VTRC
Virginia Transportation Research Council

We Bring Innovation to Transportation

Traveler Information for the Commercial Vehicle Operations Community

ALEJANDRA MEDINA FLINTSCH
Senior Research Associate, Center for Infrastructure Based Safety Systems

YINGFENG (ERIC) LI, Ph.D., P.E.
Senior Research Associate, Center for Infrastructure Based Safety Systems

CRISTIAN DRUTA
Senior Research Associate, Center for Infrastructure Based Safety Systems

RONALD GIBBONS, Ph.D.
Director, Center for Infrastructure Based Safety Systems

ANDREW KASSING
Project Assistance, Center for Infrastructure Based Safety Systems

BRIAN WILLIAMS
Research Associate, Center for Infrastructure Based Safety Systems

ANDREW MILLER
Research Associate, Center for Truck and Bus Safety

MATTHEW CAMDEN
Research Associate, Center for Truck and Bus Safety

Virginia Tech Transportation Institute

Final Report VTRC 20-R3

Standard Title Page - Report on Federally Funded Project

1. Report No.: FHWA/VTRC 20-R3	2. Government Accession No.:	3. Recipient's Catalog No.:

4. Title and Subtitle: Traveler Information for the Commercial Vehicle Operations Community	5. Report Date: October 2019
	6. Performing Organization Code:

7. Author(s): Alejandra Medina Flintsch, Yingfeng (Eric) Li, Ph.D., Cristian Druta, Ronald Gibbons, Ph.D., Andrew Kassing, Brian Williams, Andrew Miller, and Matthew Camden	8. Performing Organization Report No.: VTRC 20-R3

9. Performing Organization and Address: Virginia Tech Transportation Institute 3500 Transportation Research Plaza (0536) Blacksburg, VA 24061	10. Work Unit No. (TRAIS):
	11. Contract or Grant No.: 110698

12. Sponsoring Agencies' Name and Address: Virginia Department of Transportation Federal Highway Administration 1401 E. Broad Street 400 North 8th Street, Room 750 Richmond, VA 23219 Richmond, VA 23219-4825	13. Type of Report and Period Covered: Final
	14. Sponsoring Agency Code:

15. Supplementary Notes: This is an SPR-B report.

16. Abstract:

Traveler information is critical for the safety and efficiency of commercial vehicle operations (CVO). The objectives of this project are to (a) review traveler information technologies and practices in Virginia, (b) understand CVO community information needs, (c) document data availability to support a CVO information system, and (d) recommend a framework for a comprehensive Virginia CVO information system and develop recommendations for improvements to CVO traveler information systems in Virginia. The research team followed a multi-pronged approach to capture CVO stakeholders' opinions, which included a survey of truck drivers, interviews with carriers and other public and private-sector stakeholders, and a thorough review of other states' truck traveler information initiatives. Carriers and truck drivers relied on several communications tools to select the "best" routing. Business models and available resources vary considerably among truck drivers and different carriers. In general, the traveler information provided by the Virginia Department of Transportation (VDOT) received positive ratings. Truck drivers and carriers put special emphasis on the need for accurate and real-time data to make informed decisions.

Based on the information collected, the researchers identified the main issues faced by the CVO community in several key areas and the main gaps in the existing practice; the researchers proposed possible actions to fill these gaps. These potential actions were ranked based on potential cost and implementation difficulty level, and were organized based on the channel most likely to be used for implementation. The study found that, while VDOT has traditionally served as collector, aggregator, provider, and presenter of data, the private sector is now participating in almost all of these roles. There is agreement among stakeholders that VDOT's major role in the CVO traveler information network must be as a data provider and facilitator to maximize the use of the data and development of new tools. An ideal system will not only provide coverage for the whole state (towns and cities included), but will also have connectivity with other states. Especially important is the development of applications that provide real-time information for truck drivers regarding presence of work zones, incidents, and traffic congestion.

Main recommendations include: (1) enhancing functionality of the trucking resource page to make information (e.g., route and bridge restriction information, work zones, and incidents) more easily accessible and publicizing this resource to the wider CVO community; (2) maximizing data sharing and outreach of available information and creating a forum to discuss with private stakeholders the best way to share available data; (3) enhancing the available truck restrictions maps by integrating length restrictions, posted bridges, and height restriction data, as well as adding at least pre-trip/stop routing capabilities; (4) expanding the current 511 systems to include truck-specific data; and (5) reviewing existing signed route restrictions for adequacy and conspicuity and providing statewide guidelines. The implementation of these recommendations will enhance the availability of information and promote collaborations between public and private stakeholders to implement new tools and applications. Collectively, this will help enhance CVO, minimize violations, and contribute to safer and more efficient truck operations in Virginia.

17 Key Words: Trucks, traveler information, commercial vehicle operations	18. Distribution Statement: No restrictions. This document is available to the public through NTIS, Springfield, VA 22161.

19. Security Classif. (of this report): Unclassified	20. Security Classif. (of this page): Unclassified	21. No. of Pages: 96	22. Price:

Form DOT F 1700.7 (8-72)   Reproduction of completed page authorized

FINAL REPORT

TRAVELER INFORMATION
FOR THE COMMERCIAL VEHICLE OPERATIONS COMMUNITY

Alejandra Medina Flintsch
Senior Research Associate, Center for Infrastructure Based Safety Systems

Yingfeng (Eric) Li, Ph.D., P.E.
Senior Research Associate, Center for Infrastructure Based Safety Systems

Cristian Druta
Senior Research Associate, Center for Infrastructure Based Safety Systems

Ronald Gibbons, Ph.D.
Director, Center for Infrastructure Based Safety Systems

Andrew Kassing
Project Assistance, Center for Infrastructure Based Safety Systems

Brian Williams
Research Associate, Center for Infrastructure Based Safety Systems

Andrew Miller
Research Associate, Center for Truck and Bus Safety

Matthew Camden
Research Associate, Center for Truck and Bus Safety

Virginia Tech Transportation Institute

Project Manager
Michael D. Fontaine, Ph.D., P.E., Virginia Transportation Research Council

DISCLAIMER

The project that is the subject of this report was done under contract for the Virginia Department of Transportation, Virginia Transportation Research Council. The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Virginia Department of Transportation, the Commonwealth Transportation Board, or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation. Any inclusion of manufacturer names, trade names, or trademarks is for identification purposes only and is not to be considered an endorsement.

Each contract report is peer reviewed and accepted for publication by staff of the Virginia Transportation Research Council with expertise in related technical areas. Final editing and proofreading of the report are performed by the contractor.

ABSTRACT

Traveler information is critical for the safety and efficiency of commercial vehicle operations (CVO). The objectives of this project are to (a) review traveler information technologies and practices in Virginia, (b) understand CVO community information needs, (c) document data availability to support a CVO information system, and (d) recommend a framework for a comprehensive Virginia CVO information system and develop recommendations for improvements to CVO traveler information systems in Virginia.

The research team followed a multi-pronged approach to capture CVO stakeholders' opinions, which included a survey of truck drivers, interviews with carriers and other public and private-sector stakeholders, and a thorough review of other states' truck traveler information initiatives. Carriers and truck drivers relied on several communications tools to select the "best" routing. Business models and available resources vary considerably among truck drivers and different carriers. In general, the traveler information provided by the Virginia Department of Transportation (VDOT) received positive ratings. Truck drivers and carriers put special emphasis on the need for accurate and real-time data to make informed decisions. Based on the information collected, the researchers identified the main issues faced by the CVO community in several key areas, the main gaps in the existing practice, and proposed possible actions to fill these gaps. These potential actions were ranked based on potential cost and implementation difficulty level and were organized based on the channel most probable for implementation. The study found that, while VDOT has traditionally served as collector, aggregator, provider, and presenter of data, the private sector is now participating in almost all of these role. There is agreement among stakeholders that VDOT's major role in the CVO traveler information network must be as a data provider and facilitator to maximize the use of the data and development of new tools. An ideal system will not only provide coverage for the whole state (towns and cities included), but will also have connectivity with other states. Especially important is the development of applications that provide real-time information for truck drivers regarding presence of work zones, incidents, and traffic congestion.

Main recommendations include: (1) enhancing functionality of the trucking resource page to make information (e.g., route and bridge restriction information, work zones, and incidents) more easily accessible and publicizing their resources to the wider CVO community; (2) maximizing data sharing and outreach of available information and creating a forum to discuss with private stakeholders the best way to share available data; (3) enhancing the available truck restrictions maps by integrating length restrictions, posted bridges, and height restriction data, as well as adding at least pre-trip/stop routing capabilities; (4) expanding the current 511 systems to include truck-specific data; and (5) reviewing existing signed route restrictions for adequacy and conspicuity and providing statewide guidelines. The implementation of these recommendations will enhance the availability of information and promote collaborations between public and private stakeholders to implement new tools and applications. Collectively, this will help enhance CVO, minimize violations, and contribute to safer and more efficient truck operations in Virginia.

FINAL REPORT

TRAVELER INFORMATION
FOR THE COMMERCIAL VEHICLE OPERATIONS COMMUNITY

Alejandra Medina Flintsch
Senior Research Associate, Center for Infrastructure Based Safety Systems

Yingfeng (Eric) Li, Ph.D., P.E
Senior Research Associate, Center for Infrastructure Based Safety Systems

Cristian Druta
Senior Research Associate, Center for Infrastructure Based Safety Systems

Ronald Gibbons, Ph.D.
Director, Center for Infrastructure Based Safety Systems

Andrew Kassing
Project Assistance, Center for Infrastructure Based Safety Systems

Brian Williams
Research Associate, Center for Infrastructure Based Safety Systems

Andrew Miller
Research Associate, Center for Truck and Bus Safety

Matthew Camden
Research Associate, Center for Truck and Bus Safety

Virginia Tech Transportation Institute

INTRODUCTION

Freight transportation is a pillar supporting the development of the vibrant American economy. In 2015, the U.S. transportation system moved a daily average of 55 million tons of freight valued at more than $49.3 billion, and tonnage is expected to increase at about 1.4% per year until 2045. Of the 55 million tons moved around the nation and across its borders, approximately 70% was transported by trucks (USDOT, 2018). While playing a vital role in the state and national economies, large trucks were also involved in 475,000 police-reported crashes, including 3,684 fatal crashes in 2016 alone (NHTSA, 2018).

By 2040, it is projected that Virginia's state transportation system will carry 1 billion tons of freight annually, valued at $1.7 trillion (VTRANS, 2017). Virginia not only represents a significant share of the national economy, but the commercial vehicle community also provides vital freight transportation services for the state's economy and its businesses by transporting approximately 500 million tons and $481 billion worth of freight within and across the state

border each year, which is projected to increase to 838 million tons by 2040. The Commonwealth's pro-business climate makes it an attractive location for companies to consider basing their operations. While providing economic development benefits, the large volume of heavy trucks on the roadway system also results in a safety concern for many citizens. In 2014, for example, Virginia recorded 82 fatal crashes involving large trucks, translating to a loss of 90 lives. Providing a safe and efficient network for freight movement becomes an important mission for state transportation agencies such as the Virginia Department of Transportation (VDOT). Furthermore, the Moving Ahead for Progress in the 21st Century Act (MAP 21, 2012) and the later Fixing America's Surface Transportation Act (FAST Act, 2015) require states to provide, in their freight plans, evidence of consideration of innovative technologies and operational strategies that improve the safety and efficiency of freight movement.

Traveler information is critical for the safety and efficiency of commercial vehicle operations (CVO). Large commercial vehicles that do not have sufficient information to properly inform route decisions can also damage roadway infrastructure and/or result in delays to roadway users. Commercial vehicles require various types of roadway- and traffic-related information to operate safely and efficiently. In general, the CVO community's needs include information regarding traffic conditions, truck routes, routing restrictions (height, weight, width, etc.), alternate routes, road maintenance and construction, parking availability, port activity, truck stop/fuel stop/repair facility locations, and permit requirements. The information needs of different CVOs vary with a number of factors, such as the size and type of the company, shipment type, and shipment origin/destination. While large carriers typically have better developed information sources, communication methods, practices, and policies, sufficient and effective travel information is more critical for smaller operators.

Commercial vehicles traveling on the state's roadway system frequently become a challenge for roadways with restrictive geometric and structural features. Virginia currently manages oversize/overweight loads through the Department of Motor Vehicle (DMV) Oversize/Overweight (OS/OW) routing program. However, many secondary roads that do not have formal restrictions still possess geometric characteristics that make them less desirable as truck routes. Smaller trucking companies tend to rely on consumer GPS devices for routing, which do not contain information on truck height/weight restrictions and do not necessarily consider limiting geometrics that could impact truck flow. This can create situations where trucks strike bridges and tunnels or are forced to turn around due to restricted geometrics, thereby impeding flow.

Truckers not only need traveler information to select their routes and be aware of traffic conditions, but they also need to comply with Hours of Service (HOS) regulations. Therefore, possible congestion, incidents, work zones, and parking information will not only alter driver routes but will affect drivers' HOS. Some of the newly available telematics systems allow drivers to choose a more beneficial break earlier in the route rather than continuing on, so state traveler information systems must aim to satisfy these needs.

A number of studies have investigated the CVO community's traveler information needs, although many of these have targeted carriers of specific regions, corridors, or sectors. The 2016 American Transportation Research Institute (ATRI) survey of a large number of commercial drivers, motor carriers, and other stakeholders in the trucking industry showed that trucking

parking and infrastructure/congestion were among the top 10 concerns of the CVO community (Figure 1) (ATRI, 2018).
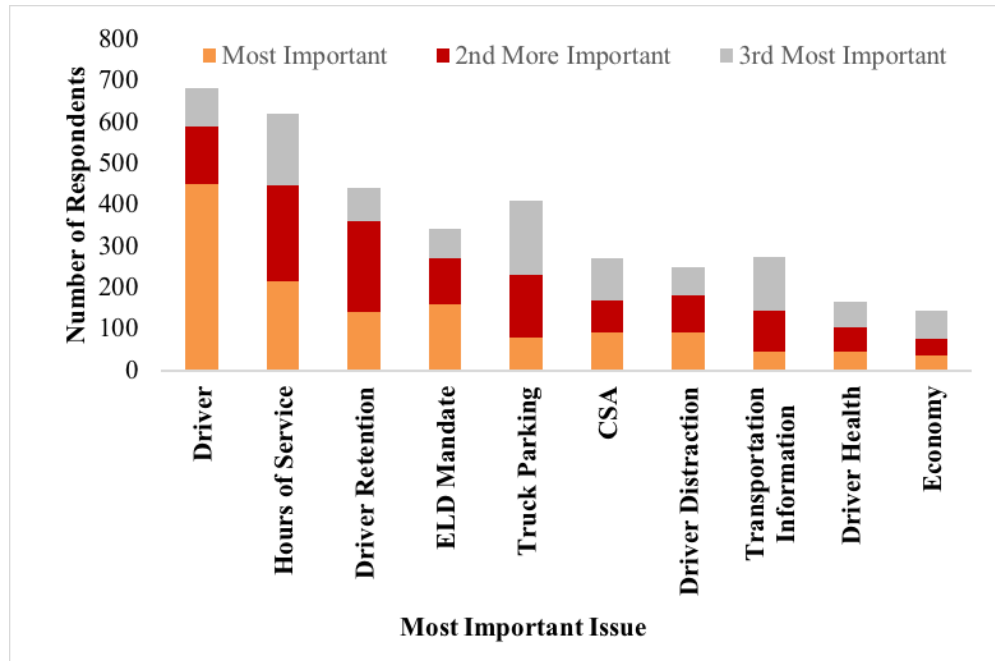
Note: ELD = electronic logging device, CSA = Compliance, Safety and Accountability (score)

Figure 1. American Transportation Research Institute (ATRI) Survey of Top 10 Issues (adapted from ATRI, 2018)

PURPOSE AND SCOPE

The main purpose of this project is to investigate effective methods to provide important route, traffic, and other relevant information to the CVO community to ensure a safe and efficient travel system for all users. The specific objectives of this project include:

1. Reviewing traveler information technologies and practices in Virginia
2. Understanding CVO community information needs
3. Documenting data availability to support a CVO information system
4. Recommending a framework for a comprehensive Virginia CVO information system and developing recommendations for improvements to CVO traveler information systems in Virginia

METHODS

The following tasks were conducted to achieve the study objectives:

1. Investigate available data to support the CVO community
2. Conduct CVO community interviews and surveys
3. Conduct stakeholders interviews
4. Investigate state and federal initiatives

5. Conduct a review of private sector stakeholders
6. Conduct a gap analysis
7. Formulate a high level CVO traveler information framework
8. Identify actions to bridge the gaps and to support the proposed framework

The research team followed a multi-pronged approach to capture the most important stakeholder needs in terms of truck fleet traveler information from the following sources: truck drivers, carriers, public-sector stakeholders, private-sector stakeholders, and other states' truck traveler information initiatives, as shown in Figure 2.
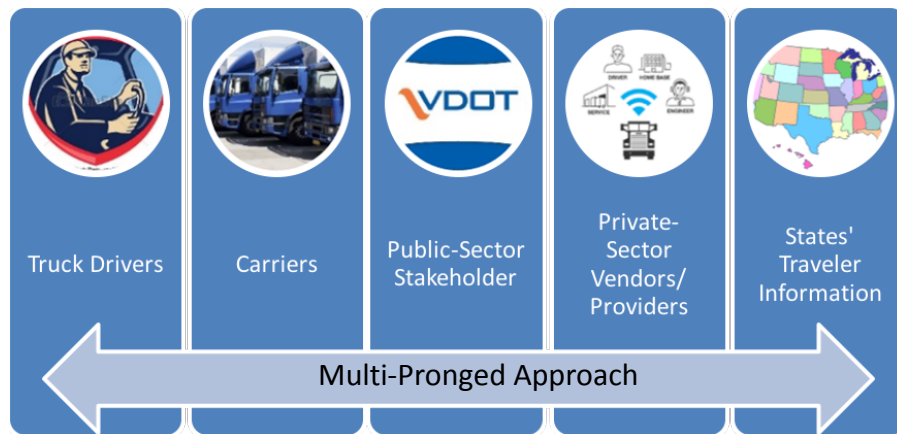
Figure 2. Project Stakeholders

Available Data to Support CVO Community

To complement this multi-pronged approach, the research team investigated available data to support the CVO community. Data collected and analyzed in this area were used to generate a comprehensive catalog that provides a clear understanding of each type of data as characterized by its availability, format, completeness, and other relevant attributes. The developed catalog contains detailed metadata classified by data type, source, etc., and serves as the basis for understanding data availability and suitability to support an advanced CVO information system at VDOT.

Based on all the data collected and existing capabilities, a comprehensive gap analysis was conducted followed by the development of a high level framework for CVO traveler information in Virginia. Finally, specific actions were identified to support the proposed framework.

CVO Community Interviews and Surveys

The purpose of reaching out to the CVO community was to gather information about their data needs, desired methods for receiving information, recommended communication message format and frequency, and desired improvements to current information systems. The

collected data represent a major effort toward defining the Virginia CVO community's information needs.

Two different instruments were used to capture the opinion of the CVO community in Virginia:

- A survey for truck drivers traveling on Virginia roads

- A phone interview for carriers domiciled in Virginia

All Institutional Review Board procedures were followed to conduct the surveys and telephone interviews.

Truck Driver Survey

The Truck Driver Survey was used to collect the opinion of truck drivers traveling on Virginia roads. The survey data were collected at different truck rest stops around Virginia, at a truck service facility, and at a Virginia Trucking Association (VTA) statewide truck driver's meeting from February to May 2018, as shown in Table 1. A total of 178 truck driver surveys were completed.

Table 1. Truck Driver Survey Locations

- Ironto Safety Rest Area, I-81, Elliston (2/15/28, 3/28/2018, 3/29/2018)
- Dale City Truck-Only Safety Rest Area North, I-95 North, mile marker 154, Dale City (4/18/18)
- Charlottesville Safety Rest Area West, I-64 West, mile marker 113, Charlottesville (4/19/18)
- Abingdon Truck-Only Safety Rest Area, I-81 North, mile marker 13, Abingdon (3/15/18)
- Rocky Gap Safety Rest Area, I-77 South, mile marker 61, Bastian (3/16/18)
- Truck Service facility (4/18/2018 and 4/24/2018)
- VTA truck driver's meeting - Richmond

Drivers were asked several questions regarding the importance of their preferences about, and major sources of, CVO traveler information while traveling through Virginia. In addition, truck drivers were asked if their company headquarters were in Virginia (domiciled) and the type of haul they usually made. A sample of the administered survey is shown in Appendix A, and the results are given later in this report.

Carrier Interviews

The carrier interviews were intended to solicit input from commercial motor vehicle companies to collect data regarding their communication methods, drivers' information needs, and preferred means to obtain such information. Efforts were focused on identifying carriers that conduct business in Virginia and to select a representative sample of these enterprises. Selections were based on common commercial motor vehicle and fleet parameters. Of special interest was the size (number of power units) of the carrier. According to the U.S. Department of Transportation (USDOT), in 2018 there were 543,061 Federal Motor Carrier Safety Administration (FMCSA)-regulated carriers in the U.S. Carriers with one power unit represent 47% of the total carriers, and carriers with less than 10 power units represent 89% of the total

carriers, as shown in Figure 3 (FMCSA, 2018a). To this end, two driver population types were identified: small carriers and large carriers.
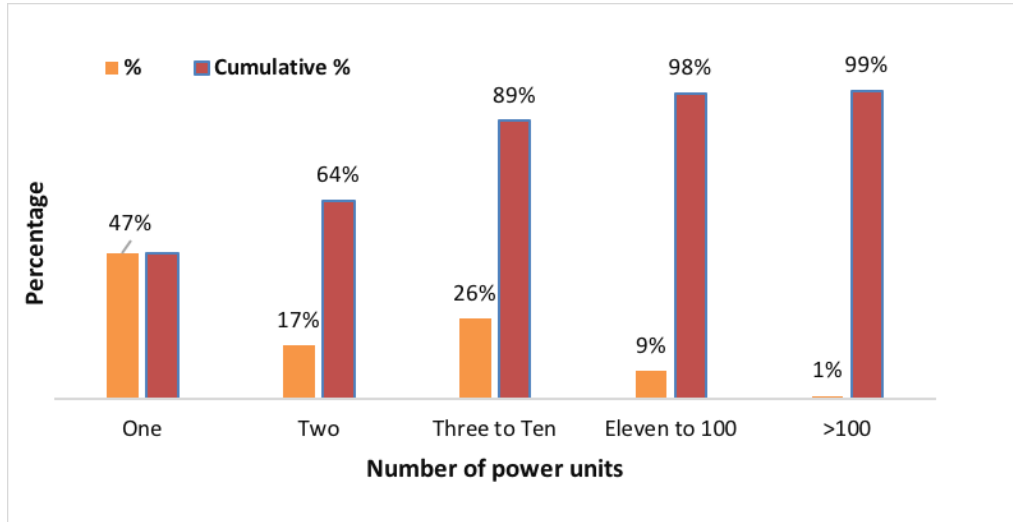

Figure 3. Percentage of Power Units among U.S. Carriers (FMCSA, 2018)

The research team followed strict procedures to contact potential carriers by phone. During the phone call, the researchers introduced themselves and explained the reasons for the call and the objectives of the study. If the carrier agreed to participate, the interviewees were asked several screening questions, including whether they worked on a regular basis in logistics or communication within their organization. If the potential participant was qualified, then they were asked for email information to which a consent form was sent and were prompted to reply with a potential date/time to conduct the interview. All interviews were conducted in closed quarters at the Virginia Tech Transportation Institute (VTTI).

The outreach efforts for the small carriers covered a variety of representatives from trucking companies, including 23 smaller owner-operators. For the small companies, the number of trucks ranged from 1 to 37. Interviewees identified themselves as owners, managers, or vice presidents. Several of the carriers can be classified as what is commonly referred to as "mom and pop operations."

The large carrier interview efforts covered a variety of representatives from five trucking companies. The size of the companies ranged from 1,000 to more than 10,000 trucks. For larger carrier interviews, the research team used a procedure similar to the one described for small carriers. Carrier representatives selected for the interview included vice presidents of safety and risk management, directors of operations, and terminal managers.

Stakeholder Interviews

The purpose of the stakeholder interviews was threefold: 1) to identify what types of information are currently provided and/or need to be provided in the future to facilitate safe and effective commercial vehicle travel in Virginia; 2) to understand the effectiveness of current

CVO information practices, including desired improvements and potential technological, data, and/or institutional challenges; and 3) to identify existing and potential sources for data needed by the CVO community. Selected stakeholders included:

- VDOT officials:
  - VDOT traveler information program officials
  - VDOT freight planning officials
  - Regional and district officials
- Public-sector stakeholders outside of VDOT:
  - DMV, particularly focusing on hauling permit processing and information
  - Virginia State Police (VSP) with a focus on weight-in-motion operations and commercial vehicle safety
  - I-81 Coalition
  - Federal Highway Administration (FHWA)
  - FMCSA
- Private-sector industry association
  - VTA

During the stakeholder interviews, the research team in general followed an agenda to gather stakeholders' feedback and opinions on a range of topics, such as:

- The impacts of CVO on the Virginia transportation system
- Factors contributing to such impacts
- How public and private stakeholders can play a role in mitigating the impacts
- CVO traveler information needs and availability
- Use of public CVO data sources by the private sector
- Other topics as appropriate

State and National Initiatives

As part of the project, the research team reviewed and contacted state personnel regarding the state of the art of their state's traveler information capabilities. The research team investigated other tools that states use or have implemented to support the CVO community. The 511 traveler information systems were reviewed for all states. Those states with a separate portal for truckers were reviewed in detail. In addition, the research team investigated national level initiatives and projects related to traveled information and contacted FMCSA and FHWA representatives to get additional information.

Private Sector

The role of the private sector with regard to traveler information systems is threefold. First, private vendors provide information directly to the user. Secondly, private vendors provide information to the states, which use that information directly or in combination with other sources to provide information to the system's users. Third, and specifically in the case of the trucking industry, private vendors provide information to other private vendors that support carriers. The research team reviewed the state of the art of private vendors by first conducting a

literature review and then contacting vendors for additional information. The private-sector analysis includes third-party data providers, navigation tools, telematics, and applications.

Gap Analysis

After all the above information was collected, the team conducted a comprehensive gap analysis of the current traveler information provided to truck drivers and carriers and the supporting data accessible by third party data providers and vendors.

The team analyzed the current state and compared it with a future state where the needs of the stakeholders were satisfied. Stakeholders included not only carriers and drivers, but also private and public stakeholders, including VDOT.

Gaps were grouped into six major areas/categories including:

1. Truck route restrictions
2. Work zones, incidents, and traffic congestion
3. Truck parking
4. Alternate truck routes
5. Access to information and outreach
6. Regional integration

Finally, the information was tabulated for each area/category, showing the associated objectives, relevance, and gaps.

