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<th>Abbreviation</th>
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<tr>
<td>AASHTO</td>
<td>American Association of State Highway and Transportation Officials</td>
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<td>ATCMD</td>
<td>Advanced Transportation and Congestion Management Technologies Deployment</td>
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<td>ATDM</td>
<td>Active Transportation Demand Management</td>
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<td>ACDSS</td>
<td>Adaptive Control Decision Support System</td>
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<tr>
<td>AV\CV</td>
<td>Automated Vehicle\Connected Vehicle</td>
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<td>CBP</td>
<td>Customs and Border Protection</td>
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<td>CCTV</td>
<td>Closed-Circuit Television</td>
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<td>CIDNY</td>
<td>Coordinated Intelligent Transportation Systems Deployment in New York City</td>
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<td>CSW</td>
<td>Curve Speed Warnings</td>
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<td>CVII</td>
<td>Commercial Vehicle Infrastructure Integration Program</td>
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<tr>
<td>CVSA</td>
<td>Commercial Vehicle Safety Alliance</td>
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<td>DERA</td>
<td>Diesel Emission Reduction Act</td>
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<td>DOT</td>
<td>Department of Transportation</td>
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<td>DSRC</td>
<td>Dedicated short range communications</td>
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<td>FAA</td>
<td>U.S. Federal Aviation Administration</td>
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<td>FAF</td>
<td>Freight Analysis Framework</td>
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<td>FAST ACT</td>
<td>Fixing America's Surface Transportation Act</td>
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<td>FAST Program</td>
<td>Free and Secure Trade program</td>
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<td>FHWA</td>
<td>Federal Highway Administration</td>
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<td>FMCSA</td>
<td>Federal Motor Carrier Safety Association</td>
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<td>FRATIS</td>
<td>Freight Advanced Traveler Information System</td>
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<td>G-MAP</td>
<td>Goods Movement Action Program (for the New York-New Jersey Metropolitan Region)</td>
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<td>HOOCs</td>
<td>Highway Oversize/Overweight Credentialing System</td>
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<tr>
<td>HOS</td>
<td>Hours of service</td>
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<td>ICM</td>
<td>Integrated Corridor Management</td>
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<td>IFTA</td>
<td>International Fuel Tax Agreement</td>
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<td>IRP</td>
<td>International Registration Plan</td>
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</table>
ITD – Innovative Technology Deployment Program (FMCSA)
ITS – Intelligent transportation systems
LPR – License plate readers
NATSO – National Association of Truck Stop Operators and other organizations
NITTEC – Niagara International Transportation Technology Coalition
NJDOT – New Jersey Department of Transportation
NUAIR – Northeast UAS Airspace Integration Research Alliance
NYSDOT – New York State Department of Transportation
NYSERDA – New York State Energy Research and Development Agency
NYSP – New York State Police
OMSS – Office of Modal Safety and Security
OS/OW – Oversize/overweight
PRISM – Performance and Registration Information Systems Management
PTC – Positive Train Control
REEPT – Reduced Emissions through Efficient Parking for Trucks
RSU – Roadside units
STP – Smart Truck Parking Program
TIM – Traffic Incident Management
TOC – Traffic Operations Center
TMS – Transportation Management System / Truck Management System (see context)
TPIMS – Truck Parking Information and Management System
TTMC – Trusted Truck Management Center
UAS – Unmanned aircraft systems
USDOT – United States Department of Transportation
VMS – Vehicle Management System
VMS – Variable message sign
V2I – Vehicle to infrastructure
V2V – Vehicle to vehicle
WIM – Weigh-in-motion
Introduction

Technology related to freight transportation and operations is evolving rapidly. New York State Department of Transportation (NYSDOT) continues to implement programs that target improved freight operations in the state. Rapid advancements in information technology, sensors, artificial intelligence, communications, and vehicle technology hold the promise of opening many more technological opportunities for the future. The application of autonomous and connected vehicle (CV) technologies will likely have a significant impact on how freight movements occur in the future. Application of new monitoring and sensing technology to warehouses, ports, freight yards, intermodal facilities, fleets, and equipment will improve the visibility of the entire supply chain. Advances in robotics and additive manufacturing may also change the distribution of market supply and demand that causes demand for freight transportation.

The FAST ACT requires that state departments of transportation (DOTs) include,

“A description of how innovative technologies and operational strategies, including freight intelligent transportation systems, that improve the safety and efficiency of freight movement" in the freight plan.

To inform its statewide freight planning process, NYSDOT requested the development of this policy white paper with a set of recommendations for technology actions, strategies, and policies that NYSDOT can pursue to support improved freight-related operations statewide. This paper focuses on actions that NYSDOT and industry partners can take to improve and expand the quality and availability of reliable and actionable data supporting safe and efficient freight operations. In addition, opportunities to better utilize existing data are identified.

Recommendations identified in this paper are based on several research activities. First, an inventory of existing actions pertaining to freight technology deployment was created, based on interviews with NYSDOT staff. Second, interviews were conducted with experts from the public and private sectors regarding general emerging practices for integrating freight technology. Lastly, a review of emerging practices and important trends was compiled.

This white paper has the following broad sections:

1. Existing programs and technological gaps of NYSDOT and its partners
2. Expert interviews and high-level recommendations
3. Literature review summary – technological emerging practices
4. Recommendations for NYSDOT
5. Appendices – additional detail on current activities, interim recommendations, interviews, and emerging practices
Existing Programs and Initiatives

NYSDOT, working in collaboration with its partners, is engaged in many innovative programs and initiatives to apply technology to improve freight operations in the state and beyond. Error! Reference source not found. below summarizes some of the most significant of the initiatives undertaken by NYSDOT. A more detailed version of this table is available in the supplementary section “Additional Detail on Existing Programs and Initiatives,” which is provided at the end of this document.

