corridor, as well as the railroads serving the corridor, have invested heavily on improvements designed specifically to encourage truck traffic diversion. Impediments to double-stacking containers have been removed and new intermodal facilities have been constructed or are planned. In

18 Slide from Norfolk Southern Presentation ' Intermodal & Automotive," by Mike McClellan, Vice President – Intermodal and Automotive Marketing. http://www.sec.gov/Archives/edgar/data/702165/000070216507000154/mcclellan1.htm.

addition, both NS and CSX have improved their connections to east coast ports and the central part of the U.S. Lanes dedicated to intermodal traffic have been put in place to reduce delivery time and ensure on-time delivery.

Not all traffic on I-81 is suitable for conversion to rail however, so before designing a strategy it is necessary to come up with a methodology to determine what traffic currently traveling by truck is potentially divertible. For instance, one of the first steps in the analysis must be determining the characteristics of goods that can be carried by both rail and truck. These characteristics include type of commodity, length of haul, size of shipment, availability of suitable intermodal infrastructure, among others. Evaluating the potential for truck diversion to rail should be done in a systematic repeatable way, using the most detailed current data available. Such a methodology is described below, along with an example applying the methodology.

Methodology

To determine the possibility for diversion to rail of freight currently traveling by truck on the I-81 corridor, it is necessary to analyze current freight patterns and trends, the types and volume of products being moved. Parsons' RTFI provides the rich data with the needed depth of coverage to evaluate diversion possibilities for I-81 (see inset box on next page for more detailed information). This data includes all of the elements necessary to perform the analysis. One of the unique characteristics of this data is the availability of shipping cost data. In today's supply chain environment shippers/receivers are often mode agnostic. They want their goods where they need them, when they want them and at the lowest cost. Most items are not so time-sensitive that the fastest option is the best option. For most goods shippers/receivers can plan for the difference in shipping time between the modes as long as the goods arrive reliably on time and in good condition, so the differentiator is often the cost to ship. No other primary data source includes cost to ship, an important variable in the choice of a carrier. Another benefit of the RTFI data is its timeliness because it is near real-time with new data being added monthly.

The proposed methodology involves multiple steps, each of which are described in following sections. They include:

- Determination of criteria – what are the determinants of whether a truckload can potentially be moved to rail?
- Identification and selection of prospective origin-destination (O-D) pairs – which pairs of origins and destinations in the study area along I-81 meet the criteria for diversion, most notably length of haul?
- Extraction of the data – out of the universe of truck moves for the selected O-D pairs for which we have data which meet the minimum criteria for diversion and further study?
- Analysis of the data and summarization of the results.

Parsons Real-Time Freight Intelligence (RTFI)

Parsons has established a set of analytics that makes it possible to examine freight movements in a more comprehensive way. Parsons combines exclusive and publicly available datasets with expert transportation consultant skills. RTFI utilizes more than 45 data public and private sources to identify and track trends in freight movement including:

Proprietary detailed freight waybill data from more than 25 million shipments annually, representing $26 billion in freight transactions. The data covers all modes and includes origin, destination, mode, commodity, tonnage, mileage, shipping costs with linehaul and accessorials, such as fuel surcharges, broken out separately. The data provides analysis of historical trends and modal shifts, as well as current freight flows and modal distributions

Port Import Export Reporting Service (PIERS) – a private source of maritime data collected by the Journal of Commerce's that includes data collected from more than 17 million bills of lading for all waterborne cargo entering or exiting the U.S. The detailed data includes twenty foot equivalent units (TEUS), tonnage, commodity, estimated value of the cargo.

Commodity Flow Survey (CFS) - primary source of national and state-level data on domestic freight shipments by American establishments in mining, manufacturing, wholesale, auxiliaries, and selected retail and services trade industries. Data are provided on the types, origins and destinations, values, weights, modes of transport, distance shipped, and ton-miles of commodities shipped. The CFS is a shipper-based survey and is conducted every five years as part of the Economic Census.

Freight Analysis Framework (FAF) - produced through a partnership between Bureau of Transportation Statistics (BTS) and Federal Highway Administration (FHWA). FAF integrates data from a variety of sources to create a comprehensive picture of freight movement among states and major metropolitan areas by all modes of transportation. Starting with data from the 2012 Commodity Flow Survey (CFS) and international trade data from the Census Bureau, FAF incorporates data from agriculture, extraction, utility, construction, service, and other sectors.

Import/Export data – Customs based data the U.S. Census Bureau, Foreign Trade Division.