High Level Framework

After the gaps were identified, a high level framework for VDOT CVO traveler information systems was proposed. The framework was complemented with specific actions described below. During this process, several meetings were held with the Technical Review Panel (TRP) and other stakeholders. The TRP and stakeholders provided valuable input to further redefine the framework and the list of actions. This high level framework was developed focusing on leveraging VDOT resources, improving data integration and dissemination, and promoting the participation of other public and private stakeholders.

Potential Actions

Potential actions were identified in order to bridge the gaps and to support the proposed network. The high level framework identified the basic components and the relationships among them. The potential actions complement the framework by addressing specific gaps in more detail.

Several potential actions were identified based on the gap analysis and associated areas. For each of the actions, the team identified the activities involved to complete the gap(s) and the

challenges and limitations expected to complete the action. Several interactions were needed to complete the final list of actions and their associated gaps and areas. Furthermore, each of the actions was ranked in terms of potential cost and implementation difficulty level and categorized based on the stakeholders that most probably would be involved in the execution of that action.

RESULTS

The following sections summarize the results of the efforts described in the Methods section.

Available Data to Support the CVO Community

Data collected and analyzed in this area were used to generate a comprehensive catalog that provides a clear understanding of each type of data as characterized by its availability, format, completeness, and other relevant attributes. The developed catalog contains detailed metadata classified by data type, availability, source, etc., and serves as the basis for understanding data availability and suitability to support an advanced CVO information system at VDOT.

Data types that were analyzed in this study comprised the following:

- Roadway restrictions, such as truck weight, height, or length
- Truck parking data, including inventory data, availability, and restrictions
- Truck weight and inspection data, including information about weigh stations
- Private truck stops and public rest areas
- Hauling permits
- Fuel and supply stations
- Ports and common trucking destinations
- Real-time traffic information (travel time, incidents, etc.)
- Real-time weather information and related incident data

To develop a clear understanding of the data that are used from different sources, samples of data were selected and analyzed to identify relevant attributes (e.g., availability, format, etc.). The information collected from state and private sources is provided in the following sections.

State Data Sources

VDOT SmarterRoads and Virginia Roads Information

These two portals contain information related to the state's transportation infrastructure and provide easy access to the traveling public to explore various data categories with the goal of ensuring improved driving experience and increased safety. The SmarterRoads portal (https://smarterroads.org) provides information on myriad transportation features, such as road conditions or work zone activities. The data on this cloud-based portal are available in different formats, are updated at various time rates (e.g., every minute, daily, or yearly), and are collected

9

via a network of sensors and systems that continuously supply diverse data sets that make the latest data available to subscribers. Table 2 lists the types of data available on the portal that were deemed relevant to this study.

Data provided in different categories contain detailed information about the data type and format, a link to the store datafile, and a description of the data set. The format for data types, such as truck restrictions, includes multiple fields detailing specific information about district, jurisdiction, route, etc. Listings of relevant features are presented in the table below. Similar information about attributes, such as designated truck routes or route length, is available on the Virginia Roads (http://www.virginiaroads.org) open data portal, but in different formats and with certain overlapping of the information presented (e.g., jurisdiction, route type, etc.).

Other Information Sources

Regarding truck roadway restrictions, hauling permits, and real-time traffic data, VDOT and the Virginia DMV are the main available sources of information. A complementary source is the Motor Carriers' Road Atlas issued yearly by Rand McNally, which provides brief information on low clearance locations, permanent weigh and inspection stations, and restricted routes, along with state and city maps and indexes. Some county and local roads with untrustworthy low clearance posts may not be listed for some locations. Some discrepancies in the data may be caused by roadway features, such as curvatures or slopes, or changes due to scheduled infrastructure maintenance. Ultimately, the driver will be responsible for determining the adequate clearance before accessing any route. For weigh stations, information on their locations is provided by state and local agencies. These locations are specified in the Road Atlas or can be found under VDOT's Virginia Trucking Resources.

Although other sources of information are available (e.g., National Park Service, state police, private businesses), the majority of these sources rely, in part, on information supplied by DOTs through state, provincial, and official agencies. DOTs collaborate closely with various transportation agencies and private companies to collect, compile, analyze, and disseminate the most accurate and reliable data to travelers and the CVO community.

<div align="center">

Data Elements

</div>

Table 2 provides a brief description of data elements and attributes (e.g., availability, format, etc.) that were most relevant for developing a comprehensive CVO data catalog. However, some attributes (e.g., accuracy or data usage), while important for the CVO community, could not be easily verified or evaluated due to certain factors such as update rates or potential issues associated with accessibility. For these reasons, they were not included in Table 2.

Table 2. Roadway and Truck Data Types Classification and Attributes.

Data Type	Available Data Sets	Format/Update Rate	Related Fields	Data Use	Observations	Source
Roadway Restrictions	Truck Restrictions: Available information indicates restrictions on bridges and culverts along with other relevant attributes.	Shapefile/ Monthly XLS and .tgz files provided	District, Jurisdiction, Route, Route Name, Single/Dual Sign, Weight Posting, Structure Length/width (ft), Health Index	Upon subscription and complying with terms and conditions	Not all restrictions are posted. Unmarked map routes are clear for traffic. No height available. Bridge/Culverts data available in the .xls file.	Smarter Roads www.smarterroads.org
	Bridges and Culverts: Information about the physical structures on interstate, primary, secondary, and urban roads. Available app showing map info.	XLS, KML, Shapefile; Metadata available/ Yearly	Route type, Posted capacity, length, NBI rating, Structure ID, General Condition Rating (GCR)	Data sharing use agreement. Disclaimer specifies that VDOT does not guarantee system availability or accuracy	Color-coded legend shows bridge/culvert condition; Some structures are unclassified; No guarantee of accuracy, timelines, or completeness	VA Roads www.virginiaroads.org
	Truck Restrictions: Information provided is similar to that on Smarter Roads regarding roadways and structures.	XLS, KML, Shapefile; Metadata available/ Yearly	Similar to data fields under Smarter Roads	Same as above	Same as above; color-coded map showing restrictions; Height/width not available; weight in the xls file	VA Roads
	VDOT Designated Truck Routes and Length Restrictions: Overview, Data (.csv file), and Visualization (color roadway map)	Table with fields (Zone type, Label, Description)/ Weekly update or as received from districts	Similar to fields above; additional fields added	Same as above	Height/width available in the csv file; only length available in table; Weight posted in csv file	VA Roads

11

Data Type	Available Data Sets	Format/Update Rate	Related Fields	Data Use	Observations	Source
	information on roadway and structures					
	Structure Points on Master Route: Data provided includes information on multiple structures along the road, such as bridges, overpasses, and tunnels.	XLS, KML, Shapefile; Metadata available/ Yearly	Multiple structures fields are similar to the fields above	Data-sharing use agreement	Some data files may need frequent updates	VA Roads
	Truck Restrictions: Information on low clearance, restricted routes, and weigh stations	Catalog/Yearly	Text; Short description of route and location	Upon purchase	Similar data are provided by VDOT	2018 Rand McNally Motor Carriers' Atlas
	CVO Restrictions: A special use permit is required to drive on park roads.	Per park requirements/ Biannual	Bridges with low clearance	Brochure available	None	National Park Service (www.nps.gov)
	Truck Restrictions: Provides route and navigation along with truck optimization	Every minute	Cell/Tablet; GPS data (WorldNav)	Service purchase	Multiple data sources available	Instant truck routes (www.Smarttruckroute.com)
	Website provides info on truck mileage, routing, and fuel optimization	Every minute	Web based (FleetOne, Trucknet) Permit services, Road conditions, Fuel prices, Truck stops	Service purchase (Network licensing)	Multiple data sources (VA 511)	ProMiles (Software) (www.Truckmiles.com)
Real-Time Traffic Information	Travel Advisories & Lane Closures: Provides information on a	XML/ Every minute	Event type/severity, route name,	Data-sharing use agreement	None	Smarter Roads VDOT 511

Data Type	Available Data Sets	Format/Update Rate	Related Fields	Data Use	Observations	Source
	weekly basis		Travel direction, Lanes affected, Delays, Alternate Routes			
	Dynamic Message Signs: Could be active or not; indicate location and current displayed messages statewide.	XML, GeoRSS/Every minute	Title, Description, Link to XML, GIS location	Data-sharing use agreement	Based on current display; cannot be readily validated	Smarter Roads
	Temporary Restrictions & Incidents	Information on current traffic conditions, incidents, temporary restrictions, road closures/ Every minute	Maps	Disclaimer	None	VDOT website www.511virginia.org
	Traffic Sensor Stations: Information covers various sensing devices installed on different routes	XML; TSS Data are structured by day/monthly folders/ Every minute	Detector status, Device name, Lane, Occupancy, Route name, Speed, Marker; Weigh-in-motion not provided	Data-sharing use agreement	None	SmarterRoads VDOT 511
	Incident Data: Available data on various incidents, such as crash, congestion	XML/Every minute	Location, Lane, Travel Direction, HazMat, Work zone, Severity, Delay	Data-sharing use agreement	Information is rich and difficult to verify	Smarter Roads VDOT 511
	VA Crash Data: Data are aggregated by reportable accidents, including	XLS, KML, Shapefile Quarterly; Various layers	Collision type, Lighting, Road Surface condition, Crash	Disclaimer (no guarantee of accuracy, timeliness, or	Same as above	VA Roads Portal

Data Type	Available Data Sets	Format/Update Rate	Related Fields	Data Use	Observations	Source
	fatalities and property damage	provided	severity, Driver age, Vehicle number, Weather condition	completeness)		
	Crowd-source data on real-time traffic flow incorporating market-specific criteria (construction and road closures, incidents, forecast hazards)	TPEG Data, Tile API, Instant update	100m granularity, wind direction/speed, rainfall rates, weather visualization capability	Disclaimer/ No warranties	None	INRIX
Real-Time Weather	Weather Events: Available weather and road information on short- and long-term events	XML files available for download/Every minute	Event ID, Event type/category, Severity, Priority, Route name, Travel direction, Location, Jurisdiction, Lane count	Data-sharing use agreement	Observed and forecast weather and pavement conditions; National weather services (NWS) watches, warnings, and advisories	Smarter Roads VDOT 511 Clear Path Weather Iteris
	Trucker weather forecasts provide hydrologic and warnings; CVs	Instant update/ Radar, satellite, weather maps	Winds, flood, hazardous weather, temperature, current hazards	Terms of service for users; Disclaimer	None	National Weather Service (NWS) (www.roadtrucker.com)
	Advanced weather and pavement condition forecasts for any highway or bridge location; CVs	Every minute/Weather stations, sensors	Wind speed and direction, Pavement/bridge temps/ condition, Precipitation rates, Visibility and obstructions	Terms of service for users; Disclaimer	None	Iteris (ClearPath App)
	Provides information on local,	Every minute/Weather	Road condition, wind advisories,	Terms of service for	None	NOAA, NWS www.Truckerweather.com

Data Type	Available Data Sets	Format/Update Rate	Related Fields	Data Use	Observations	Source
	road, and satellite weather, along with map weather	stations, sensors	flood warning	users; Disclaimer		www.Weather.com
Work Zones	Road Work/Lane Closures	Every minute	WZ location, starting point, description		None	Smarter Roads 511
	Road work/Inactive RW	Hourly/Daily	WZ location and description, Traffic alerts	Disclaimer	None	VDOT 511 Service
	ITS and Smart WZs	Provides solutions/services on WZ safety	Mobile queue Warning Alert System (MQWAS), TCDs operations	User agreement	None	Sitesafe (www.sitesafeonline.com)
Public Rest Areas Parking. Emergency Parking and Private Spots	Truck Parking: Information includes the parking lot name and status (i.e., spaces available)	XML, GeoRSS; link to the xml message provided; Title, Description, GIS location/ Every minute	Lot name/status (ID), Availability, Total/Available spaces, Lot type/Name, Route name, Marker, Travel Direction	Data-sharing use agreement	Only 5 lots available on 511 map; no restrictions mentioned	Smarter Roads (VDOT 511)
	VA Park and Ride Lots: Data available as web map and app	XLS, KML, Shapefile; Not truck related/Quarterly	Overnight, Lot name, Route #, Jurisdiction, Lighted, Space count, Lot ID, Structure type	Data-sharing use agreement; disclaimer in place	None	VA Roads VA DOT
	Services include real-time truck parking information during travel and in-advance parking reservations	Web-based and cell apps/ Every minute	Parking availability, Safety monitoring, parking spot reservations, locations maps	Disclaimer/User responsibility	None	Truck Specialized Parking Services (www.tsps.io)

Data Type	Available Data Sets	Format/Update Rate	Related Fields	Data Use	Observations	Source
	Parking space management solutions	GIS Maps/ depends on app	Space occupancy and availability, Lot Access monitoring, traveler information	Data-sharing use agreement	App currently being developed	Iteris
	Traffic Data for Rest areas categorized by mile marker and location; Fixed number of parking spots	Web pages/Yearly	Car and designated truck safety areas	Public use; compliance with web requirements	None	VDOT website (Truck resources web page) 511
	Parks, recreation/rest areas, and other points of interest	Yearly	Hospitals, airports, government buildings, ranger station, information centers	Upon purchase	None	Rand McNally Road Atlas
Weigh Stations	VA Trucking Resources	PDF file / Yearly	Data related to size, weight, and equipment requirements	Web policy	Files may need frequent update	VDOT website
	Weigh station locations	Listing	Portable scales; state and province weight and size limits	Data provided by state and provinces	None	Rand McNally Road Atlas
	Parks, recreation/rest areas, and other points of interest	Yearly	Hospitals, airports, government buildings, ranger station, information centers	Upon purchase	None	Rand McNally Road Atlas
Hauling Permits	DMV website (DMV's)	Various application forms	Various information	Website policies	Per website notification;	VDOT website

Data Type	Available Data Sets	Format/Update Rate	Related Fields	Data Use	Observations	Source
			available covering truck restrictions and special use permits		Information may not be available on other websites	
Fuel & Supply Stations	Provides information on several factors such as fuel stations location, services available, and updated prices	Every minute/ API	Fuel type, stations, cost calculator	Website policies	None	https://afdc.energy.gov/stations/#/find/nearest
Ports and Common Truck Destinations	Port of Virginia	Web page/ PDF file	Storage areas, Pier length, # of containers	Data-sharing use agreement	None	VDOT website
	Weigh stations may be used as Ports of Entry by state and provinces	Atlas directory/ Yearly	Weigh stations may issue haul permits; Portable scales noted	Upon purchase	None	Rand McNally Road Atlas

* VA Roads and SmarterRoads websites do not provide information on weigh stations, rest areas, port entries, fuel & supplies, and private truck stops

Roadway Restrictions

In addition to the downloadable data sets available on the SmarterRoads website, the Virginia Roads portal offers traffic camera feeds, web maps, and roadway/traffic applications (not downloadable). Certain features (attributes) on the Virginia Roads website, such as route name, jurisdiction, or structure ID, are described similarly on the SmarterRoads portal. The applications cover multiple data sets, including parking information, truck restrictions, and structure conditions. The same information is available on the VDOT website (www.virginiadot.org).

Structural data include a Structure Points on Master Route feature encompassing tunnels, culverts, and overpasses, along with data on coding, rating, and capacity. Related data can be found under Responsibility Master Route, Linear Referencing System (LRS) Road Intersections, and LRS Route Overlap. Additional information on structures and truck restrictions can be found under the VDOT Designated Truck Routes and Length Restrictions Map and App, as well as Truck Restrictions and Bridges and Culverts open data sources. Various layers of data (e.g., VDOT operational regions or districts) are also provided within the Overview tab of the web map. Overlapping information occurs among Web maps and Apps features.

Each Open Data set, such as Truck Restrictions, displays three tabs providing various information: Overview, Data, and API Explorer. Under web maps, a Visualization feature is available displaying legend, filtering options, and configuration attributes. Some data are available for download in either spreadsheet (XLS), KML, or Shapefile or APIs ArcGIS services. The Apps portal includes features such as app information, legend, data, directions, and others.

The Overview tab typically provides service information (attributes) on highways and other VDOT-maintained roadways designated for use by certain trucks and vehicles. A description of the map information is provided, along with limitations and exclusions within the Commonwealth of Virginia. The Data tab shows tabulated information about the attributes described under the Overview tab. The API Explorer tab allows selection of different fields to perform queries and retrieve information about fields of interest and output options.

Several other private companies/firms offer similar services, although their sources are multiple (e.g., local agencies, utility maintenance crews, traffic surveillance) and the data formats and description may vary significantly. Two examples of such companies and their services are provided herein.

Other Trucking Routing Services

Truck Parking and Emergency Parking

The Virginia Park and Ride Lots application has certain features that can be used (e.g., data filter, measurements, layer list, etc.) to explore the available data. However, no truck-related data are available under this app. Layered information and base maps are available under the Web Map feature, while various attributes are listed under the Open Data feature. Information is also available on parking lot inventory and parking availability and restrictions.

Supplementary parking information is provided by numerous private sources, such as Iteris or SensitParking (see above) to make finding truck parking more convenient via a smartphone or computer. In addition to the general information that DOTs are providing, such as parking location, space availability, and other features, these private sources offer services such as parking reservation on-location and in-advance, fuel station locations and prices, real-time traffic safety alerts, work zones, and road weather incidents.

Public Rest Areas

Traffic data for rest areas, for both cars and trucks, are available under Travel/Map areas on the VDOT website (http://www.virginiadot.org/travel/map-rest-area.asp). These maps provide information on interstate location, amenities, and available spaces for cars, trucks, RVs, and buses. There is no information available for private truck stops on the VDOT website.

Fuel and Other Supplies

Information on fuel and other supply stations is not readily available on SmarterRoads or Virginia Roads websites. Other rest areas may provide these services. However, trucks equipped with specialized GPS units are able to find this information easily as it is provided as a separate feature in their main menu.

Real-time traffic information includes data about lane closures and potential delays among other variables on the SmarterRoads website, while the Virginia Roads website only lists information about truck type and average daily traffic under the Traffic Volume data set. However, due to accessibility issues (data can only be downloaded in XML format), the Virginia 511 (see above) service is listed as a much faster way of retrieving the traffic information.

Detailed information can also be accessed on websites such as INRIX or Iteris, which provide different data formats (e.g., traffic event compact, traffic flow and prediction) for traffic- and travel-related services, including traffic flow, weather incidents, parking, and fuel (http://docs.inrix.com/traffic/typetpegdata/). INRIX provides a service that delivers data in Transport Protocol Experts Group (TPEG) format, specific to traffic-related data, which allows applications to retrieve the data in an efficient and configurable fashion.

Weather Information

Real-time weather and related incident data are readily available on the SmarterRoads website and Virginia 511 service. The Virginia Roads portal does not provide such data under an individual data set but offers weather-related data as an attribute under the Crash Data layer. Iteris, through the ClearPath Weather app, provides location-specific weather data and applies advanced data assimilation and modeling technologies to deliver customizable data solutions.

Work Zones

Information about road work is mainly provided by DOT field crews to various jurisdictions, districts, residencies, and area headquarters, which subsequently process the data and upload it on the 511 website. Uploading of data can be performed by Traffic Operations Center traffic engineers or other qualified personnel as soon as the correct information becomes

available. In addition, some Traffic Operation Centers will send out compiled data on current roadside activities on a weekly basis, indicating modifications to their original schedules or adjustments to their locations (i.e., widening of a shoulder, lane closure, or detours). The data are available for third-party providers on the SmarterRoads website as a Lane Closure and Road Work database.

Summary of Available Data to Support Commercial Vehicle Operator Community

To summarize, VDOT website data—in conjunction with its data portals, Virginia Roads and SmarterRoads, and private agencies such as INRIX or telematics service providers—make available extensive traveling information data. Findings from this task are detailed below:

- Extensive data exists among the various public and private sources of available information, whether from VDOT (SmarterRoads and Virginia Roads portals) or from private sources.

- Some information that is available in the VDOT portal is not available in Virginia 511 (e.g., truck route restrictions), but the presentation in the portal makes the information difficult to use (i.e., too many details and attributes) and hard to access for use in real-time.

- Web-based data, especially truck restrictions from the VDOT website, cannot be accessed readily by truckers, and existing online VDOT apps are not downloadable.

- Fuel services are not covered by the 511 service and VDOT data portals, but detailed information is available from private sources.

- The VDOT website and its complementary data portals (i.e., Virginia Roads and SmarterRoads) provide limited data on ports and other common trucking destinations.

- Recent applications (e.g., parking, weather, routing) have improved considerably over the past 5 years and have become as detailed and accurate, if not more accurate than, the Virginia 511 service.

<div align="center">

CVO Community Interviews and Surveys

</div>

Truck Driver Survey

Traveler Information Needs

To identify the relevance of different types of information, truck drivers were asked to rank the importance of different types of traveling information when driving in Virginia. Figure 4 shows that information about route height/width/length restrictions, work zones/lane closures/detours, and incidents were considered the most critical when traveling in Virginia. Information regarding parking locations and availability, alternate routes, and weather were ranked slightly lower but were still considered extremely important. Information regarding port terminals and services (including maintenance centers and food) were ranked as least important.
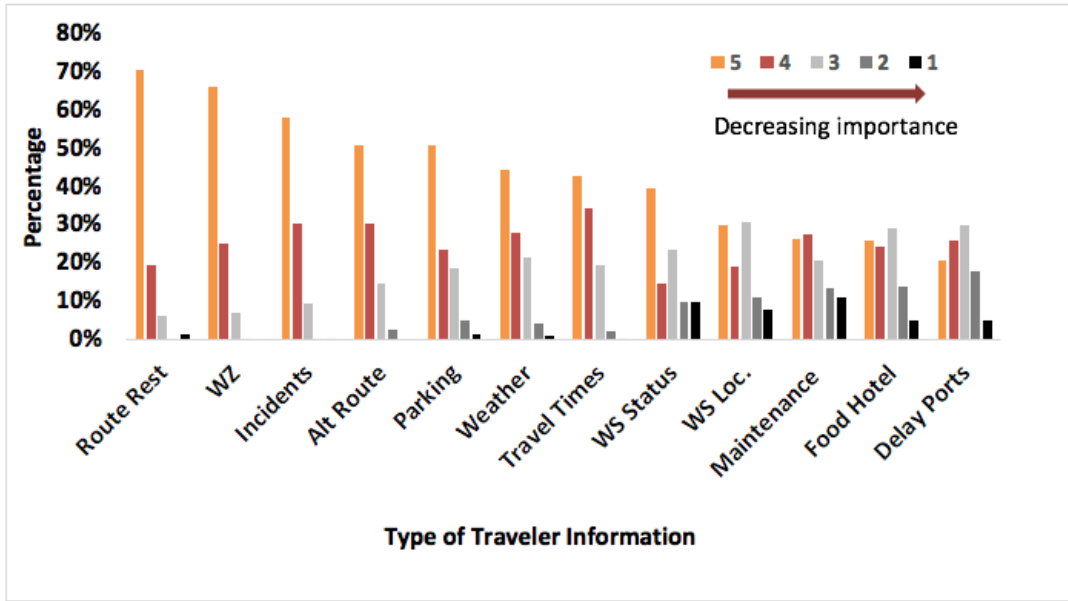
Note: Route Rest = Route Restrictions, WZ = Work Zone, Alt Route = Alternate Route, WS = Weigh Station

Figure 4. Types and Importance of Truck Driver Traveler Information

To capture the distribution of opinions, an overall index was computed, with five being the highest possible value. A high index value indicates that the surveyed drivers found the type of information to be very important. The non-domiciled companies reported being headquartered in 22 states and Canada. Figure 5 compares the average indices for the two groups, as well as for the long- and short-haul carriers. In general, the importance ranking for the different types of information shows no statistically significant difference between the opinion of truck drivers whose company headquarters are in Virginia and those whose company headquarters are not in the state (using a Chi-square test, p values of 0.79, 0.27, and 0.57 were found for route height, work zone, and incidents, respectively). One exception is that weather was considered more critically important for companies not domiciled in Virginia ($p = 0.019$).

Route restrictions, work zones, and incidents were, under the composite index, the most critical information. Travel time, parking, and weather information comprised the second group. Information regarding alternate routes usually received a ranking between these two groups. Weigh station locations and status index were ranked higher than maintenance, services, and ports and terminals.

21
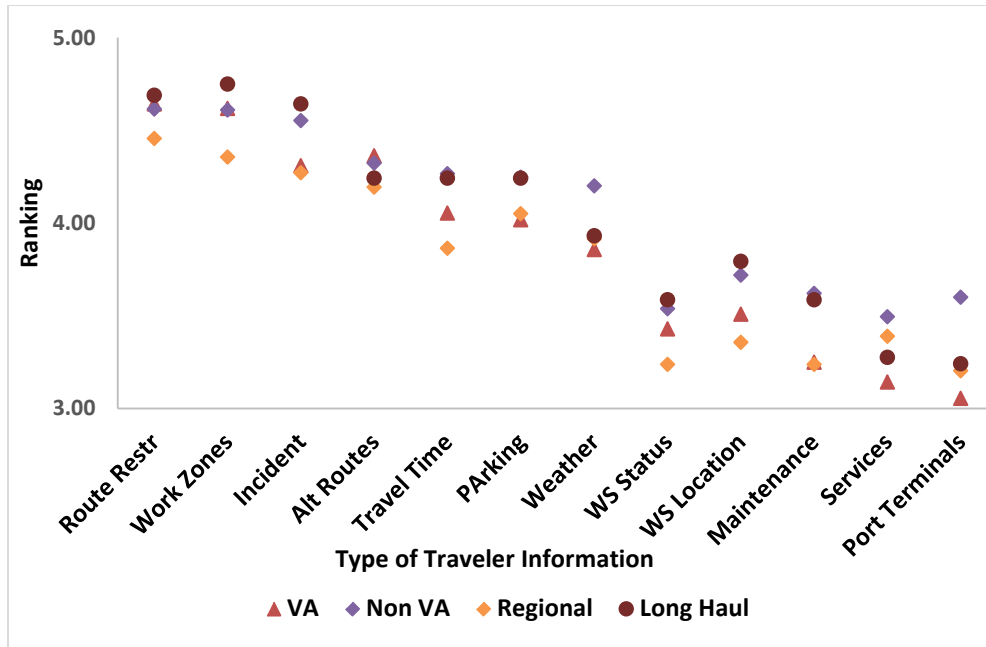
Note: Route Restr = Route Restrictions, WZ = Work Zone, Alt Route = Alternate Route, WS Status = Weigh Station Status, WS Loc. = Weigh Station Location

Figure 5. Composite Index of Importance for Different Types of Carriers

Regarding preference on how to receive information (Figure 6), truck drivers indicated that direct communication was the preferred approach (70% or more), while a small proportion was satisfied with the manager/dispatcher conveying the information.
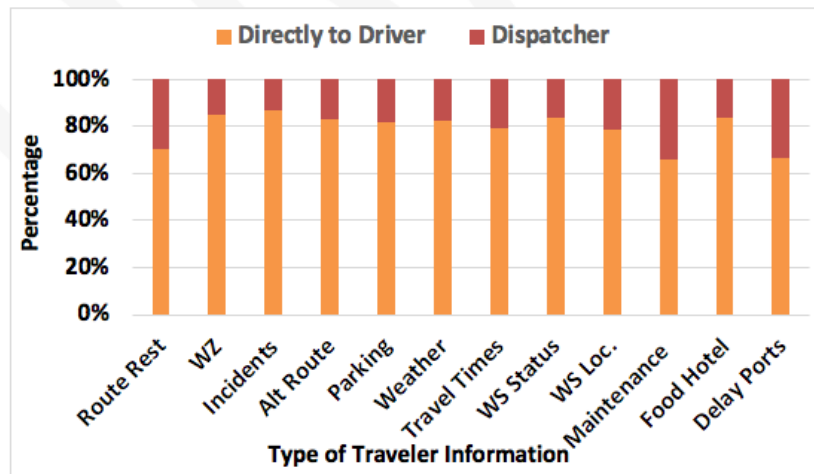
Note: Route Rest = Route Restrictions, WZ = Work Zone, Alt Route = Alternate Route, WS Status = Weigh Station Status, WS Loc. = Weigh Station Location

Figure 6. Truck Driver Preference in Receiving Information

Channels of Information

To identify the most common sources of information, truck drivers were asked to indicate the sources they use for each type of information while traveling in Virginia. Table 3 depicts the three major sources of information that truck companies generally use regardless of haul length. The table shows that most truck drivers relied on newly developed apps, truck GPS, and variable message signs (VMS) for most of the information data types.