<table>
<thead>
<tr>
<th>Programs\Initiatives</th>
<th>Description</th>
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<tr>
<td>New York State Freight Plan</td>
<td>NYSDOT is developing a statewide freight plan that will be a comprehensive guide governing short and long-term strategies and capital investments affecting the movement of freight. The Plan recognizes all modes of freight movement, including highway, rail, marine ports and inland waterways, air, and pipeline, as well as an accompanying focus on intermodal terminals, where freight changes between modes.</td>
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<tr>
<td>Goods Movement Action Program for the New York-New Jersey Metropolitan Region</td>
<td>G-MAP is a joint initiative of the Port Authority of New York and New Jersey (PANYNJ), the New Jersey Department of Transportation (NJDOT), and NYSDOT. Some of the early action technology-related items in the plan include:</td>
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<td>• Developing a Regional Strategic Plan for commercial vehicle enforcement operations;</td>
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<td>• Streamlining the permitting process for oversize/overweight (OS/OW) vehicles, including coordinating existing agency permitting web portals; and</td>
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<td>• Integrating ITS components—such as real-time traffic and truck routing information, weigh-in-motion (WIM), and shared enforcement information—to improve truck operations along I-95.</td>
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<td>NYSDOT’s proposed Framework for Active Transportation and Demand Management in New York State</td>
<td>Focused on seamless, door-to-door reliability, NYSDOT’s ATDM framework provides policy guidance on implementing active traffic and demand management strategies in a collaborative, multi-modal manner. From a freight perspective, solutions targeting enhanced information to truckers are included in the framework. To consider freight within an ATDM approach, the framework recognizes freight’s differences from passenger traffic. Freight movement is typically multi-jurisdictional, interregional, and affected by global economic factors. Freight involves a different set of stakeholders. Freight transportation providers employ a diverse fleet of vehicle types with an array of different vehicle sizes and weights and different cargo types.</td>
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<td>NYSDOT’s Office of Modal Safety and Security</td>
<td>The mission of the Office of Modal Safety and Security (OMSS) is to promote the safe transportation of people and goods in New York State, and to assist passengers and freight transportation providers in establishing proactive safety, consumer, and accident prevention programs, and in complying with safety and regulatory requirements. The OMSS oversight</td>
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<td>Programs/Initiatives</td>
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<td>authority encompasses bus safety, truck safety, rail safety, motor carrier safety and compliance, commercial vehicle credentialing, and permitting and security program monitoring and coordination.</td>
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<td>NYS Commercial Vehicle Screening Program</td>
<td>Over the last decade, NYSDOT has developed a mainline, high-speed commercial vehicle screening network as part of FMCSA’s Innovative Technology Deployment (ITD) Program. New York State’s Commercial Vehicle Electronic Screening (e-Screening) Program is managed by NYSDOT in partnership with other New York State agencies that have a responsibility in safety, asset management, and compliance, including but not limited to the NYS Department of Tax and Finance and Department of Motor Vehicles as well as the Division of NYSP. The ITD Program utilizes a dedicated screening communications network and roadside intelligent transportation systems (ITSs) that integrate various components including:&lt;br&gt;  - License plate recognition and overview camera systems and 915 MHz and 5.9 GHz dedicated short range communications (DSRC) to uniquely identify the commercial vehicle;&lt;br&gt;  - WIM devices to determine vehicle class, length, axle distances, axle weights and gross vehicle weight, capable of meeting Federal Highway Administration’s (FHWA’s) traffic monitoring data requirements, and;&lt;br&gt;  - Other technologies to supplement the above core components, depending on the location, including United States Department of Transportation (USDOT) number reader systems, over-height detection, and real-time traffic monitoring.</td>
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<td>Highway Oversize/Overweight Credentialing System</td>
<td>NYSDOT is advancing a Department-wide management system encompassing comprehensive permitting software integrated with GIS functionality that can be configured to support the Department’s needs for use as a Highway Oversize/Overweight Credentialing System (HOOCS), which will (1) improve NYSDOT’s oversize/overweight (OS/OW) permit workflow activities; (2) provide better data consistency; (3) resolve several process issues implicit in the stovepipe nature of the Department’s/State’s current applications and disparate systems/databases; and (4) support future Department-wide plans, processes, and operating environments. The goal is to implement a Commercial Off-the-Shelf (COTS) HOOCS software solution and to obtain the accompanying integration services necessary to fulfill NYSDOT’s Central Permitting Bureau's business requirements. HOOCS will benefit other participating permitting agencies and their customers. The outcome will be a scalable/configurable enterprise solution capable of supporting future technologies and offering more permit application types in nature.</td>
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<td>Programs/Initiatives</td>
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<td>Commercial Vehicle Infrastructure Integration</td>
<td>The Commercial Vehicle Infrastructure Integration (CVII) program focuses on developing, testing, and deploying connected vehicle technology for heavy vehicles. Since its inception, the CVII program has developed numerous vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) applications for trucks that leverage communication with roadside infrastructure and other light and heavy-duty vehicles to meet the objectives of the program.</td>
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| Coordinated Intelligent Transportation Systems Deployment in New York City | The Coordinated Intelligent Transportation Systems Deployment in New York City (CIDNY) project funds multiple different ITS strategies and systems in New York City. These include:  
- The application of Active Transportation Demand Management (ATDM) strategies along critical multi-modal highway/arterial street corridors  
- A multi-agency/multi-modal construction management tool  
- Development of packages of dynamic data collection of vehicular movement and conversion of real-time speed data for identifying traffic speeds  
- An introductory course on Traffic Incident Management (TIM) response developed for transportation operators, customized to address unique congested condition of New York City highways  
- A comprehensive guide to traffic signal timing, new detection technologies, and advanced signal timing concepts applicable in New York City  
In addition, research is being conducted on pedestrians’ and cyclists’ safety using ITS Technology in New York City. A data storage and access platform for MTA bus time data is being developed. |
| The Integrated Corridor Management Initiative Project | NYSDOT has been involved for a long time with TIM activities and coordination that comprise the core elements for an ICM program. Within the New York/New Jersey/Connecticut region, TRANSCOM provides the data collection, fusion, and dissemination that can be used to coordinate ICM operations. TRANSCOM is a coalition of 16 transportation and public safety agencies in the New York, New Jersey, and Connecticut Metropolitan Region that was created in 1986 to provide a cooperative, coordinated approach to regional transportation management. |
| Buffalo-Niagara Integrated Corridor Management Project | The objectives of the Buffalo-Niagara Integrated Corridor Management Project on I-190 are to optimize traffic operations by identifying effective traffic management strategies to mitigate congestion and the associated environmental impacts. The project involves the development of a data-driven decision support tool for:  
- Congestion management on critical transportation corridors in the Buffalo-Niagara Region that provide access to New York State’s bi-national border crossings |
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<th>Programs/Initiatives</th>
<th>Description</th>
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<tr>
<td>Niagara International Transportation Technology Coalition: Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD)</td>
<td>The Niagara Frontier Transportation Authority received a $7.8 million grant from FHWA ATCMTD program to fund the project <em>Connected Region: Moving Technological Innovations Forward</em> in the Niagara International Transportation Technology Coalition (NITTEC) Region. This provides funding for CV applications using multiple communications technologies to alert truckers of border wait times and available parking to reduce congestion in the Buffalo-Niagara Region. This grant has funded some important projects to advance the Buffalo-Niagara Integrated Corridor Management Project described above.</td>
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<td>ICM-495 Concept of Operations Study</td>
<td>Partnering agencies and authorities in the New York/North Jersey Metropolitan Region have engaged in significant dialogue to support the development of a Concept of Operations Study for the ICM-495 Corridor that would entail deployments of traditional and innovative transportation management systems (TMSs), an all-encompassing term that generally consists of ATDM and ITS concepts and solutions.</td>
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Interviews with Partner Organizations

ICF, in conjunction with NYSDOT, conducted nine interview phone calls with 15 total participants from 10 different organizations. The purpose of these interviews was to listen to the ideas and priorities of external freight stakeholders in New York State. The following interviews were conducted:

- Daniel Pelczynski, CBP, Department of Homeland Security
- Adam Ruder, Patrick Bolton, Robyn Marquis, NYSERDA
- Victoria Farr, Jennifer Bates, Steve Brown, PANYNJ
- Ron Rienas, Peace Bridge Authority
- Dave Schmitz, Price Chopper
- Robert Horr, Thousand Island Bridge Authority
- Kendra Hems, Trucking Association of New York
- Jim Manno, Sonwil Distribution, and Craig Turner, International Trade Gateway Organization
- Diniece Peters and Stacy Hodge, NYCDOT

These interviews focused on stakeholder needs and emerging technologies, which could be used to address these needs in New York State. The interviews sought to identify technology areas where collaboration and partnership with NYSDOT would be most productive. The interview guides are included in a supplementary section at the end of this document.

Key Takeaways from the Expert Interviews:

- Parking should be included in the freight plan. Improving information on truck parking availability would help to better define and solve the problem.
- Alternative fuels and alternative fuel corridors should be considered in the freight plan.
- Improving awareness of border wait times, including pushing information out to truckers, could help to ease queuing and improve routing at the border.
- Upgrading outdated IT infrastructure at the border should be a priority.
- More research on truck platooning could be useful for taking advantage of a significant fuel and emissions savings opportunity.
- NYSDOT should consider developing a test bed for platooning, automated vehicle, and other new technologies.
- Installing and improving traffic management systems is important. Better collaboration with local municipalities on traffic management and ICM can be productive.
- Increasing the efficiency of communication by creating a mechanism that can target the driver in the cab and the dispatcher with relevant information on road closures is important. This mechanism would screen the information provided to the users by the roads they actually have used in the past or are on now.
- NYSDOT should enable real-time data feeds based on 511 information for use by vendors and third party information providers.
- Improving the quality of geographical information in databases is important. Consider applications for geo-fencing to improve routing and safety.
- NYSDOT should improve communications infrastructure at the Thousand Islands border crossing. In addition, there is an opportunity to partner on screening technology by sharing...
camera and WIM data between NYSDOT and the Thousand Islands Bridge Authority. NYSDOT could also screen permits and let the bridge authority know what oversize and overweight loads are being permitted to travel up to the bridge.

- Promote sharing of real-time freight system performance data between public and private stakeholders.

Emerging Practices in Freight Technology

This section summarizes emerging practices in the use of technologies for freight systems, as seen in literature on existing systems and pilot programs. In some cases, technology is established, and determinations can be made on best practices according to experience with pilot demonstrations or existing programs. In other cases, such as with CV technology, many applications are still in testing and suggestions of best practices are largely conjectural, hence they are collectively termed “emerging practices.” This section includes these nascent technologies in addition to established ones since they have potential to be either directly harnessed by NYSDOT to improve the freight system, or because they have an impact on NYSDOT freight programs and operations.

Emerging practices are explored in the following four areas of focus: mobility, safety and security, supply chain efficiency, and environment and energy efficiency. These were identified based on the interviews (Task 2) and discussions with NYSDOT (Task 1). Table 2 summarizes the emerging practices discussed in this section, broken out by impact area. A more thorough discussion of each of these practices is presented as supplementary materials in the section “Emerging Practices in Freight Technology” at the end of the report.

**Table 2. Technology Emerging Practices Summary**

<table>
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<tr>
<th>Focus Area</th>
<th>Emerging Practices Summary</th>
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| Mobility   | • Leverage communication technology to deliver trucking-specific alerts. For example, the Minnesota DOT developed a new app, specific to truckers, which can be used to alert truckers of conditions on their chosen route, and the Vermont 511 system uses a targeted twitter feed.  
  • Utilize data from Waze to assist with vehicle routing, as 13 states have done.  
  • Provide information on delays at border crossings and ports via applications like Geostamp, DrayQ, Metropia, and e-Alerts.  
  • Use drones for aerial accident scene surveillance.  
  • Analyze data to target contract towing units for heavy trucks at strategic locations, as is done by Colorado DOT.  
  • Use smartphone apps to disseminate ICM data, as done in Chicago and Kansas.  
  • Pilot a freight signal priority system, as is being done in Miami.  
  • Partner with applications like HERE Real-Time Traffic, which provide accurate and contextualized information for drivers and Advanced Driver Assist Systems applications.  
  • Deploy the Regional Truck Parking Information and Management System (TPIMS), as Eight Midwestern states are doing. |
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<th>Focus Area</th>
<th>Emerging Practices Summary</th>
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<td><strong>Focus Area</strong></td>
<td><strong>Emerging Practices Summary</strong></td>
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<td>• Deliver real-time parking availability information to truckers via smartphone, as has been done in the California Smart Truck Parking (STP) program, the National Association of Truck Stop Operators (NATSO), and other organizations.</td>
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<td>• Go a step further and provide a mechanism to make reservations through a real-time interface, as is the case in the California Air Resources Board’s Reduced Emissions through Efficient Parking for Trucks (REEPT) program that provides real-time parking availability info and reservations.</td>
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<tr>
<td>Safety and Security</td>
<td>• Develop a framework for planning for connected and automated vehicles.</td>
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<td>• Provide curve speed warnings, bridge height warnings, and overweight warnings.</td>
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<td>• Provide permit automation for permits up to the threshold of 14 feet wide, 14 feet 6 inches tall, 110 feet long, and 150K pounds.</td>
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<td>• Improve license plates to facilitate use of license plate readers (LPRs).</td>
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<td>• Explore automation of Level 3 roadside safety inspections—including the Drivewyze pilot system.</td>
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<td>Supply Chain Efficiency</td>
<td>• Work with the private sector to collect data on corridor supply chains. Develop supply chain performance measures.</td>
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<td>• Work with private sector app developers and firms to share real-time location and trip data between drayage companies, drivers, and ports.</td>
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<td>• Support port automation.</td>
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<td>Environment and Energy Efficiency</td>
<td>• Apply for clean diesel grants and invest in retrofits, repowering and replacing older trucks and locomotives.</td>
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<td>• Apply for grants to promote adoption of alternative fuel vehicles.</td>
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<td>• Provide education to encourage maintenance of advanced emissions control systems.</td>
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Recommendations for NYSDOT

This section provides a summary of the recommendations developed for NYSDOT. These recommendations focus on actions that NYSDOT and industry partners can take to improve and expand the quality and availability of reliable and actionable data supporting safe and efficient freight operations. It focuses on recommendations with near-term implications. The following pages detail each recommendation, including a description, location, listing of technologies involved, key implementation steps, stakeholders, and relevant technology themes.