Waterborne Commerce Statistics – data collected by the Army Corps of Engineers covering inland waterways and ports. The data includes commodities, tonnage, length of haul, and where the shipment traveled on the water.

Tolling Data – collected from a variety of sources including states and tolling authorities.

Cass Information Freight Indexes – monthly index series calculated that includes indexes for total expenditure for freight and total number of shipments based on the freight waybills that go through their freight payment system.

Vehicle Probe data – private data collected and disseminated by a variety of sources such as ATRI, INRIX, NAVTEQ

U.S. Maritime Administration data

Bureau of Transportation Statistics – produces a wide variety of freight movement data including the North American Foreign Trade Act (NAFTA) database, cargo airline statistics, Commodity Flow Survey, and other modal data.

Rail Waybill – based on a 1 percent sample of U.S. railroad waybills. A version of the data masked to remove sensitive competitive information is available from the STB. The Association of American Railroads also produces rail carload and intermodal statics by commodity on a weekly basis.

Criteria Determination

Not all traffic moving on trucks in the I-81 corridor is suitable for diversion. Distance traveled, type of commodity and even type of truckload influence whether or not a truckload is divertible.

Distance traveled must be over 250 miles, and given the distance between intermodal facilities along I-81, probably more. Typically a rail intermodal move has been most efficient at over 1,000 miles, however with the addition of new intermodal terminals and alliances between major tracking companies and railroads the sweet spot has fallen to the 500 to 700 mile length of haul.

Commodity carried must be a commodity that is suitable both for truck and rail, especially commodities that can travel in containers. Many earlier studies have honed down the list of divertible commodities that trucks are carrying and looking at the commodities rail intermodal is already carrying is useful. These commodities are typically considered as possible for diversion:

- Metal Products
- Food and Kindred Products
- Consumer Goods
- Forest Products & Lumber
- Transportation Equipment and Parts
- Chemicals
- Non-metallic Minerals
- Paper
- Clay/Concrete/Glass
- Waste
- Mail
- Electrical Equipment.

(This Divertible Commodities List is be subject to refinement.)

Available infrastructure must be available on both ends of the trip. This includes transload facilities, intermodal terminals, ports or private facilities with the proper equipment. Another big consideration at every technically suitable location is the availability of sufficient dray trucks to start or finish the journey. This element requires the use of additional information and maps.

Travel time/Reliable Delivery – should be longer travel times, especially those that are longer than one day which would require rest periods for the truck driver. Truck travel times can be compared to published rail schedules. In addition, it is useful to check and on-time delivery statistics that may be available.

Type of truck – most truck types, including temperature controlled, can be included in the study. Generally tank trucks and some specialty trucks do not carry commodities readily convertible to a container or trailer.

Size of shipment –only truckload shipments were to be considered for the analysis because LTL shipments generally involve frequent stops along the way to pick or deliver goods directly to the customer, a service railroads cannot provide. LTL truck shipments are not considered competitors of rail.

Shipment volume – tons of commodity shipped; rail is suitable for carrying commodities moving in high volume.

(These selection parameters may be refined as the data is analyzed.)

Figure A-VI-4 Norfolk Southern's Crescent Corridor

Origin-Destination (O-D) pairs need to be selected to study. This traffic being considered for diversion must originate and terminate in markets along I-81 or nearby in the corridor or along routes that that feed truck traffic onto 1-81 and could also be transferred to NS' Crescent Corridor Lines. NS' Crescent corridor was selected because it feeds into and then parallels I-81. It also has numerous intersection points with intermodal facilities on the line or nearby. (See Figure A-VI-4)

The O-D pairs must involve travel of at least 250 miles and can begin or end within a radius of 50 miles of I-81. This is to enable the inclusion of truck traffic that originates terminates off of I-81, for instance, at a factory or distribution center, but travels a significant distance on I-81. The sweet spot for intermodal rail is in the 400 to 700 miles range. Although 250 miles is on the low side, the length of intermodal shipments has been dropping. If sufficient traffic volume could be captured and the requisite infrastructure is available, shorter distances may be considered in this heavily traveled corridor.

Data Extraction

For each of the selected O-D pairs, data for truck and rail movements between each pair, traveling in both directions, were extracted from Parsons' RTFI database.

The specific data that were extracted for each movement are:

- Origin and destination (available to the street address level)
- Mode (rail, intermodal, and relevant truck types, i.e., truckload only, no LTL)
- Commodity (broken out to the six digit NAICS[19] code level)

[19] The North American Industry Classification System (NAICS) is the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy.

- Size of shipment (shipment weight in short tons[20])
- Length of haul (distance the shipment traveled in miles)
- Cost to ship (line haul charge[21] and accessorial charges[22], each broken out separately).