Information regarding route restrictions was primarily accessed using GPS or route applications (51%), followed by VMS (40%), VDOT truck routes (34%), and dispatchers (32%). Information regarding incidents was most commonly obtained by VMS (47%) and GPS or route applications (45%). Work zone information was obtained the same way (56% and 42% via VMS and GPS/route apps, respectively). Truck drivers also relied on information from their peers using the CB radio. The Virginia 511 application was ranked higher than on-board communication and text messaging. As expected, the dispatcher was mentioned as the most common source of information for maintenance, service, and delays in ports. Interestingly, a close look at the responses shows that respondents almost never jointly selected the VDOT truck route map restrictions and Virginia 511.

Table 3. Main Sources of Information for Truck Drivers

Information Type	Disp.	VA 511	VDOT Trucking Resources	GPS, Route App	OBC/ Telem.	VMS	Text	CB Radio	HAR
Route Restrictions	32%	15%	34%	51%	11%	40%	11%	24%	5%
Travel Times	21%	22%	13%	61%	15%	35%	9%	17%	6%
Incidents	19%	23%	10%	45%	8%	47%	10%	31%	9%
Work Zones	14%	18%	18%	42%	7%	56%	8%	30%	8%
Weather	18%	22%	9%	26%	11%	35%	19%	26%	15%
Alt Route	19%	18%	24%	53%	11%	42%	8%	24%	5%
Parking	13%	18%	18%	32%	11%	34%	10%	24%	2%
Weigh Station Location	10%	13%	29%	36%	14%	36%	6%	23%	1%
Weigh Station Status	9%	12%	17%	27%	13%	47%	8%	30%	2%
Food Hotel	9%	17%	14%	48%	12%	27%	11%	18%	2%
Maintenance	32%	14%	18%	31%	12%	24%	8%	18%	2%
Delay Ports	35%	16%	14%	26%	12%	31%	10%	16%	3%

Note: Disp. = Dispatcher, VDOT = Virginia Department of Transportation, GPS = Global Positioning System, OBC/Telem. = Onboard Communications/Telematics, VMS = Variable Message Sign, HAR = Highway Advisory Radio

Truck drivers were also asked how *they would like* to receive the information (Table 4). The majority of drivers selected VMS as one of the top sources of information. It was clear when conducting the survey that VMSs are seen as a very useful and trusted source of information. These signs provide information related specifically to the route the driver is traveling. In the majority of cases, the information is useful; at worst, the VMS can simply be ignored.

While truck drivers recognized the costs involved in installing each VMS, they would like VMSs to be deployed far more frequently than they are now. Drivers who are currently using Virginia 511 preferred this source more often than drivers who are not using it. A similar correlation between preference and current use was observed for text messaging. On the other hand, CB radio and highway advisory radio (HAR) were the only two sources of information that truck drivers indicated preferring to use less than they actually do.

Table 4. Preferred Sources of Information

Information Type	Disp.	VA 511	VDOT Trucking Resources	GPS, route App	OBC/ Telematics	VMS	Text	CB Radio	HAR
Route Rest.	24%	25%	30%	39%	21%	45%	23%	7%	4%
Travel Times	18%	27%	20%	43%	16%	48%	21%	5%	4%
Incidents	20%	28%	17%	39%	13%	51%	29%	12%	6%
Work Zone	15%	30%	21%	38%	13%	55%	22%	12%	7%
Weather	21%	26%	18%	35%	18%	45%	30%	8%	10%
Alt Route	20%	29%	23%	37%	15%	45%	23%	11%	6%
Parking	17%	26%	20%	34%	17%	44%	21%	7%	7%
Weigh Station Location	13%	25%	27%	36%	17%	45%	17%	9%	4%
Weigh Station Status	11%	24%	22%	34%	18%	51%	18%	11%	4%
Food Hotel	22%	25%	15%	28%	16%	32%	17%	9%	5%
Maintenance	23%	25%	18%	32%	18%	36%	16%	9%	4%
Delay Ports	35%	23%	14%	21%	17%	34%	23%	10%	3%

Note: Disp. = Dispatcher, VDOT = Virginia Department of Transportation, GPS = Global Positioning System, OBC/Telem. = Onboard Communications/Telematics, VMS = Variable Message Sign, HAR = Highway Advisory Radio

Quality of Information

Survey results indicated that truck drivers were satisfied with the level of the current information sources while traveling in Virginia (Figure 7).
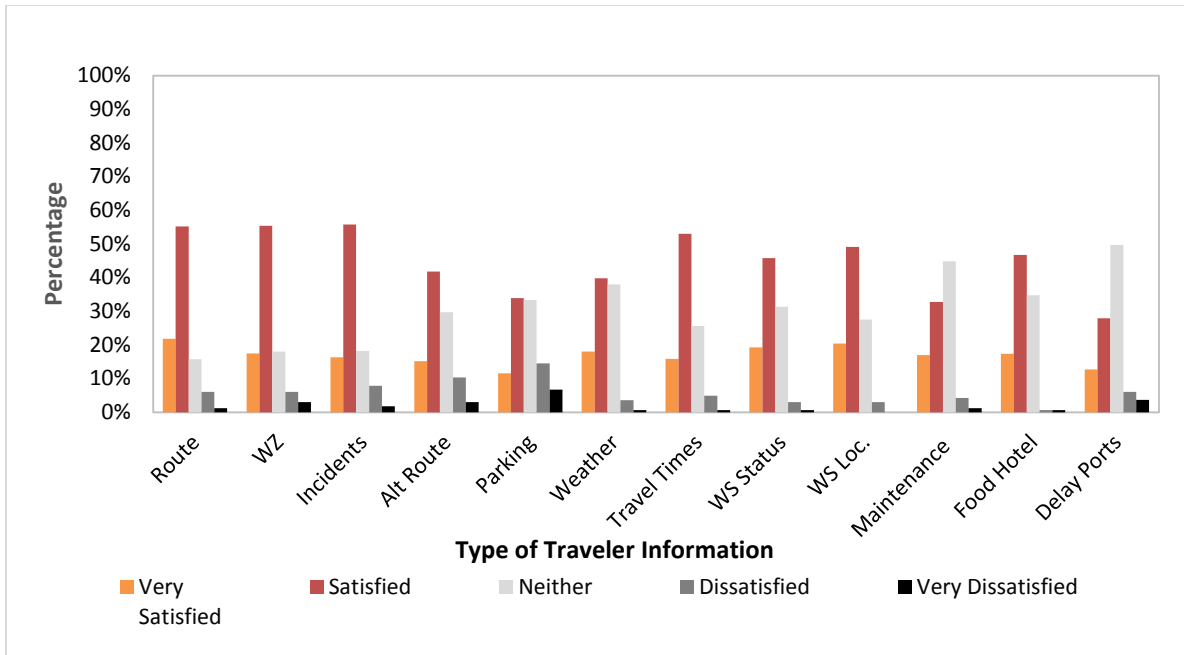
Note: Route Rest= Route Restrictions, WZ = Work Zone, Alt Route = Alternate Route, WS Status = Weigh Station Status, WS Loc = Weigh Station Location

Figure 7. Satisfaction with Current Information Sources While Traveling in Virginia

Truck drivers were also asked to identify what type of GPS or route application they used. Several truck drivers indicated that they used more than one tool (e.g., Garmin GPS and Google Maps). When there were two or more answers, such as Google Maps and Garmin GPS, only the most accurate tool, Garmin GPS, was indicated in Figure 8.
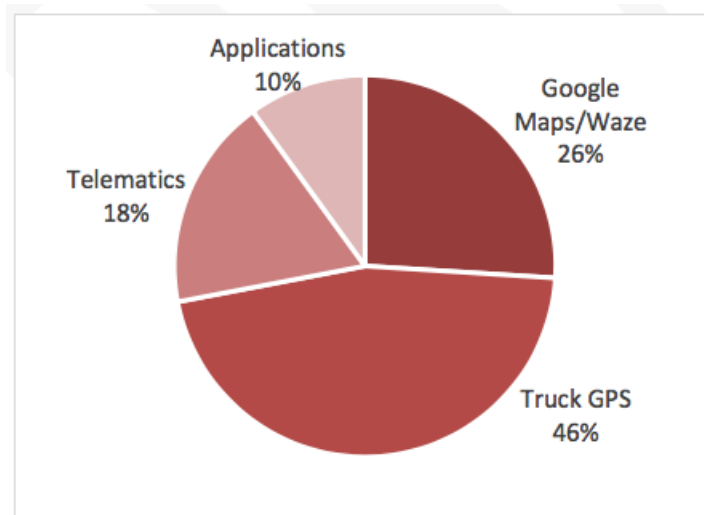
Figure 8. GPS/Applications Used

When truck drivers were asked what device they typically used to access the web or app information, the majority of the drivers indicated using a cell phone (68%), followed by a tablet

25

or laptop (20%), as shown in Figure 9. Please notice that several truck drivers have access to more than one device (88 % have access to cell phone)
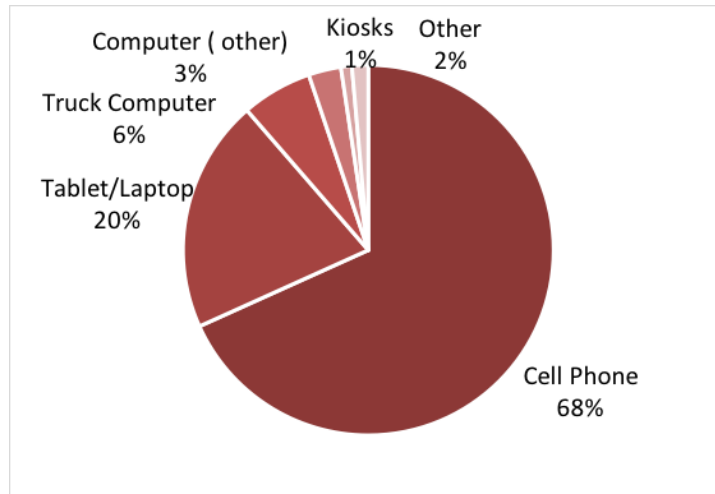
Figure 9. Device Typically Used to Access Web or Application Information

Familiarity with Virginia Information Sources

Truck drivers were asked how familiar they were with VDOT information sources. Results showed that the most widely known resource was the VDOT designated truck routes (55%). Less than 50% of truck drivers knew of other VDOT resources.
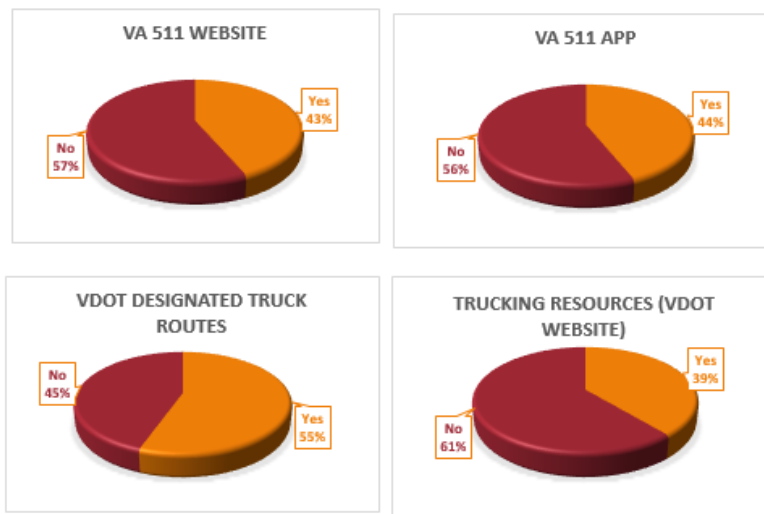
Note: VA = Virginia, VDOT= Virginia Department of Transportation

Figure 10. Familiarity with VDOT Information Sources

If truck drivers were familiar with the VDOT information sources, then they were also asked about frequency of use. The results are shown in Figure 11.
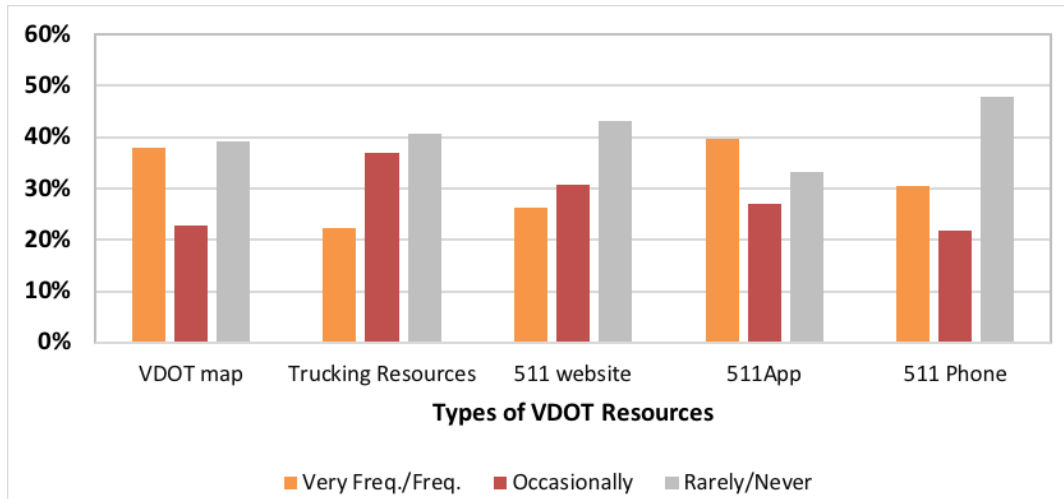
Figure 11. Frequency of Use of VDOT Resources

When comparing drivers with companies headquartered or not headquartered in Virginia, the percentages were very similar regarding their knowledge of VDOT designated truck routes and the trucking resources. Differences were more evident in the case of VA 511. As expected, Virginia-headquartered companies were more familiar with the resource than non-Virginia companies. Drivers headquartered in Virginia were 10%, 20%, and 14% more familiar than out-of-state drivers with the Virginia 511 app, website, and phone system, respectively.

Carrier Interviews

Small Carriers

Responses showed that carriers considered information regarding weather, maintenance, and food information to be satisfactory. Carriers rated information regarding work zones, travel time, and weigh stations between the neutral (neither satisfied/dissatisfied) and satisfied categories. The level of satisfaction for route restrictions, incidents, and ports was neutral. The lowest level of satisfaction experienced by carriers corresponded to alternate routes and parking information.

For the majority of small carriers, the owner communicated with the driver at the beginning of the route and, in general, company drivers were given autonomy in altering their route. When asked what small carriers or their drivers used for routing, nine of the carriers mentioned that their drivers have an in-truck GPS. Three of the carriers used telematics, and the rest relied on Google Maps or MapQuest. Several of the carriers mentioned that they used "experience" to select the best route, and that other truck drivers ran into problems due to "lack of experience" or that they used a car GPS. However, in the case of new routes, they usually relied on a Rand McNally Road Atlas (most drivers carry these) and Google Maps for route restrictions. Strategies for routing involved talking to the customer and asking for route details or checking Google Maps. One of the carriers mentioned that after a job is scheduled, they have one driver in a car check the best route, if possible, identifying all the height and weight restrictions, after which they review the best route with Google Maps. Other carriers relied entirely on

Google Maps to see the restrictions that they are facing by using the street view to "drive" the route virtually. Comments regarding route selection noted that drivers "may drive 30–40 miles on the map but it only takes 6–10 minutes," and "…maps are for consumers, not trucks, we need something tailored to trucks."

The small carriers were familiar with the formal over-height /overweight limitations and how to process the permits. However, for a blanket permit, it was mentioned that carriers struggle to review the lengthy bridge restriction information: "On a single trip for our blanket permits we have to check 80–100 pages of bridge restrictions."

Some carriers provide support to their drivers while en route from their central office. Office personnel used Virginia 511, websites, and Google Maps to get information to drivers. The Virginia 511 service was mainly used for route preplanning by most carriers, and several of the small carriers were not aware of the system's notification capabilities. Carriers mentioned that the 511 system was difficult to use. They also mentioned a lack of information regarding routing and rerouting capabilities, parking availability, and short-duration (pop-up) work zones.

Google Maps was mentioned by several carriers as one of the easiest and most trusted sources of information. For weather information, the vast majority of the small carriers used weather applications from resources such as Accuweather, the National Oceanic and Atmospheric Administration, or the Weather Channel.

In general, drivers of small carriers have access to Virginia 511, but several limitations were mentioned, including FMCSA restrictions used on routes, lack of routing capabilities, lack of specific location information, difficulty in using the system, and the fact that it is not always up to date. Noted one carrier, "511 is for consumers. [We] want to see 511 for business needs."

All of the small carriers were very aware of the consequences of being stuck and what that means for their business. The majority expressed that they had a great deal of experience with their routes. There was a level of dissatisfaction regarding route restriction information. While drivers recognized that VDOT does a good job posting the restriction information "on location," some carriers noted that sometimes when the driver sees the restriction information, it is already too late to take action.

In general, carriers using a truck GPS were satisfied with travel times and other information provided. While appreciative of the VMS, some of the owners/managers whose drivers did not have a truck GPS expressed dissatisfaction that the only information available to their drivers was Google Maps.

For incident and work zone information, carriers relied on Virginia 511, and their drivers relied on VMS. Carriers expressed concern similar to drivers that incident information is not up to date and that the information is displayed too close to the site, at which point the driver can take no corrective action.

In many cases, drivers notify dispatch of any unusual circumstance that requires clarification, and the dispatcher will try to find a satisfactory solution. As an example, for incidents or crash information, drivers check the Waze app because it provides quicker updates.

Examples of comments regarding incident or work zone information are as follows:

- "There's no information available, too short, usually after the point you could reroute and find an alternate route."
- "…then, I do what everyone else does and immediately go to Google and look at Google Maps, determining which route can get a truck on safely."
- "You don't really know until the last minute when you're right on top of it."

Managers mentioned that is not uncommon for the driver to call and ask for information about what is happening at a location where they are experiencing severe congestion or stop-and-go conditions; often, when the manager checks Virginia 511, no information is yet available on the site. Small carriers also point to the fact that if the information is available, it is limited to identifying the location and lanes closed. There is no indication of how long it will take to clear the crash or of the potential impact on traffic. When managers are faced with that situation, usually they rely on Google Maps or phone applications. Carriers are in general dissatisfied regarding alternate routes information and notification. Small carriers expressed that not only do they need to do rerouting by themselves but that when rerouting, because of lack/limitation of information, they are not sure if the selected route will be an appropriate truck route. Additional concerns arose from the fact that route restrictions information is hard to find in a timely manner and that it may not be up to date. Even when data were available, carriers noted that some drivers faced situations where locations were not accurate, and alternate routes were not designed for truck traffic.

Examples of comments regarding alternate route information included the following:

- "Pretty much self-help…"
- "It's a big problem on my end, because of bridge weight limits."
- "There is very little information on detours."
- "There is really no notification. You have to figure it out by yourself."

There was also general dissatisfaction with truck parking information. However, this dissatisfaction was heavily related to parking availability. This is not surprising, as the ATRI truck parking survey indicated that parking was the number five priority, 50.2% of the respondents identified parking availability as top priority, and 11.7% found this related to truck parking information (ATRI, 2018). According to the small carrier interviews, parking availability limitations extend to public and private facilities. The point was made that information is not sufficient if there are not enough parking spaces. However, some carriers did acknowledge and praise the convenience of newly installed parking signs providing real-time information.

Carriers would like to receive more information regarding work zones, incidents, and detours. With respect to real-time information, there is agreement amongst almost all carriers that VMS is the best way to notify their drivers. The preferred alternative method is push notifications/text messages to drivers. One concern regarding VMS was the limited amount of information that can be displayed. Carriers would like to have additional information regarding alternate routes and expected duration of delays. Several of the carriers were not aware of Virginia 511's text message notification capabilities.

Alternate route information needs to be targeted to the route and direction the driver is traveling and, if possible, relayed with enough time for them to take some action if needed. Carriers would also like to see notifications without enrolling in the program (referring to the fact that Virginia 511 requires drivers to specify the route). At this point, to receive notification in advance of an incident or work zone, Virginia 511 requires the user to select the routes they want to receive notifications about in advance. The selection of routes in advance is a common feature of most 511 systems. Consequently, if the driver is traveling on a route that is not selected in advance, they do not receive any type of notification. While there was a strong consensus on push notifications/text messages, some carriers expressed concerns that distraction was an important factor that cannot be overlooked. One carrier also mentioned being selective with text messages, since an overload of information could result in drivers ignoring notifications.

Several small carriers believed that Virginia 511 seems like the natural choice to provide the information discussed above. Comments regarding 511 included the following:

- "If they would have an app on the phone [then] they could post highway construction and predictions for those."
- "The quicker you can get to the driver and in depth information, the less stress there will be on I-81."
- "[Would like] to see 511 for business needs."
- "You have to expand the 511 app in order to move it around and see where you are, when you had the locator, it could zoom in on your location."

Large Carriers Interviews

In general, larger carriers gave good ratings to the traveler information provided by VDOT. It was also emphasized that the traveler information provided is at a minimum equal to or better than the information provided by other states.

In general, larger carriers are more in charge of driver routing, and the control that drivers have over routes depends on the company and the type of operations. For some companies, the carrier is in charge of the route; the driver does not make choices in any capacity. For others, the drivers can make suggestions. For example, a driver might choose a route based on traffic volume when they have two possible route alternatives.

All the carriers interviewed have telematics (major providers are Omnitracs and Peoplenet). However, the level of the telematics varies among carriers. All drivers have in-cab route navigation directions but not necessarily GPS. In cases where the company does not offer access to a truck GPS, carriers encouraged their drivers to buy one. Since the cost of the system can be an issue, some carriers have an internal financial mechanism to help the drivers to acquire the truck GPS. Carriers also recommend that drivers carry the Rand McNally Road Atlas.

The carrier telematics also vary with regard to text message notifications. Some carriers already have text-to-voice notification or are in the process of implementing it. Other carriers have text message notification, but the driver cannot get the message until the truck is not in

operation to keep drivers from interacting with the platforms while driving. Several of the telematics systems also have the capabilities to create geofences so the information is sent only to drivers who need it.

Large carriers consider the route information provided by their systems very reliable. The reliability of the system is lower within cities, in which case carriers rely on Google Maps. It is common for larger carriers to maintain an internal database of specific issues encountered on the route (dangerous situations, alternate routes) by their drivers that is subsequently used as an additional input to select the best route.

While drivers are provided with a route to follow, they are also always advised by their manager as a safety measure to look for signs regarding restrictions. To that end, carriers expressed dissatisfaction regarding road and bridge restriction signs, noting that several times, by the time their drivers realized that they were on a restricted road or approaching a structure weight or height restriction, there was nothing the driver could do.

To get information regarding lane closures and bridge work, large carriers check Virginia 511, but they also use the National Traffic and Road Closure Network provided by the USDOT, which uses shared state information. In general, carriers that use Virginia 511 think that the system is a reliable source of information. However, most of the large companies do not use Virginia 511 for incidents or weather.

Most of the carriers mentioned that they usually become aware of incidents due to their truck drivers, social media, or the Waze app. In general, all the carriers mentioned that they use driver dispatcher communications to become aware of any new conditions. Dispatchers pass that information to other truck drivers in the same area.

Parking is also an issue for larger carriers. They mentioned the lack of information, even for private facilities with signs, with drivers only becoming aware of availability by word of mouth. They noted that they would like to see more VMS indicating parking availability.

Larger carriers also expressed their concerns regarding closures and detour information. In the opinion of some of the carriers, trucks are not considered when planning a detour. One individual noted that they "have [had] more than one instance of clipping mirrors because the road isn't designated for a tractor trailer." For other carriers, the type of operations makes a difference. If they have long combination vehicles, their drivers have very few options when there is a closure or detour, hence the importance of the dispatcher being informed in real time to instruct drivers what to do.

For information regarding food and services, large carriers rely on websites or applications. However, they mentioned having issues when their drivers pull into gas stations or restaurant parking areas that do not accommodate big trucks. This results in a loss of time, fuel, and, in some cases, difficulty turning around.

Carriers operating in ports had no significant issues to report.

According to larger carriers, if the truck driver receives information directly from the state, they do so on their personal phones. Carriers were also open to the possibility of VDOT providing the information to the telematics service.

VMS and text messages/push notifications were considered by interviewees as the most effective ways to communicate information to drivers. One of the carriers was not aware of VDOT alerts, while the others mentioned that they were not receiving very much information from VDOT.

Carriers acknowledged that their truck drivers do not have the same real-time access to information as the dispatchers. Even though carriers receive more information than drivers do, there is still room for improvement in the provision of real-time information. Carriers would like to have push notifications sent to their drivers or themselves regarding restrictions, detours, closures, or weather events.

While, in general, carriers did not take issue with their drivers receiving information directly, some would also like the dispatcher to receive the same information as their drivers. They also acknowledge that the communication framework in their companies is set up in a way that involves dispatcher driver communication, and usually the dispatcher acquires the information from other sources.