In addition, a qualitative assessment of the cost and complexity is provided. Cost is presented using the following scale to categorize cost:

Low: < $1 Million

Medium: $1 Million–$5 Million

High: > $5 Million

The qualitative scale for complexity takes into account the extent to which implementing a strategy will be complex, and therefore riskier. A variety of factors could generate complexity, such as integrating multiple systems, coordinating the use of a technology or a program across multiple agencies, or implementing customized software.
## 1. Create a freight technology test bed

| Description | Consider establishing a freight technology test bed in New York State. Potential candidate locations could be the New York State Thruway or other similar facilities. This could serve as a test bed for truck platooning, CV technology, roadside inspection, and potentially automation. The creation of this test bed could also be a mechanism to obtain and leverage federal funding, including the next round of Advanced Transportation And Congestion Management Technologies Deployment (ATCMTD) grants. |
| Problem | It can be difficult to quickly deploy innovative concepts through traditional channels due to regulatory and procedural hurdles, but without testing, new technologies may never be approved for broader use. |
| Technological Components | Several technologies could be deployed on the test bed for evaluation. These include, but are not limited to:  
  - V2V connections via DSRC or other methods for safety, as well as platooning or eco-driving  
  - V2I connections for safety purposes  
  - Automated vehicles  
  - Automatic roadside inspections with on-board software and infrastructure |
| Key Steps | 1. Work with stakeholders to identify the scope of work covered by the test bed (primary, secondary, specific segments).  
2. Stakeholder meetings to define the technological opportunity could be conducted.  
3. Develop a Concept of Operations Plan that includes the overall vision and goals for the technology test bed and describes the operational scenarios—the who, what, why, where, when, and how—for the near-term candidate technology applications.  
4. Apply for a federal designation as an AV/CV test bed and make a commitment to test. The test bed would be a place for emphasis on technology insertion.  
5. Once the state had received the designation, the test bed could be used as a mechanism to obtain and leverage federal funding including the next round of ATCMTD grants. The state could apply for federal grants focused on the test bed, and work with private sector technology vendors to encourage testing. |
| Stakeholders | NYSDOT, Thruway Authority, USDOT, local government(s), private sector (AV/CV developers), DMV, NYSP |
| Themes Addressed | Technology testing and evaluation, freight efficiency, safety and security |
| Location | I-87, I-90 |
| Cost | Medium |
| Complexity | High |
## 2. Create a consistent data interface for freight-specific data

| Description | NYSDOT should design and, through partnerships with vendors, develop a data delivery system for freight-specific data, such as road condition and closure information specific to trucks. The key to the success of this effort would be to define the data dictionary of necessary traveler information needs for freight and develop a public interface so that they can be accessed by third parties and distributed on multiple platforms. |
| Problem | The delivery of NYSDOT and agency-owned data to trucking companies and dispatchers needs to be improved. While there are currently ways to access traveler information data through 511, it is not oriented toward freight-specific needs. As mentioned in expert interviews, there is also a need to develop better delivery methods for existing 511 data so it provides customized data feeds to freight users depending on where they are and what roads they use so that information is relevant and actionable. Vermont’s 511 Twitter feed shows one possible model to leverage Twitter to do this. Information on road conditions and road closures needs to be available to truckers in real time and in-cab to make it actionable. |
| Technological Components | • Back-end data processing and distribution centers  
• On-board software for data delivery—either through an app or vendor platform (such as Twitter) or via a new application |
| Key Steps | 1. Work with third party providers including freight telematics providers is a necessary next step to move the traveler information in-vehicle.  
2. Design and implement standards to facilitate the use of data by third parties.  
3. Identify a potential project pilot location, such as Buffalo, which would be a good location to provide a demo of the one-stop shopping concept for real-time roadway information for truckers. Once the one-stop shop is in place, delivery could be accomplished via various third party services such as Sirius XM, TANY/freight-specific portal, or other platforms. |
| Stakeholders | NYSDOT, trucking industry, Trucking Association of New York, third party vendors |
| Themes Addressed | Data, information delivery, freight efficiency |
| Location | Buffalo Pilot Test |
| Cost | Medium |
| Complexity | High |
# 3. Provide legal clarity to industry on how state law affects the deployment of automated and CV technology

<table>
<thead>
<tr>
<th>Description</th>
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<tbody>
<tr>
<td>NYSDOT should review state laws and regulations to ensure that the existing legal and regulatory environment does not provide unnecessary barriers to the deployment of truck automation and CV technologies. As part of this recommendation, NYSDOT should consult with industry to identify areas where legal and regulatory clarity may be needed.</td>
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<table>
<thead>
<tr>
<th>Problem</th>
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<tbody>
<tr>
<td>Existing legal standards and regulatory requirements can inhibit the use of certain technologies that could yield benefits. As new technologies emerge, existing statutes must be re-examined to determine whether they are unsuitable in situations using new technology, or whether they are unnecessarily prohibitive to adoption of new technology. For instance, differences in the way states regulate the following distance of trucks can serve as a barrier to the use of truck platooning across state lines. New York State uses a reasonable and prudent standard to regulate following distance, but it is not clear how this applies to platooning.</td>
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<table>
<thead>
<tr>
<th>Technological Components</th>
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<tbody>
<tr>
<td>NA</td>
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<table>
<thead>
<tr>
<th>Key Steps</th>
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</thead>
<tbody>
<tr>
<td>1. Conduct internal assessments of legal statues pertaining to freight shippers, including those focused on freight shippers (e.g., weigh limits, legal vehicle configurations), as well as those governing broader transportation (e.g., following distance, requirements to have your hands on the steering wheel).</td>
</tr>
<tr>
<td>2. Conduct interviews with key technology providers, such as those of connected or autonomous technology, to ask if potential barriers identified in Step 1 are inhibitive, and if so, possible solutions. Also, ask about other possible barriers and solutions.</td>
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<td>3. Review findings from Steps 1 and 2 with relevant regulatory agencies</td>
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<tr>
<td>4. Determine any permanent adjustments to statutes, including ability to apply for exemptions where applicable.</td>
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<tr>
<td>5. Engage with the Uniform Law Commission, which is developing model harmonized legislation and policies related to autonomous vehicles.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Stakeholders</th>
</tr>
</thead>
<tbody>
<tr>
<td>NYSDOT, state regulatory agencies, Uniform Law Commission, technology vendors</td>
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</table>

<table>
<thead>
<tr>
<th>Themes Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology testing and evaluation, legal frameworks, regulation, barriers to deployment, CVs</td>
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<table>
<thead>
<tr>
<th>Location</th>
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<th>Cost</th>
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<table>
<thead>
<tr>
<th>Complexity</th>
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<td>Low</td>
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4. Deploy technologies to more effectively utilize existing parking and to provide information on emergency parking

**Description**
This recommendation is about communicating information to truck drivers on emergency parking availability when inclement weather creates roadway closures. It consists of collecting information on emergency parking availability and then implementing a system to disseminate that information. This could be one of the use cases of the freight one-stop recommendation as well.

**Problem**
Truck parking is a technology issue, as well as an asset management issue. Currently, there are no efficient ways to communicate whether and where emergency parking is available. As emergency conditions evolve, the state may be forced to close roads with little notice, which may leave trucks and drivers stranded on the road, hours from their home base. This affects the safety of truck drivers, who may be stranded in inclement weather or forced to park their trucks in locations that may create additional safety hazards.

**Technological Components**
- Phone applications for truckers to receive emergency parking information—either as part of another travel information app or as a stand-alone application
- An integrated data center that incorporates weather data to generate real-time warnings and recommendations of emergency parking based on driver location

**Key Steps**
1. Conduct meetings with NYCDOT and other authorities to catalogue emergency parking availability information to be integrated into the system.
2. Host stakeholder meetings with the Trucking Association of New York, vendors, and other stakeholders to determine which app interface is most appropriate—either a new application or integration in an existing travel application.
3. If it is determined that dissemination via a third party vendor is preferable, contact relevant vendors about possible partnerships.
4. Develop a Concept of Operations Plan for a back-end data center and app that can generate specialized alerts and emergency parking recommendations.