Data Analysis

The RTFI truck data were processed in several steps. First the data were filtered to retain only those movements of goods on the Divertible Commodities List that can potentially be diverted to rail. Second, the truck movements within each commodity group were filtered to eliminate shipments under 250 miles. Third, the O-D pairs were checked to determine if rail infrastructure is available using Norfolk Southern system maps to identify intermodal interchange points and maps from other studies and Google maps to identify factories and distribution centers within the 50 mile radius. Finally, the data were reviewed for reasonableness and adjusted as necessary to arrive at a subset of shipments with the highest possibility of diversion to rail.

For each O-D pair direction (two groups for each O-D pair) the filtered truck data were analyzed and then summarized by commodity into averages by:

- Size of shipment or Tonnage
- Length of haul
- Cost to ship
- Total Cost (line haul plus accessorials)
- Line haul cost
- Accessorial charges
- Total Cost per Ton
- Total Cost per Mile
- Total Cost per Ton-Mile

For each O-D pair direction (two groups for each O-D pair) the filtered rail data were analyzed and then summarized by commodity into averages by:

- Size of shipment or Tonnage
- Length of haul
- Cost to ship
- Total Cost (line haul plus accessorials)
- Line haul cost

20 The short ton is a unit of weight equal to 2,000 pounds and is most commonly used in the U.S., where it is known simply as the ton.

21 Line haul charge is the base charge for the movement of cargo between and origin and destination.

22 Accessorial charges are charges made for performing freight services beyond normal pickup and delivery such as inside delivery, waiting time, fuel surcharges, expedited fees, inspection fees, tolls, drayage, storage charges, etc. It also includes hazardous materials charges.

- Accessorial charges
- Total Cost per Ton
- Total Cost per Mile
- Total Cost per Ton-Mile

The potentially divertible truck movements were matched up to similar rail movements and evaluated using the established criteria to rank truck movements in terms of potential for diversion. A series of tables were created to show the percentage of truck movements that could be diverted using the various criteria.

Example

There are many O-D Pairs that meet the criteria for potential diversion to rail. The evaluation looked at one example in terms of high volumes of goods being moved or terminated, divertible commodity, etc.

A high level preliminary analysis was done of shipments from the Memphis, Tennessee area to the Harrisburg, PA area. For this analysis a radius of approximately 50 miles was drawn around Memphis, TN and Harrisburg, VA, both cities where NS has intermodal terminals. The distance between the two cities is approximately 940 miles, or about 14 hours driving time. The zip codes within that radius were selected for inclusion in the data grab from the RTFI database. Zip codes in the radius which would entail significant backtracking to go to Memphis to be loaded on a train or were more likely to take a nearby highway that does not connect to I-81 should be culled from the list, resulting a circle with a pie slice removed. (N*ote: for this preliminary example all zip codes within the counties that fell in 50 miles radius were included. Also there was no culling of zip codes that would have represented a backtracking. This would not happen in a detailed analysis.)*

First, data for both truck and rail movements were extracted from the dataset, resulting in records for 7,425 shipments. This data was then stratified by commodity and the commodities were compared to the Divertible Commodities List. The data was then filtered to exclude the records for movements involving commodities that were not suitable for movement by rail.

Almost one half of the remaining shipments were NAICS Code 311212 Rice Milling[23] so this commodity was selected for analysis. The data for moves involving NAICS Code 311212 were analyzed to determine if they were moving in vehicle configurations that could be readily transloaded to rail. Of the 3,129 possible truck movements all were moving either by truckload or already in containers that could be moved on rail making them all potentially divertible. 3,006 movements were in containers and moved by an intermodal combination of truck/rail/truck. 123 were moved by truck only.

23 This U.S. industry comprises establishments primarily engaged in one of the following: (1) milling rice; (2) cleaning and polishing rice; or (3) milling, cleaning, and polishing rice. The establishments in this industry may package the rice they mill with other ingredients.

Finally, summaries for the following were calculated for each truck type, e.g., dry van versus temperature controlled, and for rail so comparisons could be made:

- Number of shipments
- Average length of haul
- Average Total Shipment Cost
- Average Accessorial Charges
- Average Total Cost per Ton
- Average Total Cost per Ton-mile.

The results were:

The average total cost per ton-mile and per ton were higher for truck than either the intermodal truck shipments (which are lower because a part of their cost includes a rail movement) or the rail movements. Table 1 contains the results. The figures show the comparison between truckload shipments, intermodal shipments and rail shipments.