Large carriers also acknowledge that providing VDOT with direct access to their telematics is not an easy task. One carrier representative noted that, "If they had access to our [telematics system] … that would never happen." In addition, some the drivers do not have the technology to receive the information directly. However, all carriers were open to the possibility that the information be sent to the carrier, which would then distribute it to the drivers. They expressed that the most important thing was to have the information in real time, in one case noting, "The method would not be important as having the information available."

In general, large and small carriers appreciate VDOT efforts on reaching out to the CVO community regarding their needs. Comments included the following:

- "I applaud VDOT for seeking feedback and going forward with the study."
- "If we can get more communication with VDOT to keep us informed and make the road safer it's a win both ways."
- "If we could accomplish the things we have talked about today I think it would be a huge win for VDOT and the industry and for the entire public."

Public Stakeholder Interview Results

The following section summarizes what the research team learned from the stakeholders' interviews.

Readers should note that the summary reflects the interviewees' personal opinions. Some opinions, however, are based on interviewees' experience interacting with the trucking industries as part of their job duties. This summary does not include researchers' opinions on the subject matter discussed.

CVO Impacts on the Virginia Transportation System

VDOT has experienced a wide range of challenges due to commercial vehicles on the Commonwealth's transportation system. Among the most common issues the stakeholders discussed, the interviews emphasized the following issues in particular:

- Large commercial vehicles traveling on secondary roadways that are restricted or not recommended for large trucks due to geometric configuration. Virginia has a large number of curvy and/or narrow secondary roadways in rural districts that are restricted or not recommended for large vehicles. VDOT officials reported multiple cases when large trucks and, in some cases, busses became stuck on such roadways due to sharp curves.

- Large vehicles or vehicles with large loads traveling through roadway locations with height, width, and/or weight restrictions, such as tunnels and bridges.

- Large vehicles traveling on roadways with work zones that result in reduced lane widths and/or lane closures. In such cases, the vehicles need to identify alternate routes that can accommodate them.

According to the stakeholders interviewed, commercial vehicles in such cases resulted in a number of impacts to the transportation system and its users:

- Damage to roadway infrastructure, including bridges, pavement edges, and roadside infrastructure components (e.g., sign structures and safety barriers).

- Congestion and air pollution. Large vehicles that are stuck on secondary roadways result in complete roadway blockages. Trucks turning around at tunnel or bridge entrances also result in congestion and, therefore, delays and environmental pollution. Fixed-object crashes involving large vehicles require significant time to clear the roadways and, therefore, result in significant traffic congestion, particularly on busy roadways.

- Safety issues. In addition to fixed-object crashes caused by the commercial vehicles, traffic congestion caused by large commercial vehicles frequently causes secondary crashes.

Factors Contributing to CVO Impacts

The stakeholder interviews revealed a large number of factors that have contributed to the aforementioned issues with CVO operations on Virginia roadways:

- Lack of information on roadway restrictions. Stakeholders interviewed during this project suggested that many truck drivers, particularly interstate truckers who are not familiar with the local roadway conditions, do not have sufficient information on permanent and temporary roadway restrictions in Virginia. Stakeholders speculated during interviews that this could be due to a variety of reasons, such as the unavailability of complete, accurate, and/or up-to-date roadway restriction data in the state, lack of knowledge and willingness to research for such information by certain truckers, and truckers ignoring

signage and relevant travel information. VDOT currently does not maintain a central database of roadway restrictions. There are varieties of restrictions that affect large vehicles, such as bridges for height and weight restrictions, tunnels, roadways with small turning radii (including secondary, narrow roadways, and some urban intersections), rail crossings, utility facilities, and roadway bumps.

- Use of regular GPS instead of trucking GPS. Based on their experience working with the trucking industry, many stakeholders indicated that it is common for truck drivers, particularly those from smaller companies, to rely on regular GPS for navigation, partly due to the higher costs associated with trucking GPS systems. Trucking GPSs typically contain roadway restriction information, including restricted roadways or those not recommended for large trucks.

- Truck restriction sign location. District officials suggested that some truck restriction signs are placed at locations where trucks cannot find alternate routes or in places where it is too late for them to turn around.

- Truck restriction sign design. The interviewed stakeholders also speculated that some truck routing signs could be confusing to truck drivers or may not provide accurate routing instructions. In addition, the truck restriction signs generally do not indicate restriction reasons, leading some truck drivers to mistakenly believe that the restriction is due to reasons other than roadway geometric conditions (e.g., local residents not wanting through trucks).

- Complete identification of truck restricted routes. Due to VDOT's limited resources and the lengthy process required to designate truck restricted routes, some secondary routes were not yet designated as truck restricted routes, although they likely could not accommodate large commercial vehicles.

- Enforcement. VDOT does not have legal authority to enforce truck restriction signs. Currently, trucks violating truck restriction signs are not regularly enforced by VSP, either due to roadway challenges, such as difficulties in pulling over large vehicles on narrow roadways, or limited staffing resources. In addition, VSP officers cannot issue tickets to truck drivers on roadways that are not recommended for trucks but that are not actually restricted. In the case of oversize/overweight loads, DMV does not specify routes for permit applicants and will not track or enforce the permits after they are issued. In cases when a truck enters a restricted route, it is frequently the priority of VSP officers to ensure the truck passes through the restricted section safely and in a timely manner so that it does not cause significant traffic congestion.

- Trucking company practices. Based on their working experience with the trucking industry, the stakeholders believed that some practices and policies aimed at or applicable to trucking companies potentially contribute to the issues as well. For example:
  — Stakeholders suggested that some trucking companies, including particularly small companies, do not have policies requiring sufficient route planning prior to each trip.

- — Some stakeholders noted that some companies required truck drivers to bear the costs of GPSs required for navigation, resulting in drivers being more likely to use cheaper GPSs without truck restriction information.
  - — Stakeholders also believed that the FMCSA HOS requirement, when combined with lack of route planning by some drivers, could sometimes result in illegal parking on secondary roadways, shoulders, and increased urgency to use shortcuts that may be unable to accommodate trucks.
  - — Interviewees with experience dealing with truck incidents indicated that some trucking companies preferred the use of company-designated tow service providers when stuck, resulting in delays in removing stuck vehicles on roadways.

- Coordination. Stakeholders suggested that better coordination within/among agencies and between the public and private sectors could help in collecting and making available complete and accurate CVO travel information data. For example, DMV and VSP may help distribute traveler information during their related licensing, training, and inspection activities. Some stakeholders also noted the lack of coordination and data sharing among state transportation agencies of bordering states that contributed to CVO challenges on interstate highways. An example where interstate coordination will be beneficial is a work zone with lane closures close to a border, which might cause increased truck traffic approaching from the neighboring state to look for alternate routes and parking, or congestion that extends into the neighboring state.

- Alternative route availability and identification. District officials interviewed during this project noted that certain roadways, including both arterials and secondary roads, did not have readily available alternate routes. The lack of alternate routes could result in prolonged congestion in the case of incidents or work zones, and more attempts by truck drivers to take routes restricted or not recommended for trucks as shortcuts. Some truck companies had policies that require their drivers to identify detours themselves upon roadway closures. Such practices could all result in more trucks selecting restricted routes and, therefore, increasing associated safety and operations concerns.

- Other issues. Some stakeholders noted that some outstate truck drivers did not speak English and, therefore, could not understand traffic signs. The lack of cellular and radio coverage at rural areas in the state also limits the ability to communicate traveler information relevant to the CVO community.

Information Needs and Priority

The stakeholders identified the following types of traveler information that could be specifically important for the CVO community in terms of mitigating the impacts they have on the state's transportation system:

- Roadway restriction data. Many stakeholders interviewed agreed that up-to-date, complete, and accurate roadway restriction information, including locations of both permanent and temporary restrictions, is critical for safe and efficient CVOs in the state. It is important to develop capabilities at VDOT to be able to warn truck drivers

approaching a roadway restriction location. Potential means for warning may include real-time warnings pushed to truck drivers through radios or portable electronic systems, VMS installed in advance of roadway restrictions, and/or warnings on navigation systems.

- Parking availability data. Stakeholders also recognized the importance of data on parking availability, particularly along major interstate corridors used by long-haul trucks. The lack of available parking spaces, parking availability data, and adequate route planning at some trucking companies has resulted in illegal parking activities along major highways in the state.

- Weather data. The stakeholders interviewed during this project believed that real-time, location-specific weather information is important to the CVO community as well. Severe weather events, such as winter storms and thunderstorms, can affect CVOs and increase demand for parking. Other localized weather events, such as heavy fog, gusty winds, and hail, also can create significant safety risks for trucks, and thus the accurate and timely communication of weather information is critical to truck drivers.

- Travel time and queue warning information. Some stakeholders suggested that information on travel time and queue warning on a real-time basis is important for the CVO community, particularly on major truck routes, such as interstate highways.

National Stakeholders

The research team talked to representatives from FMCSA and FHWA to identify initiatives or other projects related to traveler information. The following section presents a brief description of the most important initiatives.

One of the most important initiatives for USDOT with regard to traveler information corresponds to the Data for Automated Vehicle Integration (DAVI) initiative (DAVI, 2018). The lack of data standards have a significant cost for third-party service providers and make it very difficult to integrate data across jurisdictions.

Two of the framework components of Infrastructure to Business (I2B) and Business to Infrastructure (B2I) are directly related to traveler information. I2B or B2I data generators and users include states, in-vehicle and aftermarket devices/services, heavy-vehicle original equipment manufacturers (OEMs), and transportation network companies and fleet operators. Specific data that can be exchanged under this condition include work zone activities, geometrics, road weather information, and missing signage. The USDOT launched the initiative to address data exchange needs and to act as facilitator to inspire and enable voluntary data exchanges and pilot projects.

Specifically, the work zone data initiative finished in September 2018, following a similar system—General Transit Feed Specification (GTFS)—that allows public transit agencies to publish their data and developers to write applications to serve the users.

Two potential solutions to warn drivers are the Commercial Mobile Radio Services (CMRS) and Roadside Equipment/In-cab receiver and interface.

FHWA personnel discussed with the research team several projects that will have an impact on the CVO community, including:

- Work Zone Data Initiative
- Connected Vehicle Pilot Project Wyoming
- ConOps for CV Road Weather Applications
- Vehicle Data Translator/Pikalert System
- Standards (SAE J2945/3)

Discussion emphasized the importance of creating and adopting new standards, the value of pilot programs, and the impact that vehicle connectivity will have in CVO operations in general.

FMCSA's major efforts regarding traveler information correspond to deploying work zone and incident electronic notifications related to commercial vehicle traveler information. The systems must be able to broadcast through CMV transponders, electronic on-board systems, cell phones, and/or motor carriers' routing and dispatching systems. Alabama has an operating system that established work zone-related geofences that trigger an alert when the user enters the geofenced area. The system also notifies drivers of an estimated distance to the work zone, and different warnings are issued (ALDOT, 2018). Phase 2 of this project continues to be active.

Arizona DOT (ADOT) and Maricopa County DOT are in the second phase of the work zone warning and alert system using connected-vehicle technologies (5.9 GHz Dedicated Short-Range Communications [DSRC]) to provide in-vehicle information for commercial vehicle operators. The Arizona project is a partnership between ADOT/MCDOT, the University of Arizona, DriveWyze, and Knight-Shift Transportation. The ADOT work zone systems integration is shown in Figure 12.

Kentucky DOT is the latest state to receive an FMCSA grant to implement a project to provide in-cab notifications to truck drivers. Warnings include the active work zone, dangerous curves, and traffic congestion and incidents.

Considerable resources go not only into system development but also in getting partners to join the initiative. Applying for such grants or similar initiatives are being considered by some states as the most appropriate initial step to creating work zone notification systems.
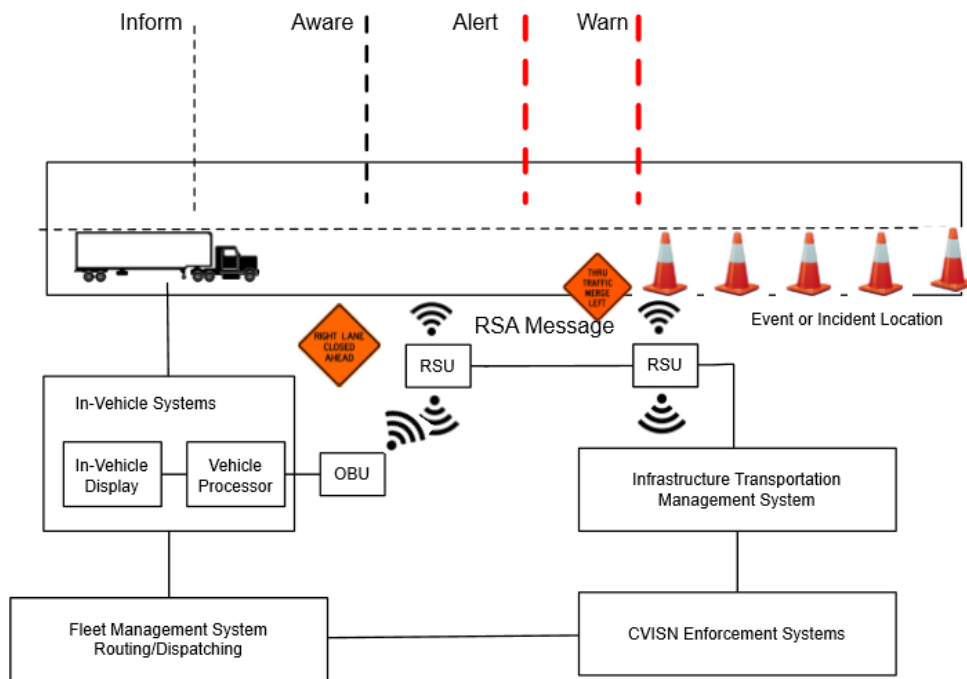
Note: RSA = roadside alert, RSU = roadside unit, OBU = onboard unit, CVISN = Commercial Vehicle Information Systems and Networks

Figure 12. ADOT Work Zone System Integration (FMCSA, 2018b)

State Initiatives

As part of their traveler information systems, states used a combination of 511 systems (phone, web, and apps), VMS, HAR, and social media. For the majority of states, like Virginia, these systems target the whole population of travelers—cars and CVOs—and are multimodal. While these tools are also generally used by the CVO community, they have limitations in the type of information provided to truck drivers. Truck drivers usually complain that there is much information that is not needed (e.g., multimodal), and there is a lack of more detailed information (e.g., truck route restrictions). As part of this project, the research team reviewed and contacted state personnel regarding their state's traveler information capabilities. The following section describes only examples of states that have developed 511 systems specific to truck drivers, CVO portals, truck parking applications, and geofenced 511 systems that can be used by the CVO community.

511 Systems for Truckers

A number of states have included traveler information specifically for truck drivers in their 511 systems. The information they offer consists of interactive maps of designated truck routes, weigh station locations, real-time overweight/oversize restrictions, online/automated

registration for permits, rest area locations and online truck parking availability, and links to the neighboring states' 511 systems.

The Iowa DOT 511 system, http://www.511ia.org/) presents users with four different types of systems, as shown in Figure 13. The Truckers option allows the truck driver to select between two options based on their internet capabilities; the slower internet option uses static maps for faster loading (Iowa DOT, 2018). The Iowa 511 mobile app also has a "Tell Me" feature that allows users to get hands-free, eyes-free audio notifications of traffic events while driving.

Figure 13. Iowa DOT 511 System Interface (Iowa DOT, 2018)

The system requires the user to register. After that, the trucker has the option of adding a route/place or defining a custom area. When the user selects a route, the system allows zooming to a place, entering the start and end address, choosing a roadway, or choosing a predefined area. If the user defines a custom area, they are prompted to draw the area in the map (Figure 14).
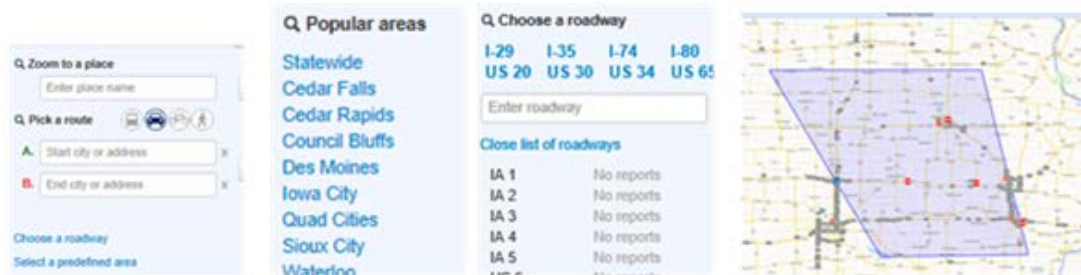
Figure 14. User Selection Capabilities on Iowa 511 (Iowa DOT, 2018)

Information is provided on incidents, construction, winter driving, weather warnings, towing prohibited, plow cameras, plow locations, cameras, traffic speeds, electronic signs, weigh stations, and rest areas, as shown in Figure 15.
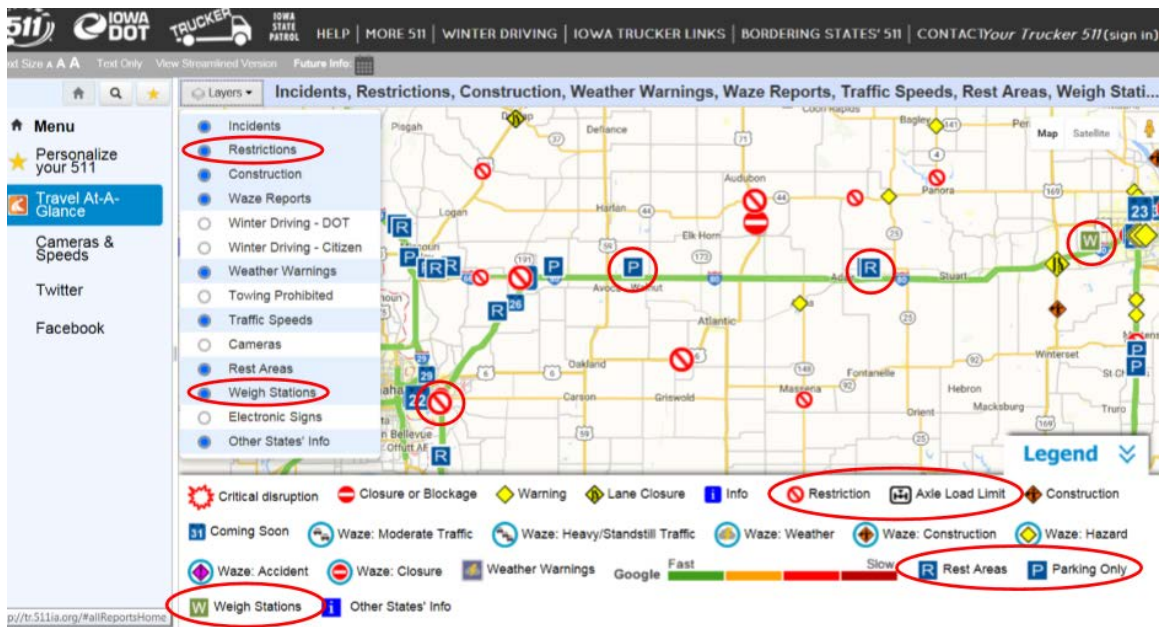
Figure 15. Iowa DOT Truck Drivers 511 System Information (Iowa DOT, 2018)

The parking information provided by the 511 system includes public and private facilities. When available, real-time parking availability information is provided for both types of facilities using three color levels to indicate level of availability, as shown in Figure 16.
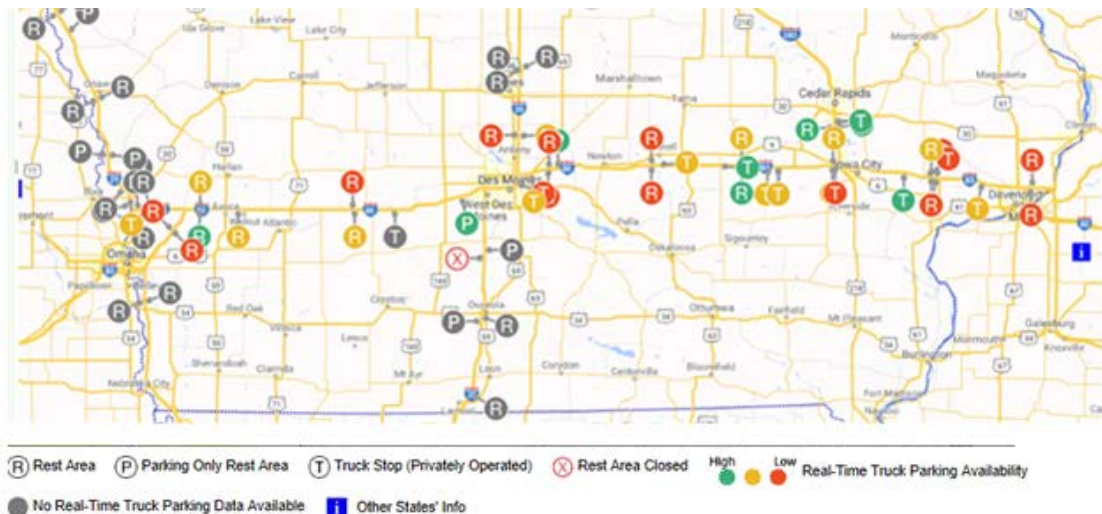
Figure 16. Parking Information Provided by Iowa 511 (Iowa DOT, 2018)

New York DOT (2018) does not have a special portal for trucks but lists height and weight restrictions as one of the layers. Since the system also has routing capabilities (for cars),

this allows the truck drivers to select their route and identify locations with potential weight or height restriction violations, as shown in Figure 17 (https://511ny.org).
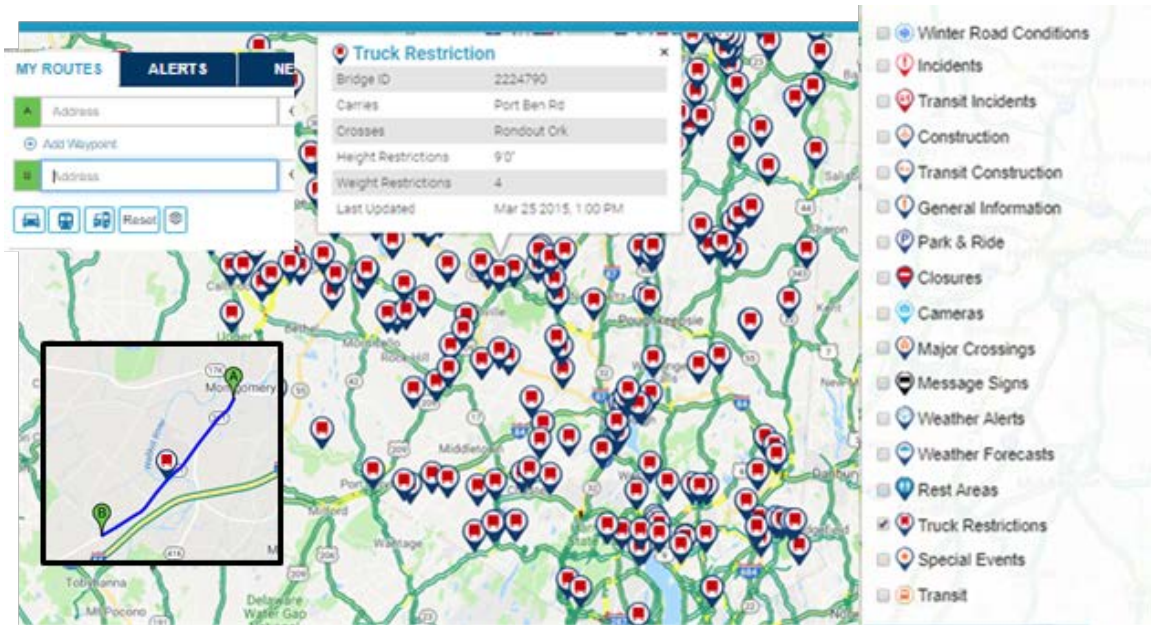
Figure 17. Truck restriction and routing capabilities provided by 511NY (New York DOT, 2018)

Idaho DOT (2018) developed a similar portal for its 511 system, as shown in Figure 18 (https://511.idaho.gov/). The information is filtered and presented differently than the traditional 511 site, focusing on information more relevant to truck drivers. For the greatest functionality, the state developed three different products, including a phone version, a low bandwidth website version, and a high bandwidth website.