**Stakeholders**
Technology vendors, Trucking Association of New York, trucking industry, NYSDOT, NYCDOT

**Themes Addressed**
Information delivery, data, active parking management, information delivery, system management

**Location**
Major parking locations

**Cost**
Medium

**Complexity**
Medium
## 5. Pilot test automation of Level 3 roadside safety inspections

<table>
<thead>
<tr>
<th>Description</th>
<th>This recommendation is to further expand automation in roadside enforcement, by conducting a pilot test of Level 3 roadside inspection automation technology in a major roadside safety inspection location. The technology relies on electronic driver logging devices to transmit most of the information required for the Level 3 roadside safety inspection and pre-populates the inspection form. All long-haul trucking companies were required to adopt electronic log books by the end of 2017, according to current FMCSA rules.</th>
</tr>
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<tbody>
<tr>
<td>Problem</td>
<td>The state of New York conducted 38,187 Level 3 inspections in 2016. This represented less than half of the total number of roadside inspections conducted. Given the scale of enforcement efforts, improving the efficiency of the inspection process reduces delays to law-abiding trucking firms, and can help enforcement agencies to reach a greater number of unsafe carriers. Under current Commercial Vehicle Safety Alliance (CVSA) rules, it is not possible to file a Level 3 roadside inspection completely without officer interaction with the driver. However, much of the process can be done electronically, thereby saving time.</td>
</tr>
</tbody>
</table>
| Technological Components | • On-board electronic logging devices and software, as are made by Drivewyze, automates Level 3 inspections; this technology is currently being tested in other states  
• Inspection center data analytics to receive and log the electronic inspection forms—also potentially provided by Drivewyze—uses its Drivewyze Bypass system that works by populating inspection downloadable forms with nearly all data before the driver arrives and minimizes the time needed for inspection |
| Key Steps | 1. Organize a stakeholder meeting with Drivewyze or another technology vendor, NYSDOT, safety inspectors, and trucking industry members to discuss the location, scope, and goals of the pilot.  
2. Monitor the progress of comparable ongoing pilot programs in other states, such as Virginia and Delaware, and consult staff involved for advice.  
3. Coordinate with the vendor to outfit several test trucks with the necessary on-board monitoring devices, and train safety inspectors in the use of the online platform for receiving and downloading pre-filled forms.  
4. Conduct the pilot program and analyze results according to project goals. |
| Stakeholders | Technology vendors (e.g., Drivewyze), NYSDOT, safety inspectors, trucking industry |
| Themes Addressed | Automated processes, safety inspections, system management |
| Location | I-90 |
| Cost | Medium |
| Complexity | High |
### Description
NYSDOT, the NYS Thruway Authority, and the NYS Bridge Authority are currently collaborating to launch the HOOCS system. After the initial launch, NYSDOT should further expand automation for OS/OW permits and IRP/IFTA registration and trip permits so that HOOCS can provide a one-stop shop for all permitting needs in the State of New York. Then, the program should expand the thresholds at which permits can be auto-issued so that permits can be provided 24/7 and made available to applicants within minutes. A goal should be set to provide permit automation and auto-issue permits up to the threshold of 14 feet wide, 14 feet 6 inches tall, 110 feet long, and 150K pounds. Lastly, NYSDOT should examine the feasibility of providing an online interface in French to assist Canadian border authorities.

### Problem
A lack of permit automation creates delays in issuing permits since carriers need to wait for permits to be processed manually. The current HOOCS program does not include all the permitting authorities in New York State. Some border authorities are unable to use HOOCS because they are required to provide a French interface, which is not available in HOOCS.

### Technological Components
- The existing HOOCS system
- Additional software updates to HOOCS to allow for additional permit types and faster permitting

### Key Steps
1. Meet with other permitting authorities to determine the feasibility and methodology for integrating other permit systems into HOOCS.
2. Conduct an assessment of the cost and complexity of providing a French language option for Canadians.
3. Assess the feasibility of raising size and weight thresholds for permit automation.

### Stakeholders
Technology vendors, bi-national authorities, bridge and tunnel authorities, New York counties, localities

### Themes Addressed
Freight efficiency, automated processes, permitting, system management

### Location
Statewide

### Cost
High

### Complexity
High
### 7. Enhance availability of border wait time information

**Description**
A number of programs, such as the Buffalo-Niagara Region Border Wait Time System, are currently providing border wait time information. Data from this program and others are linked to variable message signs. More can be done to push information out to truckers in the cab and to dispatchers, across major congested border crossings, so that data can be accessed and used. In addition, at some border crossings, wait time information is not generated and provided in a systematic fashion. NYSDOT should explore app-based systems to provide more wait time information and distribute it systematically. These systems could supplement the existing NITTEC app to provide information on additional border crossings. This recommendation is closely tied to the second recommendation in this report.

**Problem**
Truckers currently approach the Canadian border without sufficient information about potential wait times. This information could be used to plan shipments, or choose routes. Current border wait time information is either insufficient or not readily available.

**Technological Components**
- License plate and Bluetooth readers along border crossing entrances and exits for measuring border wait times
- Data analytics to determine wait time forecasting based upon collected data and current conditions
- Data distribution center to disseminate border wait time statuses and forecasts to drivers
- A user interface (presumably via a mobile phone application) for receiving wait time information

**Key Steps**
1. Review existing programs such as the Buffalo-Niagara Region Border Wait Time System.
2. Host a stakeholder meeting with NYSDOT, Bi-national authorities, and all interested private sector information service providers to determine optimal mechanisms for disseminating information
3. Determine roles and responsibilities for collecting data, managing data analytics and wait time forecasts, and developing/updating the user interface software.
4. NYSDOT should encourage efforts from the border crossing authorities to spread information (via an app or other mechanisms).

**Stakeholders**
Technology vendors, NYSDOT, truck carriers, Bi-national authorities

**Themes Addressed**
Information delivery, data, communication technology, system efficiency, border crossings

**Location**
Border crossings

**Cost**
Medium

**Complexity**
Medium
## 8. Invest in better management and delivery of spatial and geo-data; pilot test new and enhanced mapping and geo-fencing applications

<table>
<thead>
<tr>
<th>Description</th>
<th>The databases for geo-fencing applications for truck routing need to be improved. NYSDOT should conduct a pilot project to improve the data and provide it through a third party vendor to truckers. A pilot project could include geo-fencing data for bridge height, bridge load restrictions, or truck routes. These data are maintained by NYSDOT and would be useful to on-board systems and automated vehicles to assist with vehicle routing.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem</td>
<td>Current databases are not of the quality needed for use operationally for geo-fencing data purposes. Different geo-spatial databases are used by different applications leading to incompatible services.</td>
</tr>
</tbody>
</table>
| Technological Components | • On-board GPS software and communications equipment  
• A central data processing and distribution center |
| Key Steps | 1. Review existing geospatial databases and assess the quality of the information.  
2. Identify processes, procedures, and resource needs to improve data quality.  
3. Contact other state and local agencies such as NYCDOT that are responsible for determining road-restriction information, and determine an approach for integrating the information into a central data hub.  
4. Meet with trucking industry stakeholders to determine a pilot program location based upon which routes are most heavily traveled and subject to various restrictions.  
5. Issue RFP(s) for a vendor to establish the enterprise system for a data and communications system, and equip test trucks to receive data.  
6. Implement the test pilot. |
| Stakeholders | NYSDOT, local governments, technology vendors |
| Themes Addressed | Information delivery, system management, big data, geo-fencing, pilot programs |
| Location | Statewide |
| Cost | Medium |
| Complexity | High |
### 9. Conduct a pilot test of in-vehicle curve speed and roll over warnings for trucks

| Description | There are opportunities to encourage vendors to provide roll over and curve speed-warning applications that are integrated with infrastructure elements. The data exists to identify the areas that are safety risk hotspots. Drivewyze and other telematics platforms could deliver this information to drivers (via VMS signage in-vehicle). Additional research is required to demonstrate and pilot this technology. Further, vendors need to understand what the value is for their customers and their business models. NYSDOT has already conducted Phase I of the “Drivewyze Safety Application in the State of New York” which defined roll over hot spots and conducted research on an appropriate safety message. Piloting the technology on the road with third party vendor systems is the next step. |
| Problem | Trucks face unique safety challenges when dealing with traversing curves on the highway system, and while CV technology has the potential to mitigate those challenges, it is too nascent to be deployed at scale without testing. Additional pilot projects are needed to prove the business and safety value of this technology. |
| Technological Components | • Roadside units (RSU) for generating signals to incoming vehicles  
• GPS technology  
• On-board units for transmitting GPS data to nearby RSUs  
• A user interface to display warnings to the driver |
| Key Steps | 1. Identify key areas that are prone to accidents via unsafe curve speeds and/or rollovers, and narrow down to a set of locations to be equipped with CV infrastructure (some of this work has already been done the Phase I study mentioned above).  
2. With the input of trucking industry members and other stakeholders, research the range of vehicle types that may be prone to such incidents, and whether there are unique challenges for each vehicle type, thereby informing which vehicle types should be used in the pilot test.  
3. Contact vendors (perhaps via a formal RFP) to solicit proposals and cost estimates for CV technology to be installed in the designated areas and on a sample of host vehicles.  
4. Partner with vendor(s) to install software, equipment and test the technology. |
| Stakeholders | NYSDOT, Drivewyze, other technology vendors, trucking industry |
| Themes Addressed | Information delivery, safety, CVs, CV infrastructure, pilot programs |
| Location | Statewide roll over hotspots |
| Cost | Medium |
| Complexity | High |
## 10. Continue investment in technology at border crossings

### Description

There is an opportunity to provide better information at the Thousand Island border crossing (and others) and to partner on screening technology at border crossings by making NYSDOT permitting, camera, and WIM data available to the bridge authority. NYSDOT could screen permits and let bridge authorities know what oversize and overweight loads are being permitted to travel up to specific bridges.

In addition, additional investment is needed in IT and communications infrastructure along the border.

### Problem

The Thousand Island Bridge Authority does not currently have access to information from NYSDOT that would help them improve operations (including permitting, camera, and WIM data). Continued improvement in data-sharing processes is needed. There is also currently a lack of adequate communications infrastructure at the Thousand Island border crossing, which needs to find a way to move more data faster, including video, border crossing information, and data relevant to security.