Mode	Number of Shipments	Length of Haul (miles)	Average Total Shipment Cost	Average Accessorial Charges	Average Shipment Weight	Average Total Cost Per Ton	Average Total Cost Per Ton-mile
TL	129	896	$ 2,307.25	$ 516.34	41,731	$ 110.58	0.1230
IP	3,006	914	$ 1,720.89	$ 502.29	42,237	$ 81.49	0.0892
Rail	439	839	$ 4,570.57	$ 838.56	122,253	$ 74.77	0.0818
Total	3,574	913	$ 2,092.09	$ 544.10	52,047	$ 80.39	0.0880

Truck drive time is 14 hours, which will involve an overnight stop due to mandated Hours of Service Rules. NS says it can make delivery between Memphis, TN and Harrisburg, PA in 32 hours.[24]

Table A-VI-1 Shipments of NAICS Code 311212 Rice Milling Products Moving From Memphis, TN to Harrisburg, PA

TL = Truckload IP = Intermodal (Two of these containers fit on a single railcar)

The total number of shipments in the Memphis, TN to Harrisburg, PA filtered dataset was 3,574. Over 84 percent of the shipments were already moving by intermodal rail with an average length of haul of 914 miles (See Figure A-VI-5). The distance traveled for these moves include the drayage moves handled by trucks on either end. This accounts for the higher mileage than railroad moves, which at 839 miles only includes the distance between

24 Norfolk Southern presentation by Drew Marrs, "Norfolk Southern Railway The Past, The Present, The Future of Freight Transportation," October 20, 2011, p. 31,

the two rail points of origin and destination. The 129 truck shipments averaged 896 miles which reflects the more direct route deliveries from origin to destination.

Shipments by rail only weighed 122,253 pounds in a single load (See Figure A-VI-6). This is considerably higher that the shipment weight for truckload and intermodal moves at around 42,000 pounds each. With a few exceptions trucks can only carry one container and are limited by size and weight restrictions on interstates. The shipments labeled intermodal in the data also moved by truck to the intermodal terminal and were similarly limited by weight restrictions. Rail, on the other hand, can carry multiple containers on a single car.

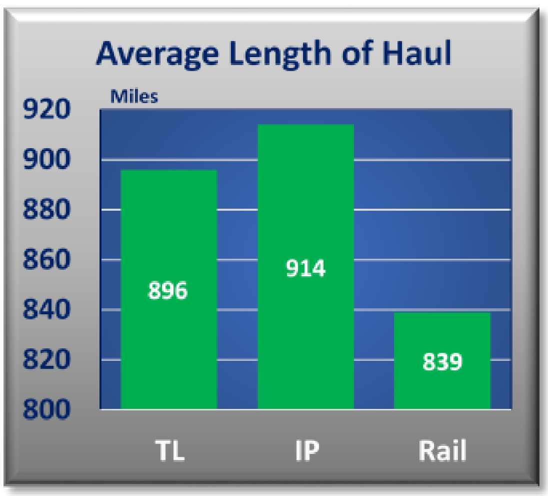


Figure A-VI-5 Average Length of Haul

Figure A-VI-6 Average Shipment Weight

Average Total Cost to Ship is much higher for rail than for truck to intermodal moves (See Figure A-VI-7). The difference can be accounted for by the larger shipment size for rail. Rail shipments often have higher accessorial charges than truck or intermodal moves, since many of those charges are related to the weight of the shipment. Note that the average total shipment cost for an intermodal moves is more than 25 percent lower than the truckload

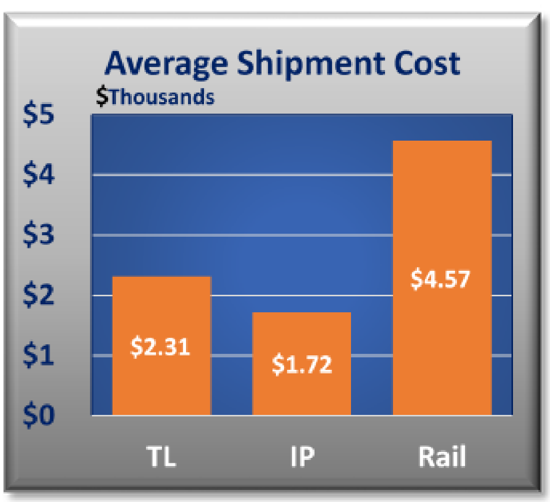


Figure A-VI-7 Average Shipment Cost

Figure A-VI-8 Average Cost per Ton

only move. This because the rail portion of the move is much less costly than truck only. This will be easier to see using average cost per ton or per ton-mile. (See Figures A-VI-8 and A-VI-9)

Figure A-VI-9 Average Cost per Ton-mile

The average cost per ton for truckload moves is 32 percent higher than the cost per ton for rail. Truck moves are generally faster than rail moves, but in the case of this commodity, rice milling products, the shipper and receiver made the trade-off to move the majority of their product by rail or rail intermodal at a lower cost. The shipper/receiver built the extra time into their schedule and depended on the rail service to be reliable. In this example only 129 shipments out of 3,574 went by truck only. The intermodal moves are higher than the rail only moves because of the drayage cost included on each end.