Figure 18. Idaho 511 Truckers Information (Idaho DOT, 2018)

The system provides information regarding trucker reports, winter driving, traffic speeds, truck ramps, weather stations, other states' information, highway advisory radio, and rest areas. Specific information is provided on mountain passes, weigh stations, and HAR. For winter driving, conditions are indicated as difficult, fair, or good (see Figure 19).
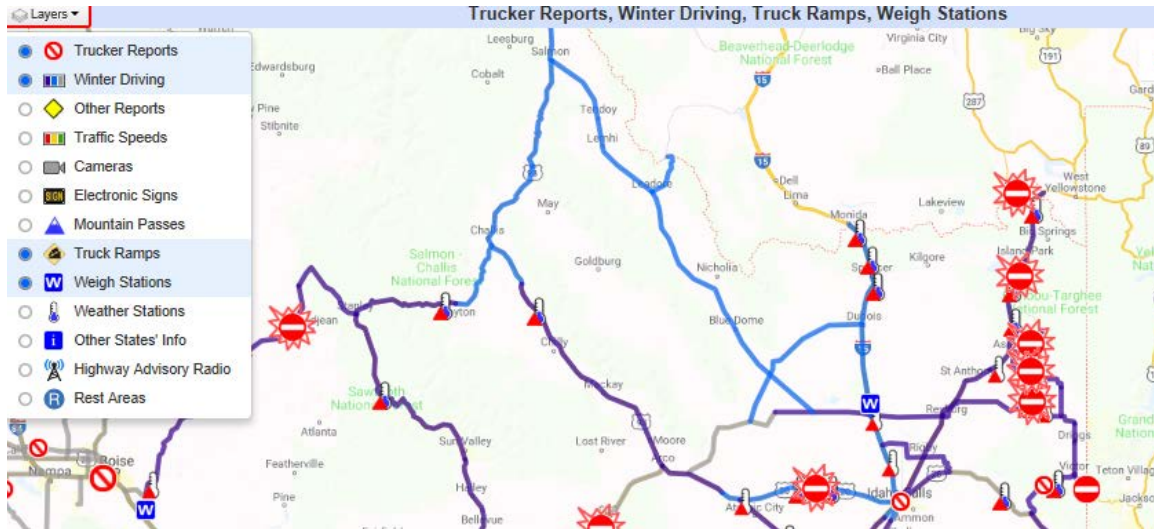
Figure 19. Idaho DOT Truck Traveler Information System (Idaho DOT, 2018)

Wyoming Commercial Vehicle Operations Portal

Wyoming DOT (2018) created the Commercial Vehicle Operations Portal (CVOP) website to give CVOs access to forecasted road conditions and wind information, as shown in Figure 20 (https://apps.wyoroad.info/cvop/). The reports are created by Wyoming DOT's onsite meteorologist. According to Wyoming authorities, 150 freight operators use the CVOP, which had 862 registered users at the time this research was conducted. All forecasts are tailored specifically to address the weather challenges that commercial vehicles face while traveling in Wyoming. To provide a better service, the site provides forecasts for different time intervals, up to a 72-hour period, in 12-hour increments for visibility and road surface conditions, and in three-hour increments for wind. One interesting aspect of CVOP is that the forecast includes a "worst condition" forecast where the driver is provided with the most severe conditions expected (wind, visibility, or road surface).
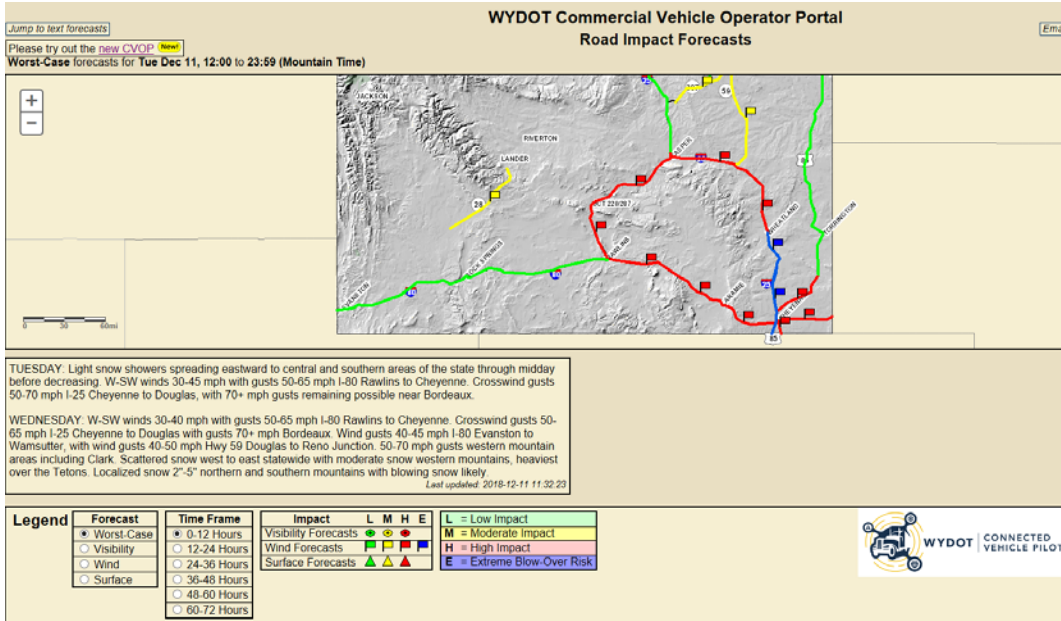
Figure 20. CVOP Road Impact Forecast (Wyoming DOT, 2018)

Weight and Height Restrictions

Posted Weight Restrictions

To help drivers avoid routes with posted bridges, Georgia DOT provides truck drivers with instructions on how to download and incorporate their Arc GISs KML bridge file into Google Maps, creating for the user a personal Google Maps with all the posted bridges in the state. The driver can input his or her origin and destinations as normal, and the posted bridges will appear in the selected route. Clicking the icon, users can see the specific posted weights for posted bridges (Georgia DOT, 2018). To select a better route, drivers can drag the route or add destinations to avoid or reroute around posted bridges (see Figure 21).
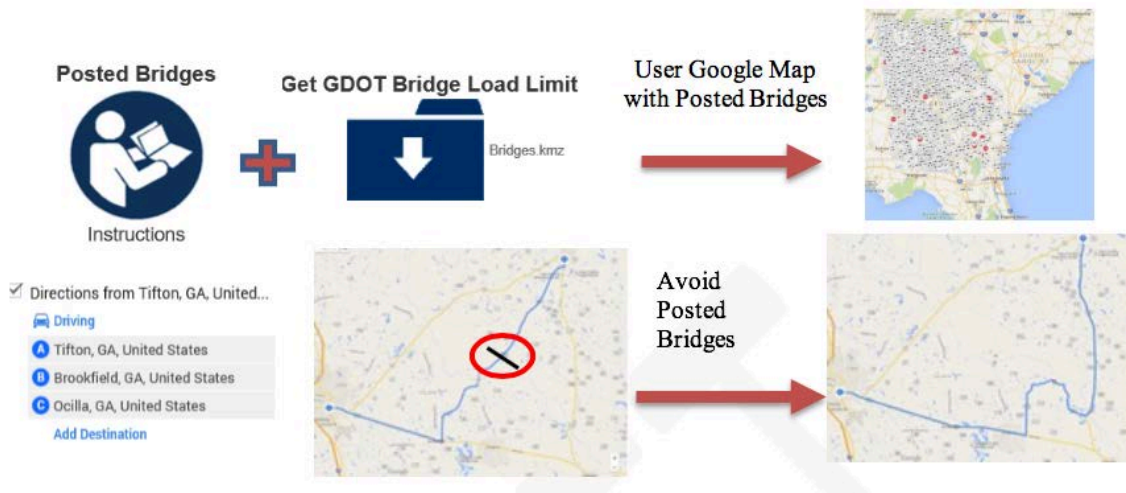
Figure 21. Georgia DOT's Posted Bridge Rerouting Tool (Adapted from Georgia DOT, 2018)

43

Height Restrictions

After a bad accident involving a truck driver at a bridge, the National Traffic Safety Board issued a resolution requesting that Washington State DOT (WSDOT) measure every lane under bridges. The WSDOT State Route Bridge Vertical Clearance Trip Planner (https://www.wsdot.wa.gov/Bridge/Structures/BVCTP.htm) was the result of that effort. Users enter the height of the vehicle in feet and inches, and the tool shows all the bridges where the truck will not pass and the bridges where the vehicle could pass if the correct lane is chosen (Figure 22). This tool brings into consideration the accuracy of the height measurements and the differences by lane (WSDOT, 2018).
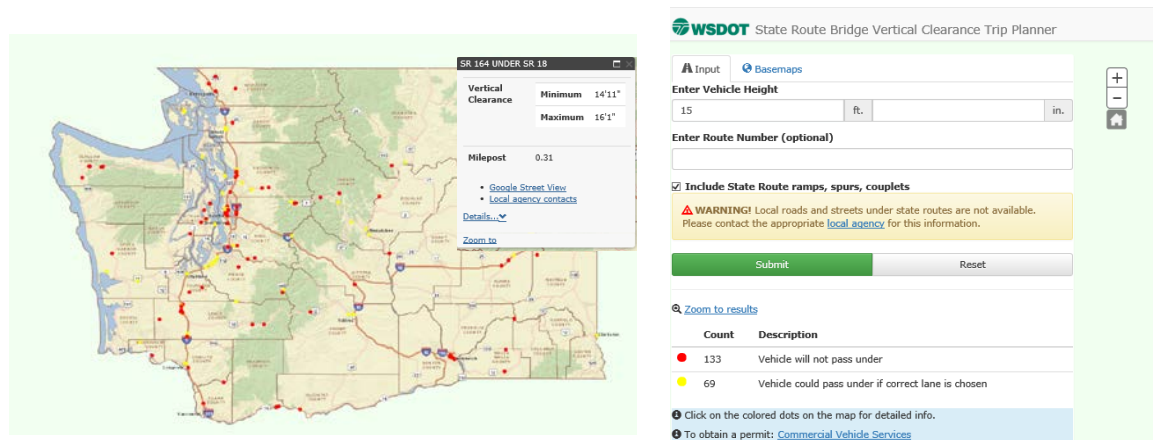
Figure 22. WSDOT State Route Bridge Vertical Clearance Trip Planner (WSDOT, 2018)

Advanced 511 Features

PA511 traveler information (https://www.511pa.com/) as shown in Figure 23, while not specifically for truckers, provides users extra services that can be useful for the CVO community, including the following (Pennsylvania DOT 2018):

1. Voice Alerts
2. Geofenced – user sets a mile radius around vehicles to receive alerts
3. User sets preference to receive alerts in all directions or only in the direction of travel
4. User defines a period in minutes to have the advisory message repeat
5. Extended coverage area to New Jersey and West Virginia

Figure 23. Trapped Traveler Emergency Communications Services (Pennsylvania DOT, 2018)

Private Vendors

Third-Party Data Providers

HERE Trucks (Navmart, 2018) is a database developed for the logistics management industry and truck drivers. The database includes a variety of information specific for trucks, such as legal restrictions, environmental zones, hazardous materials, traffic and road weather conditions, physical restrictions, CVO points of interest, distance markers, and loading dock locations. Road attributes of specific interest to trucks include vehicle width, maximum height, total weight, axle weight, total vehicle length, number of trailers, and number of trailer axles. HERE collects its own truck restriction information.

The data have been used by a variety of truck route planning software and applications to support truck navigation and route optimization, carrier route maps generation, safety and route warning information, truck routing and dispatching, and application of carrier route codes to make delivery more efficient. When selecting the route-specific information, truck characteristics, such as dimensions, weight, and type of goods carried, can be specified, as shown in Table 5.

Table 5. Truck Parameters for Routing

Truck Characteristics	Shipped Hazardous Goods
Max Speed Total Weight Axle Weight Total Vehicle Length Vehicle Width Maximum Height Number of Trailers Number of Trailer Axles	Explosive Gas Flammable Combustible

INRIX^TM Traffic Maps and GPS (INRIX, 2018) is another example that can benefit the CVO community. In addition to enabling a community of users to report incidents and special events to the map provider, INRIX uses anonymous connected-vehicle and cellular phone data, commercial vehicle tracking data, and GPS-based data to validate traffic and incident information. The INRIX Safety Alerts service consists of three modules, including INRIX Dangerous Slowdowns (warns drivers and traffic management centers about slowdowns that can be potentially dangerous for travelers), INRIX Incidents (predicts and informs drivers of crashes, work zone locations, and other anomalies on the roads), and INRIX Road Weather (provides safety warning and advice during adverse weather situations).

Drivewyze (2018) uses CMRS transponders, coupled with electronic loggings devices (ELDs), to enable weigh station bypass convenience for trucks. Drivewyze has teamed up with a number of states to provide information about weigh stations and enable truck bypasses of weigh stations at certain conditions.

Navigation Tools

At best, using consumer navigation tools (i.e., car GPS) results in no impact to the road if the roadway geometry can handle the truck. If the road is truck restricted, the lack of GPS navigation, at worst, results in trucks overturning, running off the road, or colliding with bridges. Even the redirection of a truck results in significant losses to the state in VSP and VDOT personnel involvement, traffic stopped in one or both directions, and the potential for secondary crashes. When a crash occurs, in addition to congestion and secondary crashes, there is the potential of injury or loss of life and significant costs due to damage to the road or structure involved. This problem is not unique to Virginia and is shared by several states and cities. Common causes mentioned by different stakeholders include lack of experience, using a car GPS, disregard for signs, and inadequate placement of signs.

Currently, truck drivers can be cited for circulating in restricted routes per regulation 49 CFR 392.2. These restrictions apply to routes; posted bridge weight restrictions; height, width and weight restrictions; and hazardous materials transportation. Furthermore, a conviction of failing to obey a traffic control device will be counted against a motor carrier's Compliance, Safety and Accountability (CSA) score.

The problem is so great that Senator Schumer in 2014 requested that the USDOT examine the topic and determine methods to mitigate property damage and safety risks involved. As a result, FMCSA defined several steps, including: (a) working with state and local partners ensure they understand their enforcement authority; (b) creating a GPS Selection Guide for commercial vehicles, establishing why it is critical to use specialized GPS while operating a commercial motor vehicle (Figure 24); and (c) working with commercial training schools to integrate the topic in their curriculum (FMCSA, 2014).

Figure 24. Federal Motor Carrier Safety Administration (FMCSA) GPS Selection Guide for CVO (FMCSA, 2017)

Despite their potential problems, according to drivers, some of these non-truck applications provide information that that they cannot access anywhere else. The following section describes the most common non-truck specific tools that drivers use.

Road Atlas

One of the most common resources cited as trusted and as a companion to any navigation system is the Rand McNally Motor Carriers Road Atlas (Rand McNally, 2018). For more than 80 years, Rand McNally has annually produced the Motor Carrier Road Atlas. The Atlas contains information for each state regarding: state access policies, legal weight/size limits for interstate routes, weight and size limits for each type of truck, low clearance locations, permanent weigh stations, and restricted routes. Information regarding restricted routes and low clearance location is provided to Rand McNally by the states. Restricted routes listed include routes restricted due to state law, low weight bridges, tunnel limitations, or routes that are unsafe year-round. Low clearance listed includes structures with a legal or less than legal limit. However, this list does not include structures that are located on any county road, local road, or on a designated restricted route by the state. Examples of restricted route information and low clearance information provided by the Atlas is shown in Figure 25.

Restricted Routes	
Route	**Location**
US 1 SB	VA 40 to Dinwiddie
VA 3	Fredericksburg over Rappahannock River
VA 5	US 80 to VA 895
VA 6	US 29 to VA 151 (65 ft. restricted route)
VA6/151	VA 151 W Interchange to VA 151 E. Interchange (65 ft. restricted route)
…	

Low Clearance Locations		
Route	**Location**	**Height**
VA 5	Richmond-0.8 mi, south of US 60	13'2"
VA 7	Alexandria- 0.6 mile west of US 1	13'3"
US 11	Staunton, S8 between Commerce Road and Richmond Av	10'0"
US 11 Bus	Lexington North of JCT US 60	10'6"
…		

Figure 25. Examples of Information Included in McNally Motor Carrier Road Atlas Information (Source: Adapted from Rand McNally, 2018)

Google Maps and Waze

Google Maps and Waze were mentioned often by truck drivers and carriers as tools to help them with routing and truck services. Neither Google Maps nor Waze use truck restriction information, so the route is generated independently of whether trucks have any restriction for using the route. However, carriers noted that they use Google Maps to check the height and weight restrictions on the map by looking at the corresponding signs using Google Street View. In addition, one of the most important advantages of these tools for truckers is that even the more sophisticated truck GPSs or telematics do not provide the same level of detail regarding locations. This is very important for drivers at the end of the route when they need to reach a customer's specific address. However, while Google Maps can generate optimized non-CVO routes and pinpoint specific locations, it does not have the capability to generate truck routes.

Waze has the same limitation but is perceived by truck drivers and carriers as providing more quick and reliable information regarding incidents and unplanned events. Waze has no plans to expand its navigation tool for truckers.

Telematics

Fleet telematics refers to embedded systems on a commercial vehicle that track the vehicle and combine wireless and internet communications to send, receive, and store vehicle information. Telematics have the potential to increase operational efficiency and improve driver safety in a number of ways, including: (a) GPS technology tracks a truck's location, mileage, and speed that managers can use to optimize routes and scheduling efficiency; (b) communications

technology promotes connectivity between drivers and dispatchers; (c) sensors monitor vehicle diagnostics; and (d) vehicle kinematics information and cameras monitor drivers' actions.

The two major telematics providers are Omnitracs and PeopleNet. Other providers include Verizon (Fleetmatics, Telogis, and Telematics), Garmin, Telenav, and TomTom. Most telematics providers offer a variety of products to address carriers' and drivers' needs. These platforms range from off-the-shelf products and smartphones to on-board computing mobile platforms with multiple integrated systems, including routing, messaging, compliance, and productivity. As an example for routing, PeopleNet provides voice-guided GPS navigation with industry-standard PC*MILER truck-specific routing, which helps drivers travel from dock-to-dock faster, and from mile-to-mile safely and efficiently. The system also allows for the integration of PC*MILER in the back office and CoPilot® Truck in the cab, which results in matching route generation. Omnitracs Intelligent Vehicle Gateway^{TM} (IVG) enables hands-free access to key information and message notifications.

Trucker Applications

Truckers use phone applications on a regular basis. The cell phone is the most common tool for communication, and several of the applications are free of charge. The most popular applications are related to parking, navigation, and weather. Popular parking applications include TruckSmart, Trucker Path Bro, NATSO's Park My Truck, Truck Parking USA, and TRELP. Popular navigation applications include CoPilot and Smart Truck Route. The most commonly used weather applications include Accuweather, Weather Underground, and The Weather Channel. More information regarding these applications is provided in Appendix B.

DISCUSSION

This section discusses some of the issues that are unique to the CVO community, provides a description of an "ideal" system, highlights the gaps in the existing practice, and discusses possible actions to fill these gaps.

Issues Unique to the CVO Community

Customers' Expectations – The Amazon Effect

Over the last several years, a dramatic change has occurred in the logistics industry, including new requirements, new competitors, and new technologies, resulting in a demand for superior customer experience (3PL Central, 2018). Due to what is usually called the "Amazon Effect," customers expect to not only receive their shipment on time but also to be informed if there is a delay and notified as to when the shipment can be expected. In addition, a growing number of business are enforcing strict delivery requirements (E-C 240, 2018). For example, last year Walmart reduced its delivery window from 3 days (the day before, the day of delivery, and the day after) to day-of delivery, and shippers that do not comply pay penalties of 3% of all products shipped. Carriers must attend to this new customer demand, and it is not enough for them to simply know that there is a work zone or an incident; they also need to know the impact on traffic, estimated delays, and alternate routes. For carriers, this type of information has added value in fulfilling customer expectations.

Business Models and Communication Tools

The internet and big data have created a revolution in business models, and truck fleets are evolving while adapting to this new model. Consultations with industry and state stakeholders through meetings, interviews, and surveys suggest that carriers rely on multiple platforms to route their cargo based on its origin, destination, weight, dimensions, travel time, unexpected incidents, and weather changes. Within this environment, carriers and truck drivers rely on different communication tools to select the best routing that guarantees optimal services to their customers.

Adoption of New Technologies

Although various truck technologies are currently available or under development, small trucking companies report having difficulties acquiring new technologies. Issues include the effectiveness for their company, the price, and the needed training. However, smaller companies have the advantage in that their decision-making processes are, in general, more straightforward. Some larger carriers reported that they have telematics in their central dispatch office, but some services come at an extra cost that the company may not be willing to pay, or the implementation of new technology often takes too much time.

Electronic Logging Device Mandate

The electronic logging device (ELD) mandate has increased fleets' online connectivity. Several telematics providers have incorporated ELD into their systems to provide an integrated solution for their customers. Other private-sector players have also realized the opportunity to serve the market of very small carriers and have developed crowdsourcing applications, like Trucker Path, that provide ELD equipment, services, and web-based fleet management for a relatively lower monthly cost.

Hours of Services and Parking Availability

The ELD rule is making drivers more cautious. Drivers try to park in advance to comply with HOS. This situation, in combination with limited parking availability, often results in fewer miles driven, which impacts efficiency and overall capacity. Some sources estimate reductions in overall capacity between 3% and 7% (Tucker, 2018).

Driver Distraction - FMCSA One Push Rule

Several studies have shown the negative impact of driver distraction while driving. Therefore, communication tools used en route must comply with the one-push rule by providing text-to-voice capabilities, allowing voice commands, and avoiding other interactions during driving.

Information Configuration

The same information can serve different purposes for the carrier (dispatcher/manager) and the truck driver. For example, work zone information can be important for the carrier (dispatcher/fleet manager) to select the best route and optimize pick-up or delivery schedules.

For the driver, it is important to know that they are approaching a work zone so that they can reduce speed, react to queues, find detours, or modify scheduled breaks. As a result, the data for each type of information must be tailored to support the different needs.

"Optimal" Traveler Information System

The analysis of the information collected suggests that an "optimal" traveler information system must provide information specific for each traveler category where and when it is needed. The application of such a system is expected to help improve performance measures in three key areas: safety, travel times, and compliance, as shown in Figure 26.

Safety
- Reduction in truck crashes (fatigue, work zones, weather)
- Reduction in secondary crashes
- VDOT infrastructure health

Travel times
- Reduce congestion
- Truck delay reduction

Compliance
- HOS
- Reduce number of violations

Figure 26. **Potential Benefits of a Traveler Information System**

The recommended role for VDOT in the CVO traveler information system is to be an active participant, supporting all stakeholders by providing the trucking industry with the best information possible. While an ideal system is never attainable, the desired capabilities for an optimal CVO travel information system should have the following capabilities:

- Be easy to use and available 24/7
- Provide accurate and reliable information
- Provide coverage throughout the entire state
- Support different platforms to assure accessibility for all trucks and carriers operating in Virginia
- Be adaptable and anticipate the needs of its customers
- Maximize use of resources available from other traveler information sources
- Provide real-time information to maximize safety and efficiency for truck drivers (e.g., work zones, incidents, alternate routes, truck route restrictions, travel time, weather, parking availability, weigh stations, services ports, and terminals)
- Provide navigation tools that guarantee the selection of non-restricted truck routes for specific truck dimensions
- Have integrated pre-trip and in-route capabilities
- Minimize truck driver distraction by supporting voice-to-text and voice recognition platforms
- Have geofence capabilities to provide customized information for various types of users when and where needed

The services mentioned above can be provided by the public, the private sector, or a combination of both. The objective is to select the most cost-effective method to satisfy the user information needs.

Gap Analysis

Based on the information collected in the different project tasks, the research team conducted a gap analysis and identified specific possible actions to close those gaps. Table 6 summarizes the gaps identified in six key categories: (1) Truck route restrictions, (2) Work zones, incidents, and traffic congestion; (3) Truck parking; (4) Alternate truck routes; (5) Access to information an outreach; and (6) Regional integration.

Table 6. Main Gaps Identified

1) Truck Route Restrictions		
Objectives	**Relevance**	**Gaps**
Provide truck drivers with truck route and height and weight restrictions information	- Drivers survey #1 Stakeholders' interviews - Significant cost - delays and safety - Safety - VDOT infrastructure	- Not every truck has a truck GPS navigation tool - Google, Waze do not contain truck route restriction information - Restrictions not clearly identified; signs placed when there is no possible corrective action - Route restriction length information is a static map - Posted bridge information is a static spreadsheet - Bridge height information is not available (need to be requested by email) - No integrated length, weight, and height restriction map - No information included in 511 system - No routing capabilities at all in 511 system - Violation locations and reasons not recorded - Not all stakeholders are aware of VA data portals - Incomplete coverage of static information in towns and cities
(2) Work zone, incidents and traffic congestion		
Impact	**Relevance**	**Gaps**
Improve truck driver and carrier awareness of work zones, incidents, and congestion	# 1 Drivers' survey - Stakeholders' interviews - Significant cost - Delays - Safety - VDOT infrastructure	- Truck awareness that they will encounter a work zone or incident zone - Lack of information on the impact of the delay - Not all telematics provide the incident information on the in-cab communication device - Carriers not aware of VA 511 notifications - The majority of the systems do not provide push notifications of incidents

(3) Truck Parking		
Objectives	**Relevance**	**Gaps**
Improve truck driver and carrier access to parking data availability	• #4 ranking drivers' survey • Carrier' interviews	• VDOT systems do not include private parking data • Data dissemination limited to VMS at this point • Limited information available on 511 • Parking not limited to HOS but also for emergencies and food breaks • VDOT information is not shared with truck parking applications popular among truck drivers
(4) Alternate Truck Routes		
Objectives	**Relevance**	**Gaps**
Improve alternate truck route selection and notifications	• Drivers' survey • Stakeholders' interviews • Significant cost • Delays • Safety • VDOT infrastructure	• Alternate routes not defined with trucks in mind • Guidance signs very far from one another • No information in 511 • No specific guidance posted on most telematics • No clear identification on VA SmarterRoads portal
(5) Access to information		
Objectives	**Relevance**	**Gaps**
Improve access to truck traveler information; increase data availability and awareness; maximize use of data available	• Stakeholders' meetings	• The information was in some cases difficult to find • Outreach improvement • Third party data providers not aware of all data available • There is not a formal procedure to reach developers of existing applications
(6) Regional Integration		
Objectives	**Relevance**	**Gaps**
Work with neighboring states and the private sector to provide regional integration and maximize leverage in new initiatives	• Stakeholders' meetings	• Information tends to be specific to a particular state • Need to develop tools for routing, work zone notification, and data visualization

High-Level CVO Information Systems Framework

This section presents a high-level proposed framework for the CVO traveler information system. The framework is based on CVO community information needs and preferences, types of data used and sources of information, information dissemination methods and channels, and best practices and operational policies. This high-level framework focuses on leveraging VDOT resources, improving data integration and dissemination, and promoting the participation of other public and private stakeholders. This framework is intended to show relationships at a high level, and design details would require further work and study if adopted by VDOT.

The traveler information currently provided by VDOT received a satisfactory rating by carriers and truck drivers, and the majority of stakeholders recognized VDOT efforts in increasing the information provided. Current channels of VDOT information dissemination include VMS, VA 511 web and phone applications, HAR, and the Smarter Roads and Virginia Roads portals. However, carriers and truck drivers typically complement the information provided by VDOT with input from dispatchers, third party data providers, telematics, and a plethora of other applications.