### Technological Components

- Permitting databases, software, and procedures to make NYSDOT data available to the bridge authorities
- Software updates to provide this information to officials at the border through existing software platforms for screening vehicles
- Installation of fiber optic cable links to Thousand Island border crossing

### Key Steps

1. Collect requirements from users on what data elements and timeliness of information is needed to assist enforcement at the border.
2. Conduct facilitated workshops with key stakeholders to design the scope of database and software changes that are needed in existing systems.
3. Identify and task a group to implement these changes.
4. Identify potential sources of funding to implement these changes.

### Stakeholders

Bi-national authorities, bridge authorities, NYSDOT, CBP

### Themes Addressed

Information distribution, automated processes, border crossings, system management

### Location

Border crossings

### Cost

Medium

### Complexity

Medium
## 11. Testing freight signal priority on key access points to ports and as part of the Buffalo ICM project

| Description | Freight signal priority gives priority to freight vehicles approaching a signalized intersection, granting an extended green light in some cases. Priority decisions are based on real-time traffic and emissions data to produce the fewest emissions at signalized intersections. This technology is currently being piloted in Miami. |
| Problem | Freight vehicles take longer to decelerate and accelerate, and use large amounts of fuel to do so. Stopping at frequent intersections slows shipments, and causes an increase in fuel usage and emissions |
| Technological Components | - Upgraded traffic control signals (via DSRC)  
- On board vehicle transmitters capable of sending data on vehicle type and motion  
- Software in the traffic management center for processing data at multiple intersections in real time |
| Key Steps | 1. In conjunction with the City of Buffalo, determine intersections within the city that should be used for the pilot.  
2. Develop a Concept of Operations Plan with input from city officials and technology vendors, which includes goals and describes the operational scenarios—the who, what, why, where, when, and how—for the near-term candidate technology applications. The Concept of Operations Plan should also include plans for how to measure program effectiveness and impacts.  
3. Issue a contract with qualifying vendors to supply and operate the necessary components of the pilot program. |
| Stakeholders | Technology vendors, PANYNJ, NYSDOT, NYCDOT, City of Buffalo |
| Themes Addressed | System efficiency, emissions reduction, pilot programs |
| Location | Buffalo pilot test site |
| Cost | Medium |
| Complexity | High |
## 12. Mainstreaming off-peak delivery

### Description

New York City was successful in operating an off-peak delivery pilot program. There is a need to continue to develop technologies to mainstream this concept. This could include piloting additional technologies to allow delivery of freight at night while maintaining security of freight or other concepts such as consolidated delivery centers.

### Problem

Off-peak delivery programs have been successful in improving freight system efficiency in New York City and elsewhere, but have yet to reach full scale for a variety of factors—both technological and institutional. In particular, off-peak deliveries often mean that shipment delivery is scheduled at an inconvenient time for the receiver.

### Technological Components

- On-board GPS and shipment tracking software
- Specialized security software and hardware allowing for trip-by-trip security passes for drop-offs
- Development of consolidated delivery centers

### Key Steps

1. In conjunction with NYCDOT, determine the optimal mechanism for creating a network of shippers and receivers to participate in the program, and determine realistic options for funding incentives to receivers to schedule shipments for early in the morning.
2. Conduct stakeholder meetings with government entities and technology vendors to determine which delivery methods are likely to be most effective in allowing shipments to be delivered in early and inconvenient hours for the receivers.
3. Partner as necessary with entities controlling parking spaces to determine feasibility of using spaces for freight delivery in off-peak hours that are used in other hours for non-freight functions.

### Stakeholders

NYSDOT, NYCDOT, truck carriers, receivers, shippers

### Themes Addressed

System efficiency, emissions reduction, pilot programs

### Location

New York City

### Cost

Medium

### Complexity

Medium
### 13. Investing in technologies to improve the efficiency of intermodal shipments

| **Description** | NYSDOT should make investments to incentivize innovation and increase efficiency in intermodal operations. Many innovations show promise and should be considered for study or pilot testing. For example, drayage movements may be a candidate for early application of autonomous truck technologies. Many different automation technologies are already being applied in ports and rail yards, and this trend will likely accelerate in the future. Improving management of traffic operations around ports is another area of opportunity. One example is intelligent truck control systems employed to manage traffic operations in port regions. Improved tracking of containers as they move between transportation modes would also increase visibility in the supply chain and help increase efficiency. |
| **Problem** | Intermodal shipments are subject to frictions associated with transferring modes, but there are a number of ways that technologies may improve the efficiency of intermodal operations. |
| **Technological Components** | Depending on which technologies NYSDOT chooses to focus on, some combination of the following will be used: |
|  | • Port monitoring hardware and software to supply data on port operations |
|  | • Mobile applications or on-board units capable of disseminating port shipment information to drayage operations |
|  | • Data centers capable of making automated decisions pairing multi-modal shipments at ports and rail yards |
|  | • Various automated truck and container movement technologies |
| **Key Steps** | 1. Convene stakeholders (ports, carriers, shippers, technology vendors) to discuss technological opportunities in intermodal. |
|  | 2. Collect requirements. |
|  | 3. Define project scopes. |
|  | 4. Identify funding resources to conduct technology research and demonstration. |
|  | 5. Conduct pilots and evaluate results. |
| **Stakeholders** | NYSDOT, intermodal terminals, truck carriers, technology vendors |
| **Themes Addressed** | System efficiency, information distribution, automated processes |
| **Location** | Intermodal facilities |
| **Cost** | High |
| **Complexity** | High |
Conclusions
Freight transportation is in the midst of a significant technological revolution. Advancements in communications, information technology, sensors, artificial intelligence, and vehicle automation are accelerating. These advancements provide many policy and technological opportunities for NYSDOT to exploit. NYSDOT’s role in enabling new technology will vary (innovator, regulator, data provider, etc.) depending on the area of innovation. The recommendations in this report focus on near-term opportunities in the freight sector. These recommendations are centered on four broad overarching themes discussed below.

Technology testing and evaluation – NYSDOT can further contribute to technological innovation by funding additional programs to test and evaluate new technologies. Technological innovation is made possible, in great part, by early adopters who bear the risk of testing and piloting new technologies that have uncertain value. On the leading edge of technology, innovators often assume financial and business risks associated with investing in something that has not been proven. There are often multiple failures for each achieved success. Early adopters will often encounter regulatory and legal barriers first. They may need to solve a whole host of issues associated with integrating the technology into their operations, including training operators to use the technology and adjusting business processes to exploit technological opportunities. After a technology has been demonstrated and proven in the field, it will then be more easily adopted by organizations that are more risk averse. These organizations benefit by imitating the innovators when they are successful. The rationale for NYSDOT investment in technology demonstration is to accelerate the pace of innovation and help to subsidize the demonstration of a new technology, which has external benefits that flow to many market actors beyond the early adopter. Recommendations 1, 3, 5, 8, 9, 11, and 13 address issues associated with testing and evaluation in some way.

Information delivery – NYSDOT is extensively involved in collecting and providing data on transportation system operations. A wealth of data on vehicle speeds and volumes are processed in Traffic Management Centers across the state and made available on websites, and in some cases on variable message signs. Data on road closures and congestion is provided through the 511 program in multiple formats. The diversity of data sources, formats, and information providers make it difficult for users to easily access the information they need when they can act on it. There is therefore a need for more emphasis on providing data in formats that can be used by multiple third party vendors to deliver the information in real time into the cab or to dispatchers. Ultimately, the information is most valuable to users when it can be acted on. Recommendations 2, 4, 7, 8, and 9 address some aspect of information delivery in this context.

Data – There are many opportunities to improve the quality of data available. Ultimately, improved data can increase efficiency in freight transportation operations, provide information to automated systems, and allow users to make better decisions to optimize their use of transportation. Data ultimately serves as the raw material from which improved freight transportation operations are created. Recommendations 2, 4, 7, and 8 address this theme.

Freight efficiency – The freight transportation system is complex because it involves the coordination of supply chains across multiple jurisdictions, modes and numerous firms. Freight transportation efficiency can be promoted by reducing the friction between modal handoffs, reducing the cost of screening and
enforcement, automating permitting, and improving routing and operations through the strategic use of information and technology. Recommendations 5, 6, 10, 11, 12, and 13 address this theme.
Appendix A- Additional Detail on Existing Programs and Initiatives

NYSDOT, working in collaboration with its partners, is engaged in many innovative programs and initiatives to apply technology to improve freight operations in the state and beyond. ICF met with NYSDOT on April 24, 2017, to discuss existing programs in New York. In addition, NYSDOT staff provided a number of documents describing additional freight technology programs in New York, and ICF supplemented this information with additional research. Table 3 below summarizes some of the most significant of the initiatives undertaken by NYSDOT in additional detail beyond what was presented in Table 1 of the main body of the white paper.