Rates are quoted in cents per ton-mile more often than per ton because this also includes a representation of the length of haul. Once again rail has the advantage with the lowest cost per ton-mile and truck is more than 33 percent higher. The rail and the intermodal moves will be even more cost effective the longer the length of haul.

Summary

Faced with the reality that there are more highway infrastructure needs than there is funding, even for such a truck-intensive road as Interstate 81, state DOTs and state, regional and local planners need to look to other opportunities to increase capacity in important corridors. If freight rail is available in the corridor than one significant possibility is the diversion of a portion of the truckload traffic to intermodal rail. This option may also require funding to build or enlarge intermodal terminal facilities, but the cost should be a fraction of the cost of building new highway and likely can be accomplished more quickly.

In the last decade all modes of domestic freight transportation have come close to mastering on-time reliability, barring circumstances beyond their control such as weather. Most carriers are able to provide in-transit visibility of customers’ shipments. Basically, except for special cargoes or time-sensitive shipments, shippers and carriers are purchasing a set of agreed upon delivery parameters and service level for transporting their goods. The actual mode of transportation is not as important as the cost to ship, meaning they would be indifferent between intermodal and truck, choosing the mode offering the lowest cost to meet their service needs. This notion of a shipper being mode agnostic is more simplistic than all of the other things that come into play in the supply chain. For instance, the trucking industry is currently over 95 percent engaged, with inconsistent shipment volume and a truck driver shortage stopping carriers from investing in new capacity. So rather than putting cost as first in decision-making, a shipper may choose guaranteed availability of capacity at a higher cost. This is mentioned to acknowledge that there are many other considerations that go into freight transportation choices that a simple determination if a truck shipment meets the minimum criteria for diversion. This also means the all of the shipments that are deemed divertible by the methodology suggested here will not actually be moved to rail.

Determining whether freight diversion to rail is viable requires a solid and repeatable evaluation methodology than can be accomplished with readily available data. For the best results the data should be available in sufficient local detail, be as current as possible and include cost to ship. The high level example provided herein used a private source of data, Parsons' Real-Time Freight Intelligence. It has the benefits of having shipment records with origin and destination available down to the street address (zip code level was used in this example); includes all modes of transportation, has 6-digit NAICS code commodity detail, and has detailed shipment cost information. In addition the data is updated monthly.

Designing the methodology was fairly straightforward. Determining whether trucks are moving shipments which make them possible to also move by rail entails designing criteria that would make a shipment divertible. The first step is to choose an origin-destination pair that has intermodal facilities at both end. Following that the shipments need to meet other criteria such as a shipment of a group of commodities that can and already does move both by truck and rail, or a shipment with a minimum length of haul of 250 miles (the longer, the better), or an origin or destination with sufficient product volume to warrant an intermodal train between the two points. Once the data was filtered to include only those truckload shipments that met the minimum requirements for divertibility then shipment cost could be factored in.

This methodology can be used to determine origin-destination pairs that have great promise for the diversion of multiple commodities now carried in trucks by focusing on O-D pairs with the largest number of divertible shipments. This information could be used to determine where to invest in intermodal infrastructure if it is currently not present. By focusing on the commodities with the largest divertibility in an area planners may be able to work with manufacturers or distribution centers to more efficiently ship via intermodal rail. DOTs could focus on areas with the highest congestion and determine the origins and destinations of the trucks moves to determine if diverting a portion of the traffic to rail would improve the situation. For instance, much of the traffic on I-81 in Virginia is thru traffic, with both an origin and destination outside the state, studying the composition of the traffic may enable VDOT to facilitate the use of rail reducing the severe congestion in Front Royal.

NS railroad already has available capacity and has the ability and resources to increase the capacity on its Crescent Corridor lines to absorb traffic currently moving by truck on I-81. Taking some of the truck traffic off of I-81 will reduce congestion and accidents. It will also buy some much needed time to find funding to upgrade and expand the I-81 roadways.