The framework illustrated in Figure 27 calls for a dedicated portal for trucks and has three basic components: collection of data inputs, data integration, and data dissemination. One important feature of the proposed network is that VDOT plays a key role in promoting the use of the integrated data by third party users to create new tools, applications, and technologies in order to fulfill the needs of the diverse carrier and truck populations.
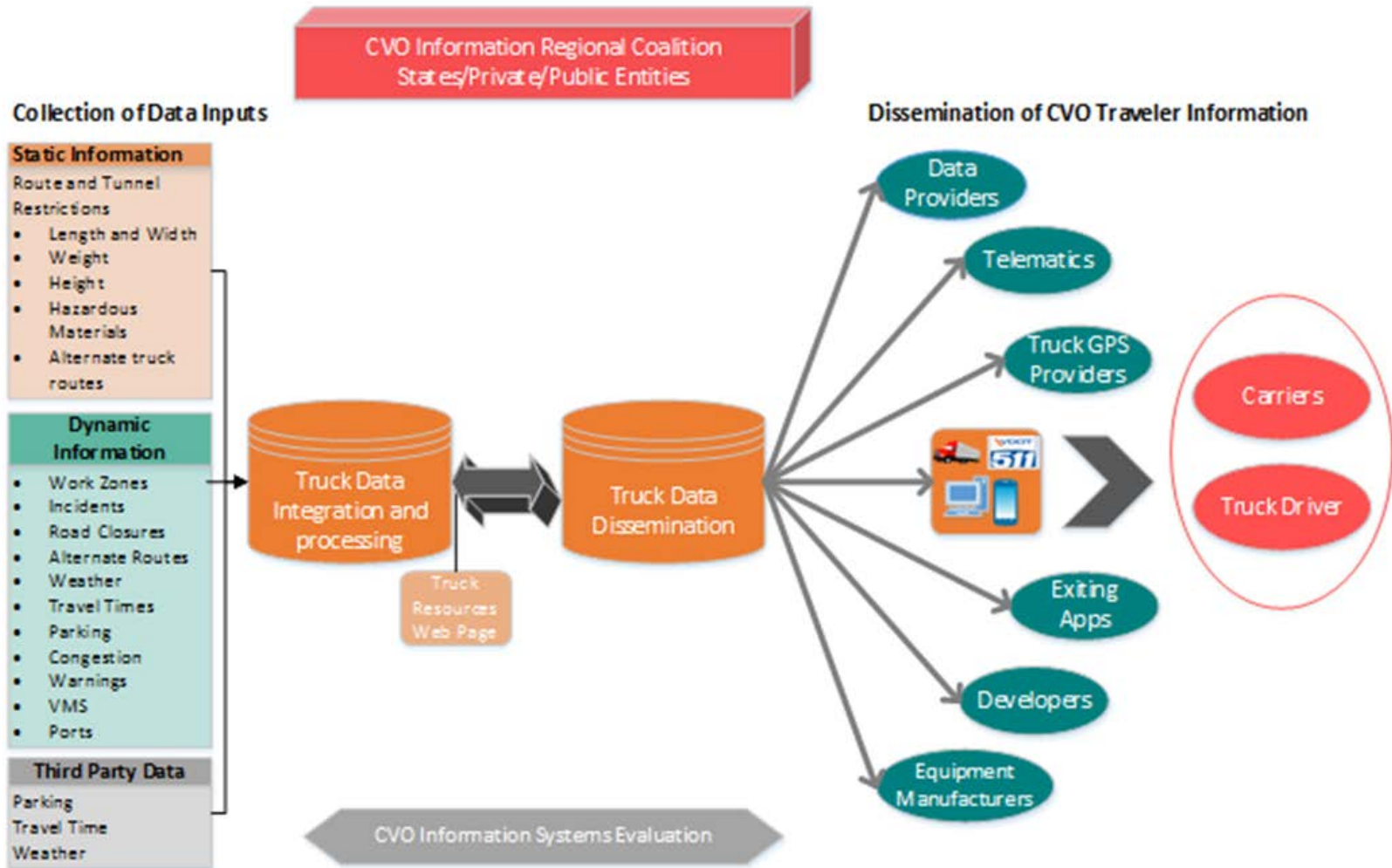
Figure 27. Proposed High-Level CVO Traveler Information System

The first component of the system is the data input module, which includes data from a combination of public and private providers. The framework calls for improving the data inputs by addressing the limitations identified during the project for each data type. For example, data reliability and coverage for truck route restrictions on major roads is considered adequate. However, reliability of the data declines significantly for lower functional class roads and town and city roads. Restrictions on secondary roads must be reviewed to be sure that they fulfill the requirements of the current fleet population. Bridge height restrictions are also of concern since height restrictions are provided for the whole section of road under the bridge in the direction of travel, but considerable differences in height restrictions can exist among different lanes. The input data also incorporates additional sources, such as freight supply chain data from port operations. The port information could include providing links to port portals, real-time information identifying if the port is operational, or port operational alerts. Links to important port information and port portals can be presented on the truck resources web page.

VDOT is already working on improving some of the data streams, as in the case of truck parking data. Current truck parking data is limited to VDOT parking facilities and real time parking data availability is provided only for a limited number of instrumented parking lots. To maximize benefits for truck drivers, the data could include, when feasible, private facilities. Directly associated with truck restriction information, is the provision of adequate alternative routes. Alternate route information is incorporated as an input in the framework to satisfy the needs expressed by carriers and truckers. This information is not currently presented to users in other VDOT platforms. This data input should not be limited to just alternate routes for routes with truck restrictions, but also include alternate routes for locations that experience non-recurrent events (incidents).

It is expected that future advances in technologies like connected and autonomous vehicles will increase the level of data provided by the private sector. Bridge height data, for example, will be an important requirement that the private sector will need to provide to users of autonomous vehicles. Work zone input data will continue to come from VDOT for the planning process, but it is expected that the exact time of the beginning and end of work zone activities on any given day will be complemented with data provided by the private sector. The combination of data sources will need to be evaluated periodically in order to assure the best use of available resources.

The second component of the framework is the integration of the information. This module combines traveler information data from different sources in a relational GIS database. For example, truck route restriction information comes from seven separate VDOT sources, each with separate platforms and data formats. As is explained in the potential actions section, if a truck driver or carrier wants to verify that there are no restrictions in a selected route, they need to open different links, correlate maps and spreadsheets, and often request additional information from VDOT.

The third component of the framework focuses on the dissemination of the integrated information. While the final users of the information are carriers and truck drivers, the aggregated data must be pushed to all the stakeholders that provide services to the CVO

57

community, including data providers, truck GPS vendors, telematics systems, existing application developers, and potential developers. Consultations with stakeholders and the private sector showed that the data is ingested by different stakeholders in different formats based on the type of data and specific applications.

As a service to truck drivers and carriers, this module includes a new 511 VA truck dedicated portal, accessible by web and phone applications. The research showed that the current VA 511 system is perceived by carriers and truck drivers as a service for cars rather than trucks. This perception is shared by truck drivers and carriers regarding other states' 511 systems. The exceptions to this rule are states that have dedicated 511 truck and web applications. The development of these systems is reflected by the CVO community's level of satisfaction in these states. The information presented in the 511 CVO layer must emphasize information useful for carriers and drivers, such as weather warnings; include important information, such as route and bridge restrictions; and eliminate unnecessary information, such as transit information.

While there are no limitations to drivers interacting with the 511 website or phone application while planning a trip or during a rest period, it is imperative that any application to be used during the trip meet the requirements of the "one touch rule" imposed by FHWA. To that end, the phone applications must have voice recognition capabilities. Integration of the 511 portal information with in-cab devices is also important. As mentioned before, carriers and truck drivers use different tools to select their routing. Unfortunately, there is an underserved population of truckers with limited or no access to routing tools. Therefore, incorporating routing capabilities prior to and/or during the trip will be very beneficial.

The dissemination of information does not guarantee that the information will be used to create added value. The ingestion of data on the third party processes or the development of new tools and technologies must respond to a viable economic model. In order to support these processes, the framework calls for the creation of a "*CVO Traveler Information Coalition*" with neighboring states and other stakeholders from both the public and private sectors. The coalition will mimic current successful efforts such as the I-95 Coalition and Mid-America Association of State Transportation Officials (MAASTO) Truck Parking Initiative. Furthermore, the coalition may provide leverage to promote change in some current data streams and encourage collaboration in other initiatives, like smart work zones. Research has shown that receiving notifications that allow the driver to be aware of specific situations in advance results in measurable safety benefits. The coalition will promote the use of in-cab technologies or applications that incorporate geofence capabilities and push notifications. To that end, it is recommended that VDOT participate in pilot projects such as smart work zones and partner with other public agencies and the private sector to develop new applications or products.

Potential Actions

The following section details specific potential actions to bridge the gaps previously identified and to support the proposed framework. The potential actions also include some intermediate actions (indicated with an *) that can be taken until a more complex product is developed.

Truck Route Restrictions

One of the main concerns of the VDOT personnel who participated in the project was truck route restriction violations. As discussed before in this document, the same concern is shared by other state DOTs. The issue is difficult to address because the information collected shows that route selection authority varies significantly among carriers. Some carriers give drivers full autonomy in route selection, while others do not give drivers any say in their route selection. Truck drivers for larger carriers, in general, have less route input authority than their smaller carriers' counterparts. In addition, tools used to choose the best route vary significantly among carriers and among truck drivers. The type of communication devices used also vary significantly. However, the most common device is a cell phone. Very small carriers rely mostly on Google Maps, Waze, the Atlas application, and truck GPSs. Large carriers take advantage of sophisticated telematics that not only provide carriers with route optimization but also allow for tracking and the simplification of several business processes. Data provided by truck GPSs or telematics that include navigation tools are, according to manufactures, carriers, and drivers, very reliable. Table 7 shows possible actions identified to help improve the availability of truck restriction information and minimize violations, arranged in priority order.

Table 7. Possible Actions Related to Truck Route Restrictions

Possible Action	Gap Addressed/ Users	Activities	Challenges/Limitations
RR.1 -Integration of all truck restriction data on the same platform including: length, width, height and weight for roads and tunnels and hazardous materials routes, - Review of restrictions on secondary roads	-Truck route and tunnel restrictions information come from seven different sources with different formats. -Furthermore, some of the information, such as weight restrictions, is presented only as a list (not in a map), and information, such as bridge height restriction is not directly available and needs to be requested by email. -Restrictions on secondary roads are not updated regularly and were not necessarily established for the current fleet population.	- Integrate all the route and tunnel restriction sources in the same platform. Information includes: route width and length restrictions, bridge weight restrictions, height and width bridge restrictions, tunnel restrictions, and hazardous materials restrictions. - Review truck restrictions on secondary roads for the current fleet.	-Inter-agency cooperation -Restrictions depend on truck characteristics and specific loads
RR.2* Develop pre-trip/stop routing tools that consider length and width restriction data	At the moment, the user has access to a PDF file or an ArcGIS file that does not allow routing capabilities for external users. -Many drivers do not have access to a truck GPS.	- Allow routing capabilities on VA road maps with truck length restrictions. The capability is already there but not accessible to the public. Since there may be a charge per use, application of this function may need to be limited.	-Available maps only give route length restrictions -Only pre-trip/stop capabilities -Technology is available in truck GPS/other applications

59

Possible Action	Gap Addressed/ Users	Activities	Challenges/Limitations
RR.3* Develop pre-trip/stop routing tools that include data on posted bridges and bridge height clearance	-User has access to an Excel sheet for posted bridges and need to request height clearance. - Many drivers do not have access to a truck GPS.	- Produce application(s) that allow the user to avoid posted bridges and become aware of height restrictions (similar applications developed by Georgia DOT and WSDOT).	-Application development -Difficult to estimate number of users -Only pre-trip/stop capabilities -Technology is available in truck GPS/other applications
RR.4 Combination of 1.1 and 1.2 for supporting route pre-trip/stop decisions	-Pre-trip routing capabilities -Many drivers do not have access to a truck GPS.	- Allow pre-routing capabilities similar to a truck GPS. - Use KML/KMZ files that allow incorporation into Google Maps.	-Difficult to estimate number of users -Only pre-trip/stop capabilities -Technology is available in truck GPS/other applications
RR.5 Develop routing application that can be used pre-trip or during trip	Provide drivers same capabilities as truck GPS.	- Develop application. - Agreement with available routing application development.	-Difficult to estimate number of users -The application will be only for routing
RR.6 Create a dynamic routing and notification application that notifies truck drivers of truck restrictions	-Inform the truck driver when on a restricted route or approaching a restricted bridge by using geofences.	- Develop a GPS-based application with geofenced capabilities.	-Difficult to estimate number of users -Identification of message to display/testing
RR.7 Incorporate route restriction information to VA511	-VA511 does not have any truck route restrictions.	- Create one or more new layers on VA511 or a specific 511 CVO portal.	-VA511 is limited to VA; need to maintain two sites (511 CVO portal)
RR.8 Sign restriction location evaluation	-Signs are placed when no corrective action is possible or are not visible enough.	- Review and revise as necessary truck restriction sign standards. - Review location of existing signs. - At a minimum, review location and type of existing signs when a violation occurs.	-Difficult to perform a complete statewide evaluation -Option: Focus first on known sites when crashes occur
RR.9 Create a database of truck restriction violations and locations	-No record of type of carrier and location where violations happen.	- Develop a procedure to record the event and location for VDOT when VSP issues a ticket.	-Institutional coordination

*= Intermediate actions that can be taken until a more complex product is developed.

Based on the feedback received, the team recommends focusing VDOT's short-term efforts on finding effective ways to incorporate truck restrictions into the tools available to all trucks. In general, there are two types of violators: truck drivers who are unaware of the restrictions until it is too late and those who take the risk anyway because the route is more convenient for different reasons. Little can be done for the latter group without providing more routing options, increasing enforcement, or increasing penalties. The routing actions proposed in Table 7 were developed to support truck drivers who do not have access to advanced truck

navigation tools. The actions proposed enhance the actual capabilities of VDOT data as such information is currently presented to truck drivers.

Since the carrier population that unintentionally violates restrictions normally uses Waze or Google Maps, the options first explored include these two applications. The research team reached out to Waze representatives. At the time this report is being prepared, it is not the intention of Waze to incorporate trucks as an optional mode for its application. Waze representatives recognized the limitations of the application's use by truck drivers, but the effort required to incorporate restrictions is not a priority at this time due to resources involved. Waze also emphasized that any effort must be conducted at a national level. Frustration with the use of Waze and Google Maps by truck drivers is shared by several states. One state agency has suggested that, at a minimum, state DOTs must be able to require Waze and Google to incorporate a disclaimer that the route information provided is not for trucks. However, efforts to require this disclaimer have not been successful.

Route selection can be made before the trip (pre-trip) or during the trip. The first set of actions proposes to enhance the actual capabilities of the ways that VDOT data are currently presented to truck drivers and their abilities to interact with the data. The VDOT Trucking Resources page presents drivers with the length restriction map, a spreadsheet for weight restrictions, and an email address to request height restriction information.

The first proposed action, RR.1, refers to the lack of integration of truck road and tunnel restrictions presented on the Truck Webpage Resource. Currently the information is presented in a disaggregated fashion by: (1) route width and length restrictions, (2) bridge weight restrictions, (3) height and width bridge restrictions, (4) tunnel restrictions, and (5) hazardous materials restrictions. The information is collected from seven separate VDOT sources, each of them with separate platforms and data formats. In addition, while some data are presented on a map, others (such as bridge weight restrictions) are only available in a list format. Furthermore, other information such as bridge height and width limitations are only available upon request. The integration of all truck restriction data on the same platform and in the same format will require interagency cooperation.

The integration of all restriction data, even georeferenced data, do not automatically support routing capabilities. To that end, the next tier of actions are focused on providing truck drivers with different truck routing capabilities. RR.2, RR.3, and RR.4 use current VDOT capabilities and enhance them at a relatively low cost and low level of effort by providing stop/ pre-trip routing capabilities. For example, possible action RR.2 supports truck drivers who do not have other truck navigation tools with truck restriction information necessary to select a pre-trip route. Currently, VDOT truck resources provide users with a static web or paper map that contains route length restriction only (Figure 28). Thus, to check for any length restrictions along the selected route, the driver must first select the route in a general application and, after the route is selected, compare a Google maps route, for example, with the VDOT restriction route site by site.
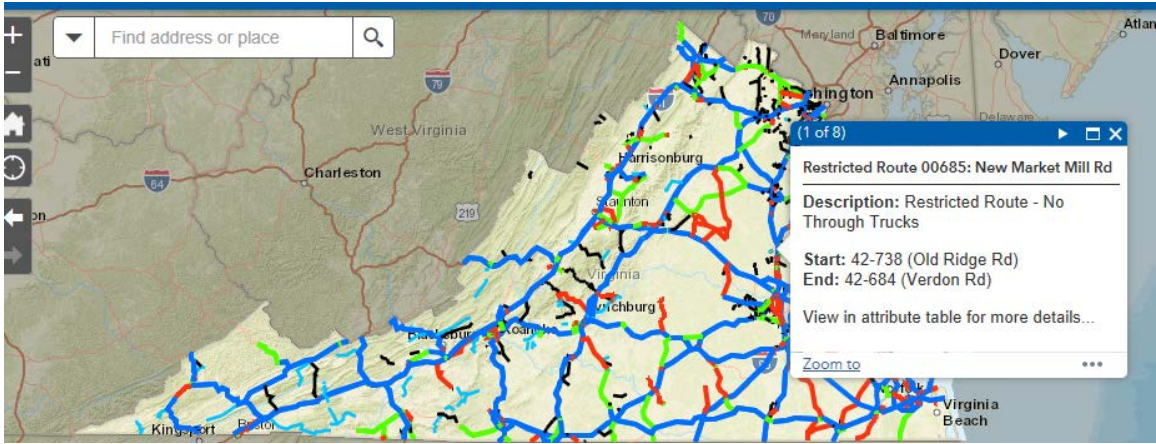
Figure 28. Screenshot of the Current VA Roads Map Showing Length Restriction Capabilities

The VDOT length and with restrictions map has routing capabilities, but VDOT does not allow the general public to access to these. Upon the research team's request, VDOT provided access to routing capabilities for a limited time. This allowed the research team to validate the routing with several examples. Making the routing capability in the maps available to drivers will allow them to easily determine if the route selected has length and width restrictions (Figure 29). If the routing capability is made available, one asset (under Apps) is that the start/end points of a selected route can be easily changed by dragging the location icon to a new position or just seeking more details about a specific location. The routing capability can also potentially be further enhanced by adding filters similar to the truck GPS, such as length of truck, which will allow identifying which routes are appropriate for travel.
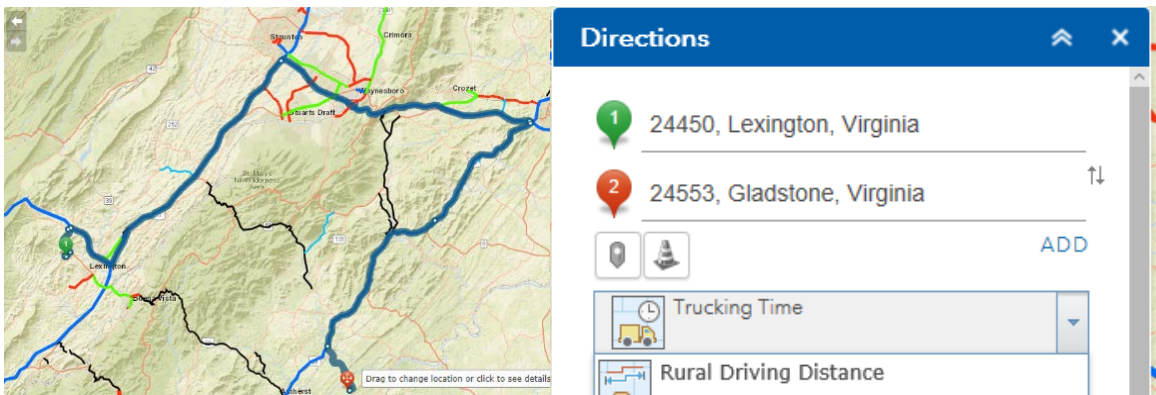
Figure 29. Map with Routing Capability

Similar to RR.2, RR.3 proposes adding posted bridges and bridge height clearances to routing applications. Similar applications have been developed by WSDOT and Georgia DOT. Currently, VDOT provides access to an Excel file that lists all the posted bridges in Virginia through Virginia Trucking Resources. Users who want to access height restrictions data must request the information by email, and VDOT will mail a PDF file, which has to be matched manually. RR.4 combines the three maps to allow the user to see the three types of restrictions at once. A KML file is an XML-based file format that can be used to display geographic data in Google Maps. This type of file can be developed and incorporated in Google Maps. To have the

62

routing information in Google Maps, the information must be provided in a KML format, and truck drivers must be educated on how to use it.

RR.5 and RR.6 focus on providing a trip navigation tool and geofenced alerts. These actions will use VDOT data but will rely on a third-party developer. It is important to note that third-party routing capabilities are already provided as part of truck GPSs or via specific applications.

RR.6 will further enhance the services provided by RR.5 by incorporating geofenced capabilities that can alert the driver when entering a route or approaching a bridge that the truck is not supposed to use. Due to the size of the information dataset made available, this application must reside in the cloud. One of the benefits of a tool of this nature, if developed by or for VDOT, is that the restriction information does not need to be limited to routing and can incorporate real-time information for other types of data, such as work zones or incidents. Essentially, when a driver is approaching a scenario that is delimited by a series of parameters, the tool will trigger one or several alarms while approaching.

The next proposed action addresses truck drivers' concerns about VA511 systems (web, application, and phone) focused on cars. To reduce truck route violations, RR.7 proposes adding one or more map layers corresponding to truck route restriction information to the VA511 platform. The same gap can be better addressed by creating a VA 511 for truck layer on the current VA511 system.

RR.8 aims to minimize situations in which violations occur because truck restrictions signs are not visible or are placed in a location that, when seen by the driver, do not enable a corrective action. The first step involves an evaluation of the sign locations. Covering the whole state can be costly and time consuming. One option is to first review sites that are known to have chronic problems. To identify those sites, VDOT will rely their engineers' experience and will benefit from input from VSP and the CVO community as a whole. The second step involves, if necessary, a revision of current VDOT practices and considering if the development of standard guidelines for truck restriction sign placement are needed.

Finally, RR.9 facilitates the identification of locations where a violation occurs. Currently, when a route restriction violation occurs, sometimes no citation is issued. Even when a citation is issued, it falls under the general category of traffic sign violation, resulting in lack of formal records of where the violation occurred. Under this action, VDOT and other stakeholders will have not only a formal record where the violations occur but will also have the capability to identify violators. Coordination with VSP will be required.

Work Zone, Incidents, and Traffic Congestion

Several stakeholders highlighted the need for timelier and easier ways to access information about work zones, incidents, and traffic congestion. Over the past years, VDOT has taken a proactive role in providing information, including using dedicated message signs (DMS), 511 updates, and 511 notification capabilities. To facilitate and maximize the use of the available information, it is important to promote its use by data providers, telematics, and third parties, including the development of applications.

63

Table 8 shows some possible actions that may be taken to address gaps related to the display and notification of this type of information. For each possible action, the research team identified the activities needed to accomplish the action and possible related challenges and limitations.

Table 8. Possible Actions Related to Work Zone Incidents and Traffic Congestion

Possible Action	Gap Addressed	Activities	Challenges/Limitations
W.1 Increase carrier/driver awareness of 511 capabilities	-Not all carriers and truck drivers are aware of VA 511 notifications capabilities	- Reach out to carriers/dispatchers and drivers	-Work with other stakeholders to maximize outreach
W.2 Visualization of work zone or incidents	-Display work zones or incidents on in-cab devices	- Encourage navigation/telematics providers to integrate real-time work zone information into their platforms - Facilitate the development of applications by third parties	-Providers'/vendors' acceptance
W.3 Push notifications about work zone or incidents	-Receive notification of work zone or incident ahead through smart phone or OBD	- Facilitate the development of applications by third parties to simplify the integration process - Encourage navigation/telematics providers to integrate real-time work zone/incidents information	-Providers'/vendors' acceptance -Geofenced procedures -Messages
W.4 Add value to the data provided by providing real travel time information and expected delays under the Smart Work Zone initiative	-The work zone data do not give any indication of delay impacts	- Build upon the smart work zone strategy to provide additional information to drivers and carriers (e.g., delay estimation) - Enhance tools to help schedule departure times or breaks - Facilitate the development of applications by third parties to compute real-time or almost real-time work zone performance measures that can be integrated into different platforms	-VDOT must be an active participant on the computation of the performance measures

The first action (W.1) aims to satisfy the needs of the user who would like to receive more information from VDOT in advance and in a timely manner. As a result of the interviews, it was evident that some of the users/carriers were not aware of all VDOT 511 capabilities. The new framework will provide data pre trip and on route. Action W.1 refers to outreach activities to inform truck drivers and carriers of VDOT's current capabilities.

The second tier of actions (W.2 and W.3) relies on the effective use of the data by third parties. To that end, these actions are combined under the strategy to promote and facilitate the ingest of available data into the CVO existing business process. While W.2 aims to maximize VDOT efforts of not only reaching existing providers but also encouraging them to use the data, W.3 focuses on a more strategic action to improve truck safety by disseminating work zone, incident, or congestion notifications. This effort involves the development of applications that must be able to communicate to commercial vehicle transponders, electronic on-board systems,

cell phones, and/or motor carriers' routing and dispatching systems. This action is similar to the states' pilot studies underway for work zone notification.

W.4 aims to increase the value of the data provided to the CVO community. Currently, most of the information available refers to the duration of the work zone. This action aims to provide carriers and drivers with delay predictions and near real-time delay information. This information can help dispatchers and truck drivers to optimize their routes. Similarly to work zones, incident information currently includes information regarding location, lane, or shoulder status, and an estimation of the length of the queue.

Parking

Over the last 2 years, VDOT has made significant advances regarding providing information on parking lot availability, real-time data collection, and message dissemination. Furthermore, several efforts are underway to increase the amount of parking equipped with real-time parking information systems. Work is also being conducted to expand the number of parking lots with real-time information and to improve dissemination. Table 9 shows other possible actions to address gaps related to the display and notification of parking information.

Table 9. Possible Actions Related to Parking

Possible Action	Gap addressed	Activities	Challenges/Limitations
P.1 Parking data availability dissemination	-Maximize use of data available -Maximize outreach efforts	-Work with existing developers to include VDOT parking information on their applications - Facilitate the development of new applications by third parties	-Providers'/vendors' acceptance -Willingness of third parties to create applications
P.2 Increase parking information	-Information limited to instrumented parking lot -Private parking information not included	-Extend parking data availability to all VDOT parking facilities -Develop agreements with private parking providers to show data availability	-Cost of collecting data -Working with private facilities -Willingness of third parties to create applications
P.3 Provide static data from non-equipped parking lots	-Cover all parking availability	- Include parking lot data for parking lots not equipped with sensors	-Confusion regarding parking data availability

Parking availability information is currently presented to truck drivers by VMSs and on VA511. The data are also shared with developers on the SmarterRoads portal. To assure that the existing information reaches a larger base of the CVO community, strategy P.1 focus on promoting and facilitating the use of the available data. Communications with the operations team of the most popular truck parking applications revealed that they were unaware of VDOT parking data availability. Action P.1 specifically encourages VDOT to work with existing parking application developers to include VDOT parking data on their proprietary applications and/or during the creation of third-party applications.

Parking data is currently limited to equiped parking lots. Furthermore, parking information introduces the challenge that not all parking facilities are public, and a considerable number of parking spaces belong to the private sector. It has been shown that drivers benefit

when parking information extends beyond public facility availability. Those benefits are shown in the popularity of some applications like Trucker Path.

Action P.2 proposes that VDOT promote not only extending the coverage to all parking lots, but also the integration of VDOT data with private parking facilities' availability on each corridor. It also aims to contemplate partnerships with other third-party data providers, such as truck parking applications developers, to provide information to all users.

As an intermediate solution, P.3 covers the gap that, currently, VA511 only shows the truck parking icon for locations where the new detection system is installed. Other available public parking areas are not shown. This new layer of information can contain not only static information for rest areas but also some static information for private vendors.