**Table 3. Ongoing Programs and Initiatives Undertaken by NYSDOT**

<table>
<thead>
<tr>
<th>Programs/Initiatives</th>
<th>Description</th>
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| New York State Freight Plan                           | NYSDOT is developing a statewide freight plan that will be a comprehensive guide governing short and long-term strategies and capital investments affecting the movement of freight. The Plan recognizes all modes of freight movement, including highway, rail, marine ports and inland waterways, air, and pipeline, as well as an accompanying focus on intermodal terminals, where freight changes between modes. The Plan will be used to:  
- Understand why, how, where and when freight moves—and is anticipated to move—in New York State and how it supports the state’s economy;  
- Create a structure for continuous interaction between freight stakeholders and NYSDOT;  
- Identify priority near- and long-term investment needs for freight infrastructure and operations; and  
- Provide a roadmap for investing in freight supportive projects and programs that foster economic vitality and quality of life for New Yorkers. |
| Goods Movement Action Program for the New York-New Jersey Metropolitan Region | G-MAP is a joint initiative of PANYNJ, NJDOT, and NYSDOT. Some of the early action technology-related items in the plan include:  
- Developing a Regional Strategic Plan for commercial vehicle enforcement operations;  
- Streamlining the permitting process for OS/OW vehicles, including coordinating existing agency permitting web portals; and  
- Integrating ITS components—such as real-time traffic and truck routing information, WIM, and shared enforcement information—to improve truck operations along I-95. |
<table>
<thead>
<tr>
<th>Programs\Initiatives</th>
<th>Description</th>
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<tbody>
<tr>
<td>Demand Management in New York State</td>
<td>The framework recognizes freight’s differences from passenger traffic. Freight movement is typically multi-jurisdictional, interregional, and affected by global economic factors. Freight involves a different set of stakeholders. Freight transportation providers employ a diverse fleet of vehicle types with an array of different vehicle sizes and weights and different cargo types. Finally, freight has unique issues and constraints (HOS rules, turning radius, restricted routes) that need to be considered if looking at dynamically shifting traffic. In urban areas in particular, there is a need to consider potential conflicts between needs for truck loading/unloading, street parking, bicycle lanes, and transit. Strategies included in the framework include:</td>
</tr>
<tr>
<td></td>
<td>• Create a Statewide Freight Web Portal. A freight web portal focused on the needs of truckers would provide targeted information designed around the needs of the freight community.</td>
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<td></td>
<td>• Develop a road and traffic condition reporting application for truckers. Technology can allow truckers to report road conditions or problems straight to DOT.</td>
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<tr>
<td></td>
<td>• Create a statewide freight coordinator role, and increase partnerships with the freight industry, including shippers and carriers.</td>
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<td></td>
<td>• Create freight-emphasis corridors to focus on specific improvements to freight. Selected corridors can include truck facility improvements, travel time messaging, border wait times, incentives to shift times and routes.</td>
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<tr>
<td></td>
<td>• Develop and pilot strategies for the last mile of freight. These have been proposed, including several operational options to reduce the number of vehicles in circulation, number of supply trips, mileage, and transport related air pollutant emissions, and noise.</td>
</tr>
<tr>
<td>Programs/Initiatives</td>
<td>Description</td>
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<td>--------------------------------------------------------</td>
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<tr>
<td>NYS DOT’s Office of Modal Safety and Security</td>
<td>The mission of OMSS is to promote the safe transportation of people and goods in New York State, and to assist passengers and freight transportation providers in establishing proactive safety, consumer, and accident prevention programs, and in complying with safety and regulatory requirements. The OMSS oversight authority encompasses bus safety, truck safety, rail safety, motor carrier safety and compliance, commercial vehicle credentialing, and permitting and security program monitoring and coordination. OMSS is involved in multiple programs to apply technology to its missions. For instance, recently OMSS conducted a research project to deliver warnings to drivers nearing roll over hot spots through the Drivewyze Preclear platform. NYSDOT is trying to encourage Drivewyze to expand the capabilities of their system to include this and other safety features. This research is documented in the report, “Drivewyze Safety Application: Crash Data Analysis and Safety Message Design, Phase I: Roll Over Crash Hotspots in New York State.” NYSDOT drilled down and pulled accident records to identify roll over hotspots. They also conducted research on the best way to provide a safety message to drivers. There are a handful of sites piloting this and they can see that drivers are responding to the message by slowing down from analyzing telematics data. Other major OMSS technology initiatives include the “Highway Oversize/Overweight Credentialing System” and the “NYS Commercial Vehicle Screening Program,” which are described separately below.</td>
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| NYS Commercial Vehicle Screening Program                | Over the last decade, NYSDOT has developed a mainline, high-speed commercial vehicle screening network as part of FMCSA’s ITD Program. New York State’s e-Screening program is managed by NYSDOT in partnership with other New York State agencies that have a responsibility in safety, asset management, and compliance, including but not limited to the NYS Departments of Tax and Finance and Motor Vehicles as well as the Division of the NYSP. The program utilizes a dedicated screening communications network and roadside ITSs that integrate various components including:  
  - License plate recognition and overview camera systems and 915 MHz and 5.9 GHz DSRC to uniquely identify the commercial vehicle;  
  - WIM devices to determine vehicle class, length, axle distances, axle weights and gross vehicle weight, capable of meeting FHWA’s traffic monitoring data requirements, and;  
  - Other technologies to supplement the above core components, depending on the location, including USDOT number reader systems, over-height detection, and real-time traffic monitoring. |
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<td><strong>The integrated screening systems use network based software and databases to screen commercial vehicles traveling at highway speeds for size/weight and credentials compliance.</strong> The system presently can check the following:</td>
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<td>• Vehicle class, size, and weight</td>
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<td>• NYSDOT oversize/overweight permits</td>
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<td>• International Registration Plan (IRP)</td>
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<td>• International Fuel Tax Agreement (IFTA)</td>
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<td>• Federal Motor Carrier Out-of-Service carriers (PRISM)</td>
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<td>By using a dedicated network, all sites utilize the same web-based application and operating software, eliminating the need to load software onto individual computers, and simplifying training since each location operates in the same fashion. In addition, the network also provides the same data to each site, which eliminates any disparity in data accuracy and reliability.</td>
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<td>The pre-screening information assists roadside enforcement personnel in making more informed decisions concerning which vehicles should be stopped for further enforcement activities. Since the systems capture commercial vehicle information 24 hours a day, seven days a week, it provides a rich data resource for planning and programming purposes.</td>
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<td>The benefits of e-Screening-based enforcement operations include:</td>
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<td>• Providing enforcement personnel with more information to help focus safety inspection and weight compliance operations on those vehicles that may have a greater probability of non-compliance with federal and state regulations;</td>
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<td>• Allowing enhanced asset management of existing infrastructure by improving the efficiencies of roadside weight enforcement operations;</td>
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<td>• Improving the overall benefit/costs of roadside commercial vehicle enforcement operations; and</td>
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<td>• For those sites with bypass capability, the systems assist in reducing the overall carrier and freight shipment costs of compliant vehicles.</td>
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<td>The initial screening site was deployed along westbound I-90 W in Schodack (Rensselaer Co.) in 2008 while the second installation was constructed along I-95 N on the approach to the Alexander Hamilton Bridge in Manhattan (New York Co.) in 2014. Four additional sites located in the Albany and Hudson Valley regions came online in the spring of 2017.</td>
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<td>NYSDOT is also evaluating the deployment of screening technology on the Kosciuszko Bridge on the Brooklyn Queens Expressway. By the numbers, the Kosciuszko Bridge is the largest single construction project and the Alexander Hamilton Bridge rehabilitation project is the second-largest single contract construction projects ever undertaken by NYSDOT. Based on the benefits the deployment of such screening systems provide (discussed above), it is recommended that a formal policy be explored on the inclusion of screening sites on all large infrastructure projects that the Department undertakes.</td>
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<td>Highway Oversize/Overweight Credentialing System</td>
<td>NYSDOT is advancing a Department-wide management system encompassing comprehensive permitting software integrated with GIS functionality that can be configured to support the Department’s needs for use as a HOOCS, which will (1) improve NYSDOT’s OS/OW permit workflow activities; (2) provide better data consistency; (3) resolve several process issues implicit in the stovepipe nature of the Department’s/State’s current applications and disparate systems/databases; and (4) support future Department-wide plans, processes and operating environments. The goal is to implement a COTS HOOCS software solution and to obtain the accompanying integration services necessary to fulfill NYSDOT’s Central Permitting Bureau’s business requirements. HOOCS will benefit other participating permitting agencies and their customers. The outcome will be a scalable/configurable enterprise solution capable of supporting future technologies and offering more permit application types in nature. The effort entails the modernization and convergence of related but separate NYS applications to produce an advanced system with automated routing capabilities and structural analyses of bridges. The HOOCS project commenced officially in January of 2015, with ProMiles Software Development Corporation selected as the vendor. In the interim, NYSDOT has reached out to local, city, state, and regional agencies to recruit organizations to take part in this modern, scalable, and highly flexible permitting application as integrated permitting partner agencies. At launch, additional participants will include the NYS Thruway Authority and NYS Bridge Authority. After the initial launch of HOOCS, NYSDOT will continue pursuing integrated permitting partnerships with other OS/OW permitting jurisdictions to grow the one-stop shopping concept. The development process is ongoing and a soft launch of HOOCS is scheduled for Winter of 2018.</td>
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<td>Commercial Vehicle Infrastructure Integration program</td>
<td>The CVII program focuses on developing, testing, and deploying CV technology for heavy vehicles. Since its inception, the CVII program has developed numerous V2V and V2I applications for trucks that leverage communication with roadside infrastructure and other light and heavy-duty vehicles to meet the objectives of the program. The program was made</td>
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| Coordinated Intelligent Transportation Systems Deployment in New York City | The CIDNY project funds multiple different ITS strategies and systems in New York City. These include:  
- The application of ATDM strategies along critical multi-modal highway/arterial street corridors  
- A multi-agency/multi-modal construction management tool  
- Development of packages of dynamic data collection of vehicular movement and conversion of real-time speed data for identifying traffic speeds  
- An introductory course on TIM response developed for transportation operators, customized to address unique congested condition of New York City highways  
- A comprehensive guide to traffic signal timing, new detection technologies and advanced signal timing concepts applicable in New York City  
In addition, research is being conducted on pedestrians’ and cyclists’ safety using ITS Technology in New York City. A data storage and access platform for MTA bus time data is being developed. |
| The Integrated Corridor Management Initiative Project    | NYSDOT has been involved for a long time with the TIM activities and coordination that comprise the core elements for an ICM program.  
Within the New York/New Jersey/Connecticut region, TRANSCOM provides the data collection, fusion, and dissemination that can be used to coordinate ICM operations. TRANSCOM is a coalition of 16 transportation and public safety agencies in the New York, New Jersey, and Connecticut Metropolitan region that was created in 1986 to provide a cooperative, coordinated approach to regional transportation management.  
The Buffalo-Niagara Integrated Corridor Management Project is an ongoing ICM project focused on improving traffic operations in the area around Buffalo and the Niagara border crossing region. This is described in more detail below. |
| Buffalo-Niagara Integrated Corridor Management Project    | The objectives of the Buffalo-Niagara Integrated Corridor Management Project on I-190 are to optimize traffic operations by identifying effective traffic management strategies to mitigate congestion and the associated environmental impacts. The project involves the development of a data-driven decision support tool for:  
- Congestion management on critical transportation corridors in the Buffalo-Niagara Region that provide access to New York State’s bi-national border crossings  
- Development of Buffalo-Niagara Border Crossing Corridor Management Plan |
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<td>Building upon the ICM vision by focusing on recurring and non-recurring congestion, which affects commuters in the downtown Buffalo area, and the re-routing of traffic to other border crossings in the area due to issues at the Peace Bridge and on the I-190 corridor</td>
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<td>The Automated Border Wait Time (BWT) Measurement program was established to measure wait times at three international crossings in the Niagara area, Peace Bridge, Queenston-Lewiston Bridge, and Rainbow Bridge. The Bluetooth-based system was deployed as a discrete vehicle re-identification system, identifying specific individual vehicles at multiple points along a trip through a measurement zone. The system consists of a series of sensors that detect individual Bluetooth devices passing through segments of the trip.</td>
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<td>Niagara International Transportation Technology Coalition: Advanced Transportation and Congestion Management Technologies Deployment Initiative</td>
<td>The Niagara Frontier Transportation Authority received a $7.8 million grant from FHWA to fund the project Connected Region: Moving Technological Innovations Forward in the NITTEC Region. This provides funding for CV applications using multiple communications technologies to alert truckers of border wait times and available parking to reduce congestion in the Buffalo-Niagara area. This grant has funded some important projects to advance the Buffalo-Niagara Integrated Corridor Management Project described above.</td>
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<td>• One important aspect of this comprehensive initiative would involve the integration of the border wait-time system with EcoTrafix dynamic integrated mobility management system, with a specific goal of providing border wait-time data to commercial vehicles through V2I applications.</td>
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<td>• There is consideration of engaging freight users around CVs as part of the grant; however, the nature of this activity is still being finalized.</td>
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<td>ICM-495 Concept of Operations Study</td>
<td>Partnering agencies and authorities in the New York/North Jersey Metropolitan Region have engaged in significant dialogue to support the development of a Concept of Operations Study for the ICM-495 Corridor that would entail deployments of traditional and innovative TMSs, an all-encompassing term that generally consists of ATDM and ITS concepts and solutions.</td>
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<td>Champlain International Border Crossing</td>
<td>To enhance the safety and security at this important international border crossing, NYSDOT in conjunction with the NYSP is advancing the design and construction of a NYS highway safety patrol and commercial vehicle safety inspection facility to be located 2,000 feet south of the CBP facility in the Town of Champlain in Clinton County, along I-87 southbound. The facility will accommodate highway safety patrol operations carried out</td>
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<td>by the NYSP in the region as well as the aforementioned commercial vehicle safety inspection activities performed by NYS DOT and the NYSP. This will incorporate state-of-the-art ITS technologies, such as WIM devices and electronic screening equipment (including license plate recognition camera systems), which will allow commercial vehicles to be pre-screened for valid credentials and weight compliance (on a 24/7 basis) as they exit the CBP facility and approach the planned Champlain facility.</td>
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<td>NYSDOT Clean Technology Freight Award</td>
<td>NYSDOT funds emissions reduction projects through the Congestion Mitigation and Air Quality Program. Freight projects are eligible, but the program is not specifically for freight. For example, in the most recent solicitation, an award of $4,630,400 was made to the Western New York Region to partner with Norfolk Southern Railroad to replace two local and yard switcher locomotives with clean technologies. NYSDOT and Norfolk Southern Railway Company will replace two Local and Yard Switcher Locomotives currently located and operating within the Norfolk Southern Bison Rail Yard (Erie County) with engines achieving EPA Tier 4 emission standards with eight shorepower stations. Total Project cost is $5.788 million.</td>
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<td>Designation of Alternative Fuel and Clean Freight corridors</td>
<td>The FAST ACT requires the USDOT to designate alternative fuel corridors. NYSDOT submitted an application to FHWA to designate Alternative Fuel Corridors in New York based on the availability of fueling stations in these corridors. Based on this application, FHWA has designated Clean Freight Corridors in New York. NYSDOT has also worked with NYMTC to designate Clean Freight corridors in New York City in conjunction with the Northeast Diesel Collaborative Clean Freight Corridors Workgroup.</td>
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<td>Positive train control</td>
<td>In May 2017, NYSDOT received a $33.75 million grant to implement the Advanced Civil Speed Enforcement System (ACSES) Positive Train Control (PTC) system on the Amtrak-controlled section of the Empire Corridor Hudson Line. A full PTC system will be constructed, along with all hardware, software, and databases required for the ACSES system. NYSDOT is also working with the railroads and other key stakeholders to implement PTC on other rail lines throughout New York.</td>
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<td>Rail freight border crossing screening – electronic manifests</td>
<td>Freight rail border inspectors now receive the electronic freight manifests in advance so they know what cargo to expect, and the rail cars then pass through the VACIS to confirm content. There is currently little demand from railroads for a more extensive program for preclearance.</td>
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<td>Unmanned aircraft systems designated test site</td>
<td>In 2014, NUAIR and Griffiss International Airport were awarded a $4 million state grant to install instrumentation to track unmanned aircraft on a test site designated by the FAA. One of the challenges facing the unmanned aircraft industry is the inability to meet the FAA’s requirement that drones</td>
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<td>be able to see and avoid other aircraft, which is not easy for them to do because they are controlled remotely by a pilot on the ground, who may be miles away. This project gives ground-based pilots the information they need to keep unmanned aircraft clear of other aircraft. FAA designated a 50-mile drone corridor from Rome to Syracuse as part of the project. In 2015, the NUAIR site was awarded an additional $600,000 grant from Empire State Development Agency.</td>
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Appendix B- Technology Needs, Gaps and Priorities Identified by NYSDOT for Freight