Alternate Route Display and Notifications

The need for availability of information on alternate routes for trucks was ranked very highly by drivers and carriers alike. One major concern is the identification of alternate routes when there is a non-recurrent event, such as an accident. Truck drivers and carriers expressed their concern that the selection of alternate routes does not take trucks into account. Even when routes are appropriate for the current fleet of trucks, there is not a reliable source of alternative route information for part of the truck driver population (those without truck GPS/telematics or carrier manager support). Table 10 identifies possible actions to close the gaps related to this issue.

Table 10. Possible Actions Related to Alternative Routes

Possible Action	Gap addressed/ Users	Activities	Challenges/Limitations
AR.1 Identify alternate routes appropriate for trucks	-Some alternate routes not suitable for trucks -Signs are scarce	- Review the procedure on how alternate routes affect trucks - Incorporate alternate route signs in locations where non-recurrent events, such as incidents, are common	-Define priorities Cost and maintenance of new signs
AR.2 Add delay information to alternate routes	-Provide additional information about the delays associated with the alternate route	- Support route selection by providing estimates of delays relative to the original route	-Reliability of delay estimation
AR.3 Enhance dissemination of alternate route information	-There is no distinct portal for alternate routes -511 does not display alternate routes	- Consider separate data feed for alternate routes that can be easily accessed by third parties - Create a special 511 platform for trucks that include alternate route information	-Could be costly

The first action (AR.1) refers to the concern of truck drivers and carriers that alternate routes are not always suitable for trucks. Truck drivers and carriers would like to know the different route alternatives not only for planned events but also for non-recurrent incidents. AR.1 involves a review of the alternate route selection criteria and the incorporation of permanent alternate route signs in locations prone to non-recurrent events. During the project, it was

mentioned how helpful simple measures like weekly VTA emails with information about work zones were.

AR.2 refers to enhancing the information provided to truck drivers by incorporating additional performance measures. The performance measures will be presented to the user using the same mechanism to provide the alternative route information.

AR.3 aims to include in the CVO portal the recommended route for trucks.

Facilitate Access to Information, Increase Use of Data by Stakeholders, and Promote the Development of New Tools.

VDOT has made significant efforts to improve the access and dissemination of CVO traveler information to the public and third party developers through the Trucking Resources webpage, SmarterRoads, Virginia Roads, and the VA511 application. During the interviews, stakeholders identified better access to the information as an area where they would like to see improvements. Table 11 identifies possible actions to close the gaps related to this issue.

Action IA.1 refers to enhancing the functionality of the trucking resource page by making the information more accessible to carriers and truck drivers. This action includes action RR.1 integration of truck restriction data on same platform

IA.2, address the gap that the CVO community perceives the VA511 system as a service for cars but not for trucks. Several states reported a higher degree of usage and a higher degree of satisfaction after the creation of the 511 truck layer. While there is a significant amount of information in the current system, the systems lack important information, such as truck route restrictions. Furthermore, at the end of 2017, VA511 added the capability to use Waze for routing. As mentioned before, using Waze or Google is the most common reason that truck drivers gave police when they were stopped for a truck route restriction violation. Waze navigation seems to be leading truckers to do what VDOT engineers are specifically trying to circumvent. Truck drivers and carriers also expressed their desire for the system to be geofenced, limiting the information they receive to the route ahead.

Over the last few years, VDOT has put significant efforts into making traveler information data available to professionals and the general public. Furthermore, VDOT presents the information in different formats, including web maps and APIs. However, the use of the available data by CVO stakeholders has not reached its expected potential. Reasons mentioned by stakeholders for their lack of use include: lack of awareness of data availability, difficulty in assimilating data in a given format, lack of a national standard or consensus among the different stakeholders on appropriate data format, and backlogs in incorporating data from different states. To that end, two specific actions are proposed in IA.3 and IA.4. IA.3 aims to increase awareness of data availability by strengthening communication channels with all stakeholders. Increasing usage by developers that would be critical in the development of more advanced tools and applications is of particular interest. IA.4 focuses on the creation of the CVO traveler information coalition to promote the development of new tools, applications, and expanding the use of the data. Under this action, the testing of new technologies such as work zone notification and FRATIS applications are also promoted.

Table 11. Possible Actions Related to Access to Information

Possible Action	Gap addressed/ Users	Activities	Challenges/Limitations
IA.1 Enhance functionality of the trucking resource page	-Information was difficult to find. -Truck restriction data was is not integrated -No information related other freight issues (ports)	-See activity RR.1 -Coordinate with other stakeholders regarding information update	-Will depend on improvement of data provided
IA.2 Creation of a VA 511 layer specifically for the CVO community	-VA 511 is perceived by the CVO community as a service for cars. -The amount of information provided in the site makes it difficult for truck drivers to focus on the most relevant information. Information to truckers must focus on data that have a great impact on trucks (e.g., wind alerts, parking, road closures).	-Create a VA511 truck layer on the current system -It is recommended that the system includes truck restriction information and, if possible, allow for navigation capabilities	-Cost of creating and maintaining a new layer -Difficult to predict the population that will use the system
IA.3 Increase awareness of the data by strengthening communication channels with all stakeholders	-Ingest of the data available by other stakeholders is limited.	-Develop a communication plan that establishes regular contact with different stakeholders	-Willingness of stakeholders to engage in the process
IA.4 Create a CVO information coalition with neighboring DOTs, private sector, and other public entities	-Limited use of data available -Facilitate the ingest of data by stakeholders and the development of new tools by promoting a regional strategy	-Create a coalition with other states, private sector representatives, and other public sector stakeholders to maximize the ingest of data by data providers, telematics, and developers	-Lack of participation by the listed parties -Some degree of difficulty to achieve a consensus

Additional Considerations

While this report focuses on recommendations for VDOT, improvements to the current CVO traveler information will benefit from the participation of other state stakeholders. The DMV may support the distribution of traveler information to the CVO community. VDOT may engage VSP officers during enforcement or educational campaigns to improve awareness of and/or prevent incidents involving the CVO community on Virginia roadways. Campaigns may be conducted to reduce truck restriction sign violations and truck size/weight violations. VDOT may also collaborate with VSP on distributing traveler information, including the availability of information sources through VSP venues such as safety inspections. In cases where trucks enter restricted roadways, VTA can help improve CVO information and education. VTA routinely

works with a large number of trucking companies based and/or operating in Virginia. The agency sends periodic fliers via email to member companies, which may be used to send out important traveler information. Other professional organizations, such as Drive Smart Virginia, can also help improve CVO information dissemination and education during outreach activities.

Figure 30 shows the research team's attempt to rank the specific actions that can support a longer term plan for enhancing truck operations and safety throughout Virginia. For each of the actions described, the team provided a ranking based on potential cost and implementation difficulty level. The potential actions were also color-coded depending on the channel most likely used for implementation.

High

IA.2. Creation of VA511 layer specifically for the CVO community	IA.4. Create coalition with neighboring state, private sector and others
W.4 Add Value to the data provided by adding real time expected delays	AR.2 Add delay information to alternate routes
W.3 Push Notifications about work zone or incidents	RR.6 Create a dynamic application that considers all truck restrictions

Cost

Medium

| RR.2 Develop pre-trip/ stop routing tools that consider length restriction data | W.1 Increase carrier/driver awareness of 511 capabilities | RR.3 Develop pre-trip/ stop routing tools with posted bridges and bridge height clearance | AR.3 Enhance dissemination of alternate route information | RR.7 Incorporate route restriction information to VA511 | RR.5 Develop Routing application that can be used pre trip or on trip |
| | | RR4 Combination of RR.2 and RR.3 for supporting route pre-trip/stop decisions | RR.1 Integration of all restriction data on the same platform | P.2 Increase parking information | W.2 Visualization of work zone or incidents |

Low

| P.3 Provide static data from non-equipped parking lots | IA.3 Increase awareness of data availability | AR.1 Identify alternate routes appropriate for trucks | RR.8 Sign restriction location evaluation |
| IA.1 Enhance functionality trucking resource page | RR.9 Create a database of truck restriction violations and locations | P.1 Parking availability dissemination | |

| **Low** | **Low-Medium** | **Medium** |

Difficulty

| **VDOT** | **VDOT / Third Party** | **VDOT/VSP/VTA** | **Third Party** |

Note: VDOT = Virginia Department of Transportation, VSP= Virginia State Police, VTA= Virginia Truck Association

Figure 30. Ranking of Potential Actions

70

CONCLUSIONS

This study involved a comprehensive investigation of traveler information technologies and practices in Virginia and the U.S. and the data needs of the CVO community. Over the past few years, VDOT has made significant enhancements to its traveler information systems, including increasing the number of VMSs and creating the SmarterRoads and the Virginia Roads portals. The main conclusions of the study are as follows:

- *While VDOT has traditionally served as the collector, aggregator, provider, and presenter of data, the private sector is now participating in almost all of these roles.* There is agreement among stakeholders that VDOT's major role in the CVO traveler information network must be as a data provider and facilitator.

- *In some cases, relevant data is unreliable or not comprehensive in scope.* Data limitations identified during this research include: (1) limited truck restriction data access, coverage, and reliability for secondary roads, as well as in towns, and cities where VDOT does not maintain the roads; (2) lack of delay estimation in cases of work zones, incidents, and congestion; (3) very limited information regarding alternate routes; and (4) alternative routes for non-recurrent events are not always appropriate for trucks according to carriers and truck drivers. While truckers appreciate the new real time parking data availability, the information is limited to instrumented parking lots and no information is presented regarding private parking facilities. Stakeholders were not always aware of trucking resources provided by VDOT.

- *It is important that all of the highway, bridge, and tunnel restrictions/limitations that apply to the type, size, or weight of trucks are conveyed to the trucking community in a comprehensive and integrated format.* This data is essential for pre-trip and in-route truck routing and re-routing, and the data should include consideration of when routes are affected by congestion, incidents, weather, or construction. However, this data currently resides in seven separate VDOT sources, each with separate platforms and data formats. Furthermore, some information, such as bridge weight restrictions, is only available in a list format, and information such as bridge height and width limitations is only available upon request.

- *Consultations with industry and state stakeholders suggest that carriers and drivers rely on multiple platforms to route their cargo based on its origin, destination, weight, dimensions, travel time, unexpected incidents, and weather changes.* Within this environment, carriers and truck drivers rely on different communications tools to select the "best" routing. While some drivers prefer VMS signs, others would like to receive notifications of work zones and other incidents in advance. Truck drivers prefer tools that have geofencing capabilities, where the information is restricted to their location and direction of travel. Visualization of work zones and incidents on in-cab devices is considered a plus for most of the stakeholders. To satisfy the needs for CVO information, different tools, applications, and channels of communications for different type of devices must be considered and included to the extent possible.

- *The VA 511 system is perceived by carriers and truck drivers as a service for cars and not for trucks.* However, other states have developed a 511 layer specifically for trucks and consider the addition a success. The information presented in the 511 CVO layer must

emphasize information useful for carriers and drivers, such as route and bridge restrictions and eliminate any unnecessary information.

- *An ideal system will not only provide coverage for the whole state (town and cities included), but will also have connectivity with other states' systems.* This is especially important in the case of freight corridors, which represent a significant portion of total travel. The ingest of data by technology providers can be accelerated if more than one state promotes the initiative and consistent data elements and formats are provided. Especially important is the development of applications that provide real-time information for truck drivers regarding presence of work zones, incidents, and traffic congestion.

RECOMMENDATIONS

The high level CVO framework proposed in this report provides a roadmap for VDOT to improve communication with the CVO community. The following are the main recommendations to implement this framework.

1. *VDOT Traffic Engineering Division (TED) and Operations Division (OD) should integrate data regarding truck routes and restrictions, including bridge weight, height and width restrictions, and tunnel restrictions (height, width, and hazardous materials) in the same data format and on the same platform.* This recommendation is intended to serve the population that does not have access to truck GPS or other truck-specific routing applications (as well as supplement those who do) and aims to improve the quality and access of available data to all users. This recommendation must be accompanied with an outreach campaign about the limitations of Google Maps and Waze regarding truck routes and the importance of using truck GPS /truck navigation applications. Support from DMV, VSP, and VTA will be beneficial to this outreach.

2. *The VDOT Operations Division should expand the current 511 systems (website and application) to include truck-specific data.* This can be accomplished by incorporating a new layer or creating a parallel site. This new layer must focus on information important for truckers, eliminating information not needed (i.e., transit). If possible, VDOT must consider the incorporation of the VDOT truck routes and restrictions information into the 511 system in a manner that allows the CVO community to identify the safest and shortest routes based on vehicle/load dimensions and weight. At a minimum, VDOT should disseminate current 511 system capabilities to the trucking community.

3. *The VDOT Operations Division should maximize data sharing and outreach of available information to support third-party application developers and traveler information providers.* This includes exposing relevant data in an easily digestible format on external data portals and actively engaging private stakeholders (navigation application developers, data providers, telematics application developers, and carriers) on the best way to share available data so they can be efficiently incorporated into private party information streams and existing CVO business processes. VDOT should act as a catalyst for collaboration between public and private stakeholders for the adoption of new technologies, such as real-time work zone and incident notifications.

4. *The VDOT Operations Division should champion the creation of a CVO Information Systems Coalition with neighboring states in order to leverage resources and accelerate the implementation of processes, applications, and new technologies.* The coalition should act as a catalyst for collaboration between public and private stakeholders for the adoption of new technologies, such as real-time work zone and incident notifications. This could be integrated within existing regional groups such as the I-95 Corridor Coalition and the I-81 Corridor Coalition.

5. *VDOT District Traffic Engineers should review existing signed route restrictions for adequacy, conspicuity, and providing statewide guidelines.* Alternative routes must be easily identified or otherwise clearly provided. The first step will involve the evaluation of locations with a history of violations. The Traffic Engineering Division should review current practices and produce standardized sign placement guidelines, if needed. VDOT may consider installing graphic signs showing alternative routes in conjunction with the existing truck restriction signs.

IMPLEMENTATION AND BENEFITS

Implementation

Regarding Recommendation 1, TED and OD will begin to work together to develop an integrated data layer that includes all relevant restriction information. This data layer will be completed within 1 year of the publication of this report, followed by outreach to the CVO community through the VTA.

Regarding Recommendation 2, OD will work with their contractor to begin development of a dedicated 511 portal or layer, focusing on information important for the CVO community. The implementation of this recommendation is contingent upon the availability of funding to perform this development.

Regarding Recommendation 3, OD will integrate the new data sets developed in Recommendation 1 with existing VDOT data portals within 6 months of the implementation of recommendation 1. This recommendation will be further enhanced with the implementation of recommendation 4 by leveraging efforts with other states.

Regarding Recommendation 4, OD will work through existing channels in the I-95 and I-81 Corridor Coalitions to discuss CVO traveler information consistency. This work will begin upon publication of this report, and is expected to be ongoing for the foreseeable future.

Regarding Recommendation 5, TED will develop guidance of the restriction sign placement guidelines following review of current standards. These will be disseminated to Districts within 6 months of the publication of this report. Districts will complete their review of problematic sites within 1 year of receiving the guidance from TED.

Benefits

All of the recommendations improve the CVO community's access to traveler information, empowering truck drivers and fleets to make better decisions. Accurate traveler information results in safer and more efficient trucking operations by optimizing routes and schedules. Appropriate route selection minimizes the risk of negative impacts on existing VDOT infrastructure, such as bridge and tunnel strikes or other roadway damage. Awareness of work zones, incidents, and congestion and information regarding bad weather/road conditions and parking availability result in reductions in crashes and violations. In addition, enhancements to the traveler information system result in increased awareness and improvements in user acceptance and perception.

Implementing Recommendation 1 will make key information available to the underserved population of small carriers. Recommendation 2 will provide the CVO community with targeted and complete information and will increase awareness of existing traveler information. Recommendation 3 maximizes efforts to increase the use of traveler information already available, promotes collaborations, and leverages resources between public and private stakeholders to implement new tools and applications. Recommendation 4 further maximizes those efforts by leveraging resources with other states. Recommendation 5 targets problematic locations to minimize violations, further reducing the likelihood of infrastructure damage and travel delays.

ACKNOWLEDGMENTS

REFERENCES

3PLCentral. *2018 State of the Third Party Logistic Industry*. The Demand for a Superior Customer Experience, 3PL Centrals, 2018.

Alabama Department of Transportation (ALDOT). *ALGO Traffic (By ALDOT and ALEA)*, Version 2.0.1, 2018. https://itunes.apple.com/us/app/algo-traffic-by-aldot-alea/id1141136558?mt=8.

American Transportation Research Institute (ATRI). *Critical Issues in the Trucking Industry – 2018*. American Trucking Associations, Arlington, VA, 2018.

Data for Automated Vehicle Integration (DAVI). *2018 Initiative*. U.S. Department of Transportation, Washington, D.C., 2018. https://www.transportation.gov/av/data.

Drivewyze. 2018. www.drivewyze.com. Accessed July 2018.

FAST Act. *Fixing America's Surface Transportation Act*, Pub. L. No. 114–94, Washington, D.C., 2015. https://www.gpo.gov/fdsys/pkg/PLAW-114publ94/pdf/PLAW-114publ94.pdf.

FMCSA. *Pocket Guide to large Truck and Bus Statistics*. Office of Analysis, Research and Technology, Federal Motor Carrier Safety Administration, Washington D.C., 2018a.

FMCSA. *Innovative Technologies Deployment of Work Zone Safety Systems* (presentation). Work Zone Safety Conference, 2018b. https://www.workzonesafety.org/files/documents/news_events/wz_conference_2018/day2_track2_large_trucks-Kelly.pdf.

FMCSA. *GPS Selection Guide for CMVs*. FMCSA-ADO-13-007, Washington, D.C., 2017. https://www.fmcsa.dot.gov/sites/fmcsa.dot.gov/files/docs/GPS_Visor_Card_508CLN.pdf

FMCSA. *Bridge Strikes and GPS*, Washington, D.C., 2014. https://www.fmcsa.dot.gov/faq/Bridge-Strikes-%26-GPS. Accessed October 2017.

Georgia DOT. *Routing Trucks through Georgia: Avoiding Posted Bridges*. 2018. http://www.gamccd.net/Documents/OSP_AvoidingPostedBridges.pdf.

Idaho DOT. *Idaho 511: Truckers' Info*. 2018. https://tr.511.idaho.gov/#truckersReports?timeFrame=TODAY&layers=truckersReports%2CwinterDriving%2CtruckRamps%2CweighStations%2CotherStates. Accessed October 15, 2018.

INRIX. *Driver Apps*. 2018. www.inrix.com/mobile-apps/. Accessed November 5, 2018.

Iowa DOT. *Iowa 511: Traveler Information*. 2018. http://511ia.org/. Accessed October 15, 2018.

MAP 21. *Moving Ahead for Progress in the 21st Century Act*, Pub. L. No. 112–141, § 1118, 23, 2012.

National Highway Traffic Safety Administration (NHTSA). *Fatality Analysis Reporting System (FARS) Encyclopedia*. Washington, D.C., 2018. http://www-fars.nhtsa.dot.gov.

Navmart. *HERE Trucks*. 2018. https://navmart.com/here-trucks/. Accessed October 21, 2018.

New York DOT. *511NY*. 2018. https://511ny.org. Accessed October 15, 2018.

Pennsylvania DOT. *PA511*. 2018. https://www.511pa.com/. Accessed October 15, 2018.

Rand McNally. *Motor Carriers' Road Atlas: United States, Canada, and Mexico*. Rand McNally & Company, Chicago, IL, 2018. https://www.randmcnally.com/product/motor-carriers-road-atlas.

Tucker, J. *Freight Performance, A Broker's Perspective*. TR Circular E_C240 Workshop on Implementing a Freight Fluidity Performance Measurement System, Transportation Research Board, Washington, D.C., 2018.

USDOT. *Freight Facts and Figures 2017*. Bureau of Transportation Statistics, U.S. Department of Transportation, Washington, D.C., 2018. https://www.bts.gov/sites/bts.dot.gov/files/docs/FFF_2017.pdf.

VTRANS. *VTrans2040: Virginia Freight Element*. Commonwealth of Virginia's Office of Intermodal Planning and Investment, Richmond, VA, 2017. http://www.vtrans.org/resources/VTrans2040-Freight-Element.pdf.

Washington DOT. *Bridge Vertical Clearance Trip Planner map*. 2018. https://www.wsdot.wa.gov/Bridge/Structures/BVCTP.htm. Accessed October 15, 2018.

Wyoming DOT. *WYDOT Commercial Vehicle Operator Portal*. 2018. https://apps.wyoroad.info/cvop/. Accessed October 15, 2018.

APPENDIX A—TRUCK DRIVER SURVEY

Virginia Department of Transportation
Truck Driver Traveler Information Needs Survey

Traveler information is critical for the safety and efficiency of commercial vehicle operations.
The Virginia Tech Transportation Institute (VTTI) is conducting this research on behalf of the Virginia
Department of Transportation (VDOT) to investigate methods to improve traveler information specifically
targeted to the commercial truck community (e.g. route restrictions, incidents, work zones, rerouting,
parking). As a truck driver, your experience and opinions are of great interest and importance. The current
survey, which will take about 10 minutes to complete, asks you about your traveler information needs, the
quality of the information and the preferred methods to obtain such information. There is also space for your
comments.

Please note the data gathered in this research will be treated with total anonymity and no names will be linked
to the data collected. Your response is critical for the success of this effort and is greatly appreciated.

For more information about the research project or this survey, please contact: Alejandra Medina, Principal
Investigator, VTTI, 540-231-1508, amedina@vtti.vt.edu

**Please answer honest and truthfully. At the end of this survey, you will have the option to submit the
survey to the research team. By choosing to submit the survey, you are implying your consent to
participate in this research project.**

Thank you in advance for your help and cooperation with this project.

1. How important is this traveler information to you when you are **traveling in VA?**

	Extremely important	Very important	Moderately important	Slightly important	Not at all important
Route height/width/length/weight restrictions	O	O	O	O	O
Travel Time	O	O	O	O	O
Incidents	O	O	O	O	O
Work zones, lane closures and detours	O	O	O	O	O
Alternate routes / Rerouting	O	O	O	O	O
Weather	O	O	O	O	O
Parking locations and availability	O	O	O	O	O
Weigh station location	O	O	O	O	O
Weigh station status (Open/Closed)	O	O	O	O	O
Maintenance/Service Center	O	O	O	O	O
Services (Food/Hotels)	O	O	O	O	O
Delays and terminals and port clearance	O	O	O	O	O
Others (Please describe)	O	O	O	O	O

2. For each type of traveler information, please select how you prefer to receive your traveler information. Please select only one of the following options: **(a) from your dispatcher, (b) directly to you** (you receive the information through VMS, text messages)

	Manager/Dispatcher	Directly to you
Route height/width/length/weight restrictions	O	O
Travel Time	O	O
Incidents	O	O
Work zones, lane closures and detours	O	O
Alternate routes / Rerouting	O	O
Weather	O	O
Parking locations and availability	O	O
Weigh station location	O	O
Weigh station status (Open/Closed)	O	O
Maintenance/Service Center	O	O
Services (Food/Hotels)	O	O
Delays and terminals and port clearance	O	O
Others (Please describe)	O	O

3. For each type of traveler information, what are the three major sources of information <u>YOU as a driver</u> commonly use in VA? Please select only up to 3 sources

	Manager/ Dispatcher	VA 511 Web/App/ Phone	VDOT truck route restriction maps/ trucking resources	GPS, routing application (i.e. Google, Waze)	On Board Computer/ Telematics	Variable Message Sign	Text message notifications	CB radio	High Advisory Radio
Route height/width/length/weight restrictions	☐	☐	☐	☐	☐	☐	☐	☐	☐
Travel Times	☐	☐	☐	☐	☐	☐	☐	☐	☐
Incidents	☐	☐	☐	☐	☐	☐	☐	☐	☐
Work zones, lane closures and detours	☐	☐	☐	☐	☐	☐	☐	☐	☐
Weather	☐	☐	☐	☐	☐	☐	☐	☐	☐
Alternate routes/ Rerouting	☐	☐	☐	☐	☐	☐	☐	☐	☐
Parking locations and availability	☐	☐	☐	☐	☐	☐	☐	☐	☐
Weigh station location	☐	☐	☐	☐	☐	☐	☐	☐	☐
Weigh station status (Open/Closed)	☐	☐	☐	☐	☐	☐	☐	☐	☐
Maintenance/Service Center	☐	☐	☐	☐	☐	☐	☐	☐	☐
Services (Food/Hotels)	☐	☐	☐	☐	☐	☐	☐	☐	☐
Delays and terminals and port clearance	☐	☐	☐	☐	☐	☐	☐	☐	☐
Others (Please describe)	☐	☐	☐	☐	☐	☐	☐	☐	☐

4. If you use **GPS, telematics** and or routing applications as a source for one or more types of information please specify the name(s) of the applications

_____

_____

_____

5. What is your level of satisfaction with the sources of information available <u>for you in VA</u> for each type of information?

	Very Satisfied	Satisfied	Neither	Dissatisfied	Very Dissatisfied
Route width/height/length/weight restrictions	○	○	○	○	○
Travel Time	○	○	○	○	○
Incidents	○	○	○	○	○
Work zones, lane closures and detours	○	○	○	○	○
Alternate routes/rerouting	○	○	○	○	○
Weather	○	○	○	○	○
Parking locations and availability	○	○	○	○	○
Weigh station location	○	○	○	○	○
Weigh station status (Open/Closed)	○	○	○	○	○
Maintenance/Service Center	○	○	○	○	○
Services (Food/Hotels)	○	○	○	○	○
Delays and terminals and port clearance	○	○	○	○	○
Others (Please describe)	○	○	○	○	○

6. What do you think that is <u>the best way</u> that VDOT can provide real time traveler information to you as a driver? **Please select up to 3 options for each.** The first option 'Dispatcher/Management Company' means that you prefer the information came from your dispatcher directly.

   Please notice that in previous questions we asked you how you received the information (now), and in this question, we are asking you <u>how you would like to receive the information.</u>

	Manager/ Dispatcher	VA 511 Web/App/ Phone	VDOT truck route restriction maps/ trucking resources	GPS, routing application (i.e. Google, Waze)	On Board Computer/ Telematics	Variable Message Sign	Text message notifications	CB radio	High Advisory Radio
Route height/width/length/weight restrictions	☐	☐	☐	☐	☐	☐	☐	☐	☐
Travel Times	☐	☐	☐	☐	☐	☐	☐	☐	☐
Incidents	☐	☐	☐	☐	☐	☐	☐	☐	☐
Work zones, lane closures and detours	☐	☐	☐	☐	☐	☐	☐	☐	☐
Weather	☐	☐	☐	☐	☐	☐	☐	☐	☐
Alternate routes/ Rerouting	☐	☐	☐	☐	☐	☐	☐	☐	☐
Parking locations and availability	☐	☐	☐	☐	☐	☐	☐	☐	☐
Weigh station location	☐	☐	☐	☐	☐	☐	☐	☐	☐
Weigh station status (Open/Closed)	☐	☐	☐	☐	☐	☐	☐	☐	☐
Maintenance/Service Center	☐	☐	☐	☐	☐	☐	☐	☐	☐
Services (Food/Hotels)	☐	☐	☐	☐	☐	☐	☐	☐	☐
Delays and terminals and port clearance	☐	☐	☐	☐	☐	☐	☐	☐	☐
Others (Please describe)	☐	☐	☐	☐	☐	☐	☐	☐	☐

7. If you select Other Sources for at least one of the information type, please specify

_____

_____

_____

8. If you need to access the information in a web site or application, what do you commonly use?

- ☐ Cell Phone
- ☐ Tablet/Laptop
- ☐ Truck Computer
- ☐ Kiosks
- ☐ Computer on other locations (i.e. hotels)
- ☐ Other (Please specify) _____

9. Are you familiar with the following sources of information?

	Yes	No
VDOT designated truck routes map	○	○
Trucking Resources (VDOT Website)	○	○
VA 511 Website	○	○
VA 511 mobile app	○	○
VA 511 phone	○	○

10. If you answer Yes to any of the options above, how often do you them?

	VA 511 Website	VDOT 511 application	VDOT designated truck routes maps	Trucking Resources (VDOT Website)
Very Frequently	○	○	○	○
Frequently	○	○	○	○
Occasionally	○	○	○	○
Rarely	○	○	○	○
Never	○	○	○	○

11. Do you have any comments regarding the above sources of information?

_____

_____

_____

12. Which best describes your employment?

Choose One:	Choose One:
O Company Driver	O Long Haul
O Owner Operator (OO) with own authority	O Short Haul
O Independent Contractor (I-C) leased to motor carrier	

13. Is your company headquarters in Virginia (VA)?

    O Yes   O No. Please specify state _____

14. Can you provide an estimation of the size of your company regarding the number of trucks and drivers? If you do not know, enter NA.

☐   Number of Single Unit Trucks _____

☐   Number of Truck Tractors _____

☐   Number of Drivers _____

15. Do you have any additional suggestions on how VDOT can improve the way of providing traveler information to truck drivers?

_____

_____

_____

_____

_____

_____

APPENDIX B—EXAMPLES OF TRUCK DRIVER APPLICATIONS

This appendix lists several examples and descriptions of popular truck applications, including Trucker Path and Trucker Path Bro, NATSO's Park My Truck, TRELP, RoadBreakers, TruckSmart, Copilot Navigation and Sygic. Views of the apps are also included to illustrate the user difficulty levels for each app.

Trucker Path and Trucker Path Bro-App 3

Trucker Path Bro is similar to a CB radio in that it facilitates communication between Trucker Path and drivers. The app is a chatbot that not only provides fast information regarding safe parking spaces in the local area but also provides drivers with information regarding local weigh stations and other facilities. It is estimated that more than 600,000 truckers currently use this particular service. The truck stops come with information regarding the stop and reviews from the truck drivers. The available parking spots are given with real-time updates and are all safe parking locations. The Weigh Station information comes with the truck scale locations and indicates whether the station is open. The Fuel prices also give the "truck-ready" fuel stations. The truck wash stations appear in the amenities tab, and the stations clarify if they have a trailer washout and if they are independent stations. Finally, the navigation comes with a trip planner, low clearance warnings, and all other points of interest. Also included with the app are rest areas, hotels, restaurants, repair shops, dealer centers, DOT inspections, job searches, and night mode. The views on the screen seen by the truck drivers are shown in Figure B-1 (https://truckerpath.com/trucker-path-app/).
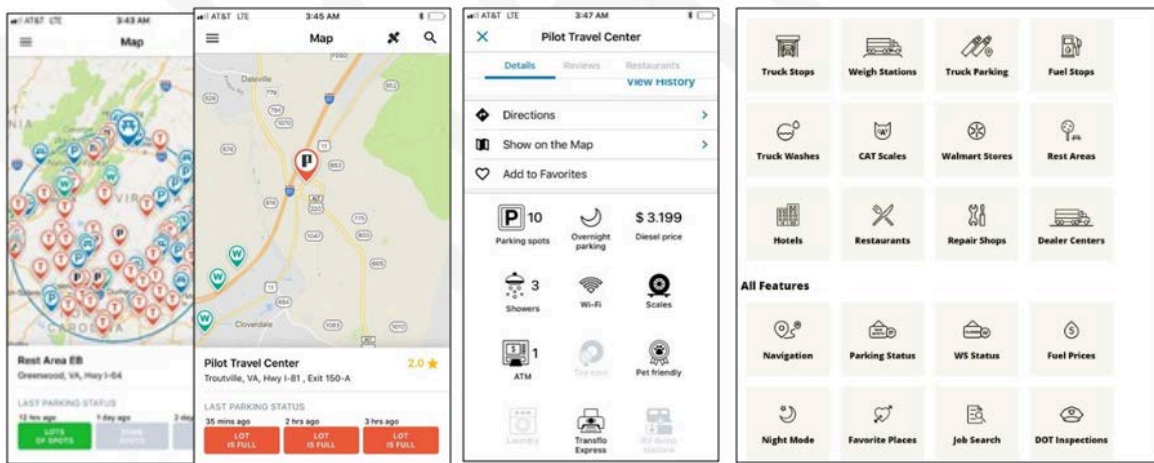

Figure B-1. Snapshots from the Trucker Path App Usage (From Left: Interactive Map Showing Nearby Amenities, Weigh Stations, Nearby Gas Prices, and Parking Areas)

NATSO Park My Truck-App 4

Park My Truck is a free app that was designed to help truck drivers find parking areas. The app uses the parking provider's information to help keep the truck up to date with a live update every two hours. The location services must be turned on for the app to operate, so the

user must agree to the terms and conditions of the app. A group of professional drivers and trucking companies were used to help design the app by ranking critical needs of parking availability (Figure B-2; https://www.natso.com/parkmytruck).
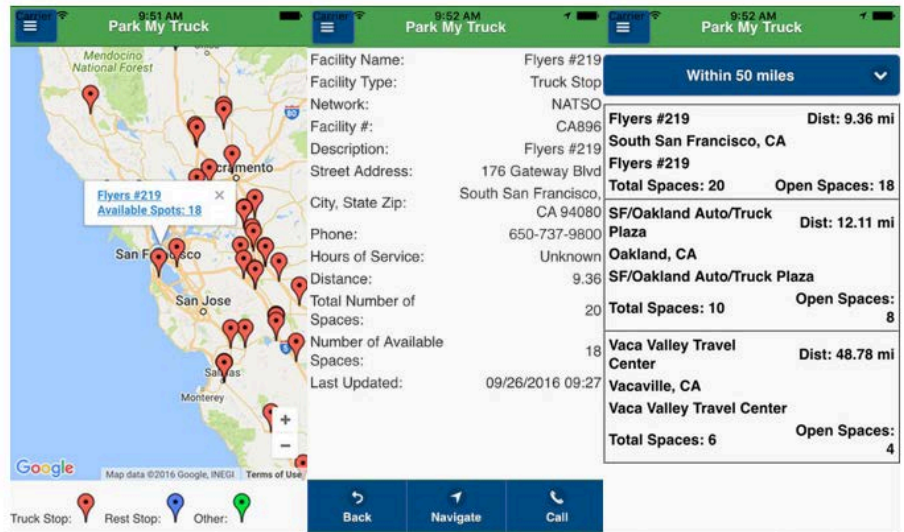

Figure B-2. Images of the Different Park My Truck App Pages Seen by the User (From Left to Right: Parking Locations, Parking Details, Nearby Amenities)

TRELP-App 6

By FMCSA regulations, drivers are allowed to spend 11 hours driving on the road per day. TRELP is an app that was developed by a team of truck drivers and software developers, and it has been defined by some as the Waze for Trucks. The plan is to have 3 million parking spots by 2019 as part of the TRELP database. The app allows the user to share traditional and nontraditional parking (e.g., shopping centers, industrial centers, and shipping and receiving companies that allow overnight parking). The user can also share last-mile directions for future drivers to reduce wasted time and gas in an attempt to find the right loading or unloading dock. After performing a job, the driver can comment on the shipper or receiver and let future drivers know what the company allows and requires. Finally, the app has a police alert warning system that allows truck drivers to share with app users when they see a police officer. Pictures of the app are included in Figure B-3.
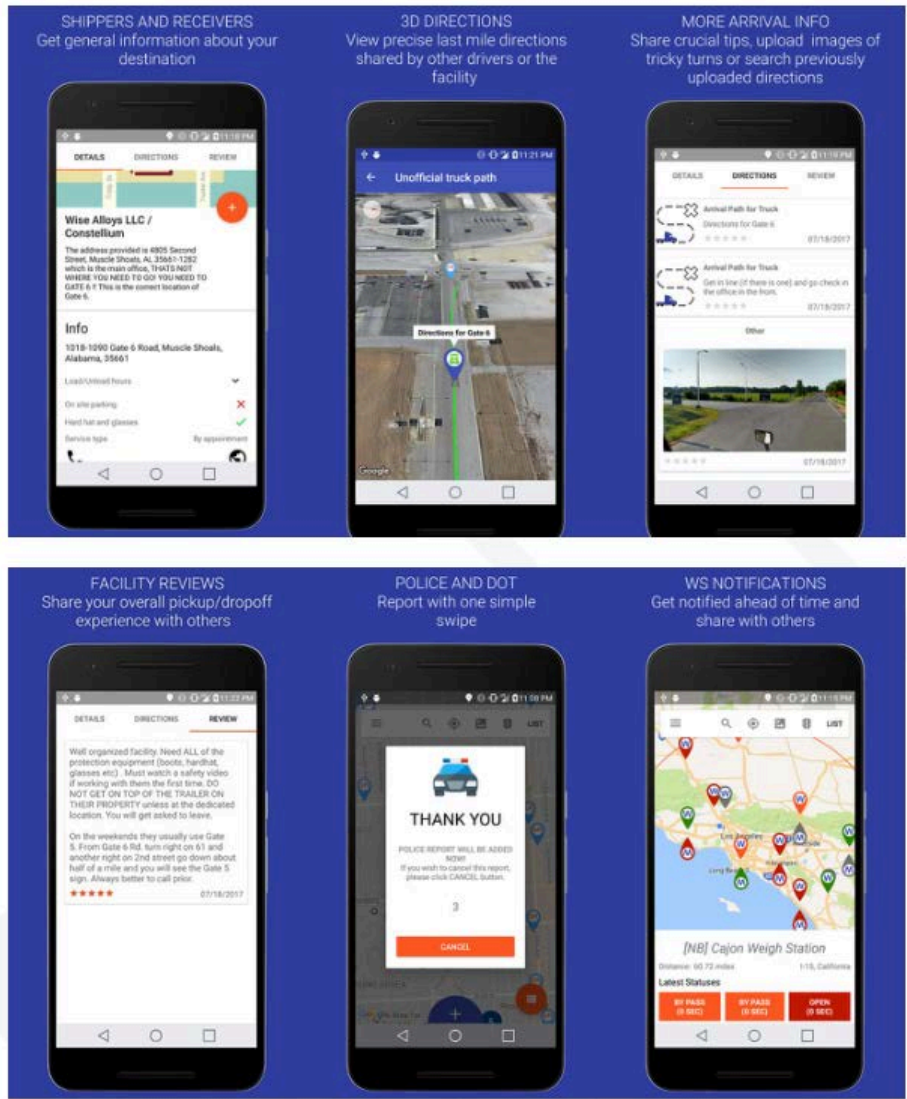
Figure B-3. Snapshots of the TRELP App Interface (Refer to the Titles above the Phones for the Applications Pictured)

RoadBreakers-App 1

RoadBreakers recently released a new app dedicated to helping drivers find a safe spot to park. The chat option on this app is a particularly popular feature as truckers can share their experiences at any given parking spot with other users. This helps keep the app up-to-date and provides truckers with specific information regarding each potential spot. The RoadBreakers app initially came out with a registration fee but is now free to download. The app does not require internet connectivity but does have the ability to use internet data to push automatic live updates. The updates come from other truckers, and the app uses the truck driver's critiques to continuously improve the app. For the app to be used, the truck drivers need to be willing to share ID names, postal addresses, and telephone numbers so the app can communicate with the drivers through text messages, emails, and calls to provide service and support. The app also collects data from the app usage for further improvements. Figure B-4 provides visual examples

89

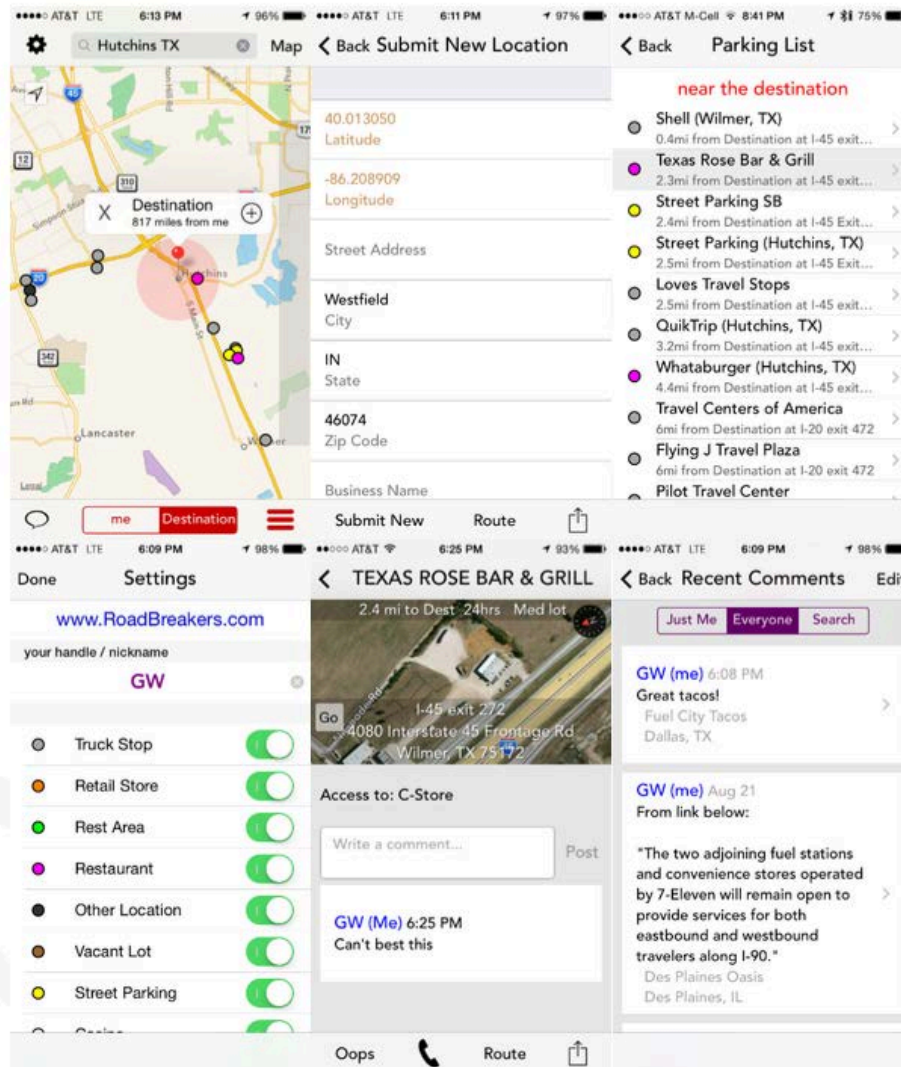of the view of the map and accessories provided by the app (https://roadbreakers.com/).

Figure B-4. Images of the RoadBreakers Map, Location Menu, and Nearby Amenities for Various Truck Stops

TruckSmart-App 2

The TruckSmart app expands the TravelCenters Reserve It program. While this program already allows truckers to reserve a safe parking spot up to 30 days in advance, previously this could only be done by contacting a TravelCenters customer service office or making a reservation on-location. With the TruckSmart app, any trucker who has an iPhone or Android can make a reservation at any time between 2 and 24 hours in advance while traveling. This allows the driver to pay for internet and a shower up to 50 miles away, with drivers receiving an email when the shower is ready for them; this ability is known as an instant shower on the app The app also includes nearby fuel prices, parking availability and amenities, current site weather, turn-by-turn directions, and a TA Truck Service RoadSquad emergency breakdown service calling. All this can be found in the interactive map that has a radius of up to 250 miles, shown

below in Figure B-5
(https://play.google.com/store/apps/details?id=com.tatravelcenters.trucksmart&hl=en_US).
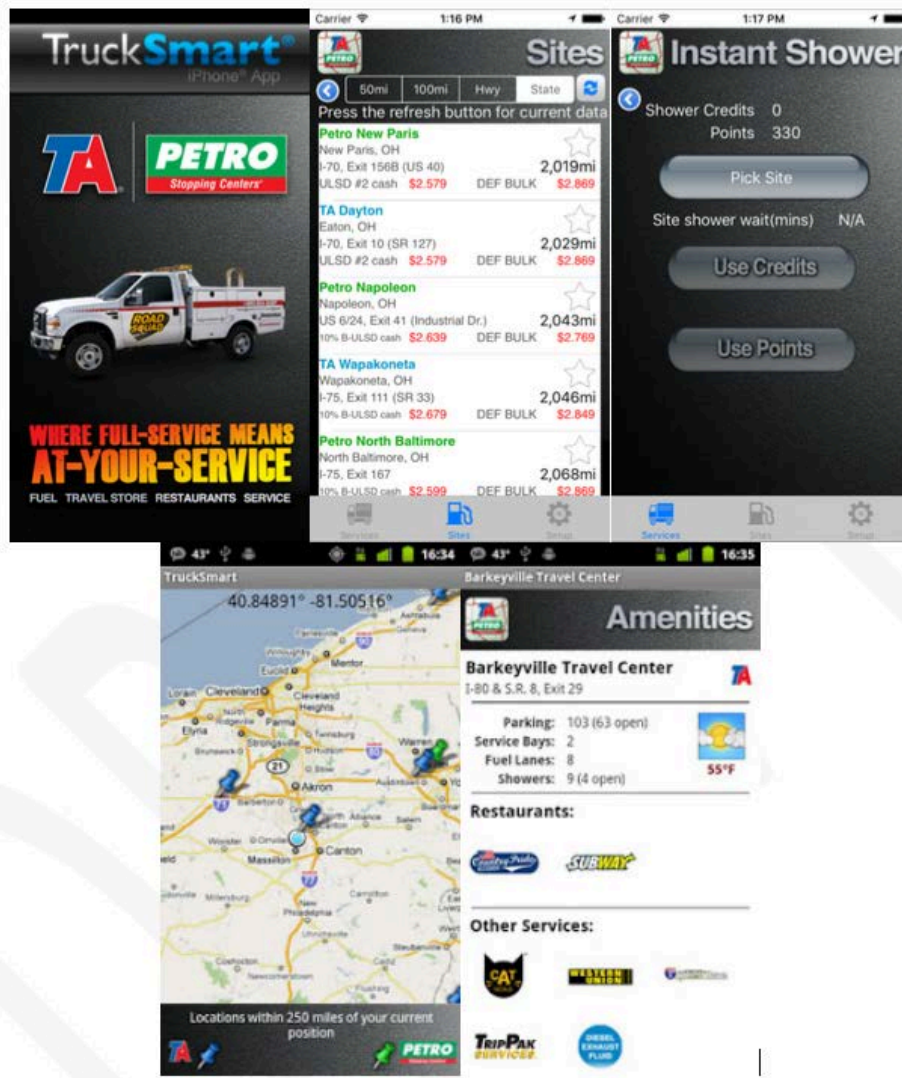

Figure B-5. Snapshots of the Various Screens Seen in the TruckSmart App (From Top Left: TA Assistance, Nearby Fuel Prices, Instant Shower Service, Interactive Map, and Amenities)

Truck Parking USA-App 5

Truck Parking USA is a new app that was created by PTV AG with the main goal of ensuring security. The locations shown on the interactive map can be filtered based on nearby amenities, as well as security. Each location comes with a review for the location and the available parking spots. The parking spots are provided by fellow truckers; if there are no spots, the app refers to alternative parking databases. As truckers must be HOS compliant, the app has the ability to track the driving times and give the driver rest reminders along his or her route. Figure B-6 provides visual examples of the app's interface (https://truckparkingusa.com/).
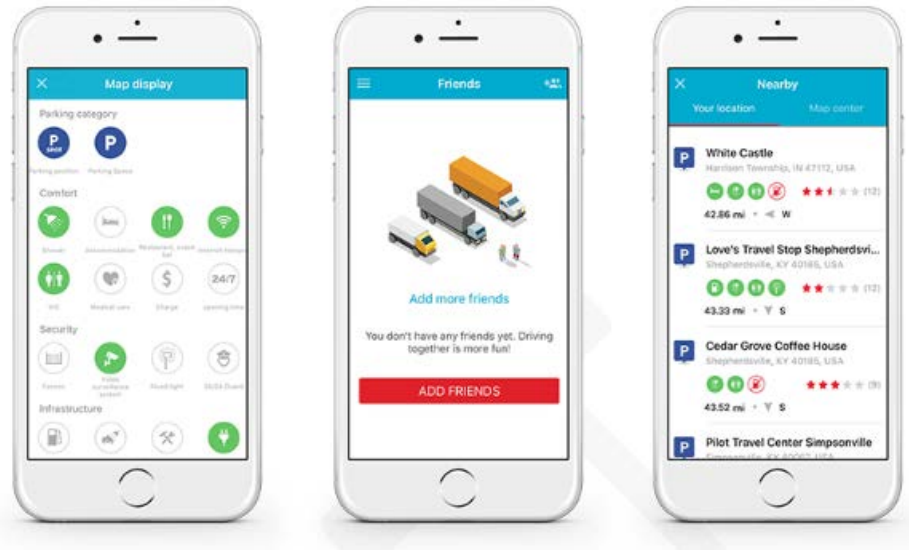
Figure B-6. Snapshots from the Truck Parking USA App (From Left: Map Display Options, Friends Connect, and Nearby Amenities)

CoPilot Truck Navigation

According to manufacturers, this mobile voice-activated GPS app helps truckers calculate the most efficient route, highlights potential commercial vehicle restrictions based on the type of load hauling, and identifies the best route for multi-stop trips. A benefit of CoPilot is that the GPS can work offline, saving data for other activities.

One of the unique characteristics of CoPilot is that it can be a standalone application but can also provide embedded integration options that allow integration with other applications. According to the manufacturers, the application is easy to use and has driver friendly user interfaces featuring visual and audio guidance. CoPilot Truck is available for Android and iPhone (Figure B-7; https://copilottruck.com).
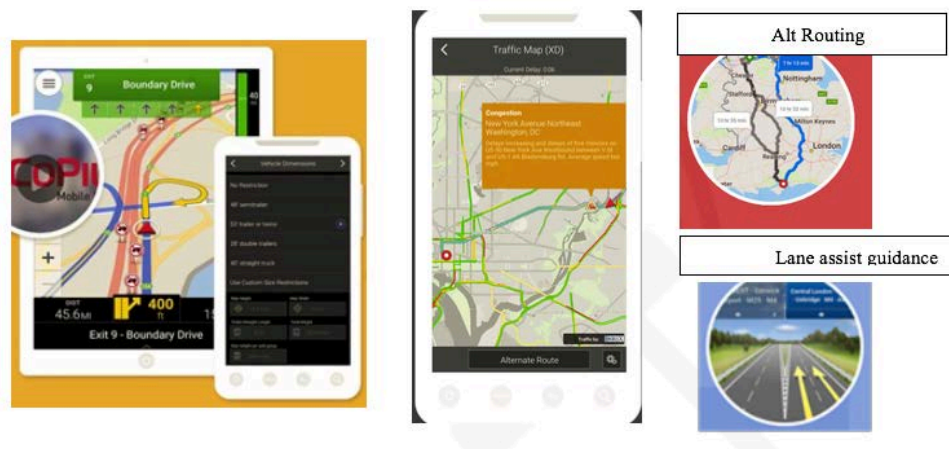

Figure B-7. Snapshots from the CoPilot Application and Some of Its Capabilities

Sygic

Sygic is an automotive navigation system based in Slovakia for mobile phones and tablets that offer navigation by iPhone and Android. The company offers car and truck navigation and is extremely popular in Europe. For truck navigation, Sygic uses 2D and 3D maps from TomTom. The users of Sygic GPS navigation can download maps to their devices and use them with or without an internet connection.

Trapped Traveler Emergency Communications Services

The 511PAConnect (511PAConnect) is a traveler emergency communication tool that has received several awards (Figure B-8). This tool allows emergency responders to communicate directly to motorists who are trapped in a roadway backup. Communication is made via automated phone or text message and does not require any initial download or action by drivers. The system functions in the same manner as an Amber Alert, in which the motorist is contacted and asked to go to the 511PAConnect app and provide his or her mobile phone number, vehicle type, and number of occupants. The motorist can select how and if they want to receive updates until the backup is over. Phone numbers are erased when the event is over. The system is extremely advantageous not only for motorist peace of mind but also for authorities to know the extent of the backup and to communicate to nearby vehicles to stay away (Figure B-8; 511PAConnect, 2018).
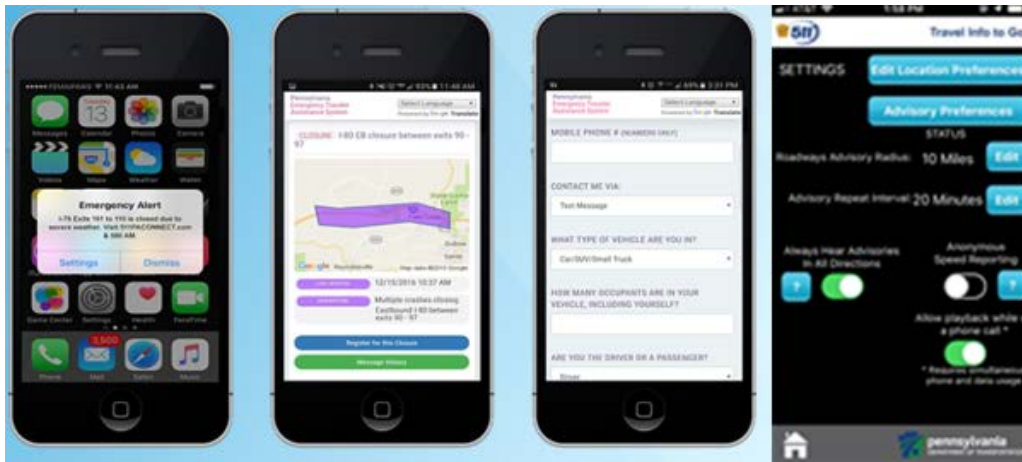

Figure B-8. Trapped Traveler Emergency Communications Services