NYSDOT has identified the following technology needs during a meeting with the research team.

- The key to advancing CV technology for trucks is completion of the rulemaking requiring DSRC in light-duty vehicles. This will allow broader possibilities in real-time vehicle-to-vehicle communication. Trucks are not currently included in the rulemaking, but many believe that the industry would support the addition of heavy-duty vehicles once information becomes available from other vehicles. Broad-scale adoption of DSRC will unlock the benefits of CV and real-time communication between vehicles especially from a safety perspective. NYSDOT could play a role by urging the National Highway Traffic Safety Administration to complete its rulemaking.
- The delivery of data to trucking companies and dispatchers needs to be improved. Distributing the 511 data more efficiently would increase its use. This could be done through the creation of a data portal that could be accessed by a number of third party information providers. Information on road conditions and road closures needs to be available to truckers in real time to make it actionable.
- The current fragmentation of the 511 information across states and regions makes it difficult for interstate truckers to use. In addition, there is too much emphasis in 511 programs on the development of custom tools to extract data. The data are currently being provided in too many formats to be easily accessed and used. Improving the underlying data while enhancing the ability of third parties to distribute this information may be a more effective strategy to distribute the information.
- Data in the 511 database provides only height restrictions, which is just a small part of the available data. Additional data fields could be added, but there is no universal policy for this and there could be liability issues associated with moving to a more open data system. Ideally, NYSDOT would seek to provide data that defines the environment for which the agency is responsible.
- NYSDOT should pursue a pilot location to provide a demo of the one-stop shopping concept for real-time roadway information for truckers. Once the one-stop shop is in place, delivery could be accomplished via various third party services such as Sirius XM, TANY/freight-specific portal, HOOCS, or other appropriate platform.
- There are opportunities to encourage vendors to provide roll over and curve speed-warning applications that are integrated with infrastructure elements. The data exists to identify the areas that are safety risk hotspots. Drivewyze and other telematics platforms could deliver this information to drivers (via VMS signage in-vehicle). Additional research is required to demonstrate and pilot this technology. Further, vendors need to understand what the value is for their customers and their business models. NYSDOT has urged Drivewyze to consume valuable data, but they are not fully realizing the potential of this data.
- There may be opportunities for identifying vehicles that are off-route based on their height and weight. Warnings could be provided to drivers concerning bridge clearance heights or weight restrictions. It is possible to integrate functionality into the vehicle and its software systems that would safely shut down vehicles that are in danger of driving under bridges that are too low or otherwise in danger of causing grave safety risks. These more advanced forms of safety
automation will likely take longer to implement given the resistance to removing control of the vehicle away from the driver.

- There also may be opportunities to expand automation further in roadside enforcement. These include systems such as the Drivewyze automation of Level 3 roadside inspections (in pilot testing). Weigh station bypass is currently provided at New York mobile weigh sites by Drivewyze. In general, vehicle to roadside communication via cell phones, transponders, or other in-cab equipment can act as a proxy for roadside screening, greatly reducing the cost of enforcement, and increasing its effectiveness. It could provide a quick way to check the credentials of trucks, including their registration and permits.
- There are technology issues with border inspections that slow border crossings. For instance, radiation portal monitors have many false positives (kitty litter can set them off).
- Bi-national authorities are considering joining HOOCs and expanding the use of automated permitting and enforcement systems that can improve freight operations at the border and elsewhere. Automated permitting can also help to streamline the movement of emergency supplies during disaster response and recovery.
- A better understanding is needed of what new data sources are available and how they can be used by NYSDOT. For instance, there is a proliferation of system data from Google, Waze, and others, but it remains unclear how this data may be used to improve performance measurement and tracking across the supply chains.
- Consideration is needed of what planning data can be collected. Can we use data to drive planning and operations? There is a need to use data on ongoing loadings/measured truck weights to determine if NYSDOT has over-designed or under-designed roadways.
- Credentialing systems can be used to assess carrier compliance and to provide data for planning.
- Continuing the expansion of HOOCs is an important priority. The first county is going online and will be automated soon. By fall 2018, NYSDOT plans to have seven agencies in the system. Once permits are in the system, it is easy to feed the permits to preclear vehicles. This does require carrier certification.
- NYSDOT currently has a lot of spatial information and geo-data, but not a delivery method. There are services that could be provided that would be useful across the department. For instance, providing lane closure information to those in charge of permits can facilitate the routing of currently permitted vehicles. Currently, the delivery mechanism for planned work zone events is email. In the future, delivery of information in real time to the cab could make it more actionable.
- Better information is needed for vehicle routing and grade crossing safety. For instance, lowboy trailers can get hung up on some tracks, or traffic can back up across tracks causing a safety hazard. Better information is needed on safety assessment for risk for grade crossings. Some crossings might require flag people to facilitate movements. Tying all this information into a uniform spatial platform would be useful.
Identification of Near-term Objectives for Freight-Related User Needs

- Fixing the core transportation system, which benefits both freight and non-freight users, may be one of the most valuable things that NYSDOT could do for freight. NYSDOT could identify where there are recurring queues and target strategies toward these. NYSDOT could document what the response time to accidents is in different locations. Quicker response and cleanup of all accidents could reduce secondary accidents, including those associated with trucks.

- NYSDOT investments in improvements for operations that benefit all vehicles could be targeted toward key freight corridors, and could have a significant impact on freight. These investments should include synchronizing traffic signals, which is one of the most significant things NYSDOT can do to improve operations.

- Most of the data products needed by carriers do not require information on the carrier’s operations. For instance, timely and accurate data on road conditions can be very useful to carriers if it is provided in the right format. Providing information on road closures and other information about current conditions is an important role for NYSDOT. Improving the quality and accessibility of 511 and other information to third party providers is needed.

- There is a need to provide an integrated source of data from multiple 511 systems. This would make the system more useful for trucks that currently travel through states and localities served by numerous different 511 systems.

- Accuracy and reliability in the data about current conditions is important to the operation of supply chains. NYSDOT needs to get better information out to the decision points where truckers make decisions about which routes, bridges, and border crossing they select.

- Providing for the safe operation of supply chains during emergencies is important. Making sure the roads are plowed and passable is critical during emergencies to ensure that important pharmaceuticals, food, and other supplies continue to flow. Truck turnarounds are needed at some border crossings to facilitate the movement of vehicles during heavy snow and ice conditions.

- The Free and Secure Trade (FAST) program provides expedited service across the border for preapproved carriers. More FAST lanes are needed to speed freight between the U.S. and Canada. FAST lanes often do not extend far enough back from the port of entry, which means truckers meant to benefit from the FAST lanes are stuck in traffic with other vehicles until shortly before their arrival at the border.

- Expediting the implementation of statewide barrier-free tolling statewide is important. In New York City, all of the MTA’s nine crossings have installed elevated gantries with sensors that read E-ZPass transponders and cameras to capture license plate images for cars that do not have E-ZPass. The Governor of New York has proposed eliminating toll booths from the New York State Thruway by 2020 by using similar cashless tolling technology.
Gaps or Identified Areas of Exploration for Future Tasks

There are a number of gaps in the data available for commercial vehicles. Additional data on emergency parking locations is needed. In addition, providing information on where plow trucks are could help commercial vehicles delivering critical supplies in an emergency.

Further exploration of how technology could allow vital information from the vehicle to be communicated directly to emergency responders/dispatch centers could be fruitful (e.g., relay placard information, relevant material safety information, etc). During extreme weather events and emergencies, it would be interesting to see how technology can be used to identify the location of stranded trucks that supply hospitals, service waterworks, food warehouses, etc. to determine which routes should be cleared/repairs first.

Fragmentation of traveler information among information providers is an additional problem, particularly with multiple 511 systems. There is a need to develop a strategy to provide information from multiple 511 systems seamlessly to commercial vehicles. Improving the quality and usefulness of data is also very important. It may be the case that NYSDOT should focus more on improving the quality of the data, and rely on third parties to disseminate and format data to better meet the needs of different users. There is also an opportunity to consider examples of different state freight portals in this research and identify any lessons learned from these that would be useful for NYSDOT in helping to integrate their data on road conditions with that of other organizations.

NYSDOT is not ready to specialize/customize information for commercial vehicles. This is a related but special challenge. They would need information on the cargo and destination. The most important current challenge is to improve the basics of IT information flow. For more specialized data for commercial motor vehicles, they will likely need a cooperative group to merge information, similar to the Trusted Truck program.

In the future, there will likely be an important role for drones for bridge inspections and situational awareness. Drones are being tested and deployed in a number of different highway agencies. BNSF Railway Company is also using drone technology to inspect rail lines. The role of drones in the freight transportation is less clear and hard to predict. Policymakers are unclear how significant their role could be and what infrastructure needs exist (assuming there is a significant market).

Automated truck technology’s implication on land use along travel corridors and along the first/last mile (e.g., curb parking management) is an area worthy of further exploration. The use of storage lockers and other innovations is also interesting. Policymakers are unclear on what their implications may be. Developing a framework to characterize the risks associated with these new developments, their likelihood of happening, and the opportunities that exist for NYSDOT could be useful.

In the Syracuse region, there is ongoing discussion about potentially developing an inland port facility as an extension of the existing CSX intermodal railyard in DeWitt. Additional research on related technologies that could be incorporated into inland port operations and surrounding facilities would be useful. This could include an assessment of U.S. Customs technological operations, especially as it relates to safety and security (from a local as well as a national homeland security perspective).

While transportation providers often obtain OS/OW permits through automated permit systems, there is still a need to streamline permitting and provide consistent regulations with neighboring U.S. states.
Differences in permitting regulations between states add time and cost to the permitting process for the movement of interstate cargo. Developing more information about how regulations vary between New York and neighboring states is needed, as a precursor to addressing this issue.

Considerations for Including Items in New York State Freight Policy and Freight Plans

A truck parking inventory and any relevant technology solutions should be included in the freight plan. A previous survey of truck parking showed that in most areas there was capacity, but this is dependent on the corridor or area. There are certain areas/corridors where truck parking supply is adequate and areas within the state where truck parking demand exceeds supply. Generally, similar to most states, New York State’s truck parking capacity issues tend to be in and around major urban areas such as New York City. One question is whether NYSDOT needs a way to conduct a capacity analysis on an ongoing basis to continually assess the demand and availability of truck parking. The factors that influence demand for particular truck parking areas that are congested are not well understood. Often, other truck parking spaces nearby go unused. It is important to note that there are truck parking issues on non-state roads, and consideration of this problem is also needed.

Focus recommendation on key priorities:

- Support programs to facilitate trade across international borders, including technologies such as NORPASS, HOOCS, the screening facility in Champlain NY, e-Screening, and others.
- Focus on operating the system. Improving operations for all vehicles will also help alleviate key freight bottlenecks.
- Seek opportunities that provide real-time operational Information that can be pushed out to the driver or dispatcher to affect route planning.
- NYSDOT should focus on managing and delivering spatial and geo-data. Exploit opportunities for enhanced mapping and geo-fencing applications.
Appendix C: Emerging Practices in Freight Technology

This section discusses emerging practices in the use of technologies for freight systems, as seen in literature on existing systems and pilot programs. In some cases, technology is established, and determinations can be made on best practices according to experience with pilot demonstrations or existing programs. In other cases, such as with CV technology, many applications are still in testing and suggestions of best practices are largely conjectural, hence why these are collectively termed “emerging practices.” This section discusses these nascent technologies in addition to established ones since they have potential to be either directly harnessed by NYSDOT to improve the freight system, or because they have an impact on NYSDOT freight programs and operations.

Emerging practices are explored in the following four areas of focus: Mobility; Safety and Security; Supply Chain Efficiency; and Environment and Energy Efficiency. These were identified based on the interviews (Task 2) and discussions with NYSDOT (Task 1).

Mobility

This section includes the discussion of technologies and strategies associated with the collection, compilation, and dissemination of reliable data for consumption by customers through a variety of delivery options to improve the availability of actionable, dynamic information for freight operations (weather, construction, closures, detours, managed use lanes status, incidents, truck parking, etc.). These strategies include partnership opportunities to improve operational data sharing and availability of actionable information to improve freight operations.

Transportation System Management and Operations Program Resources and Strategies

Technological systems offer several avenues for supplying accurate, real-time data on weather and other road condition parameters to commercial vehicles. This data can help improve safety and trip planning for freight operations. Both public and private entities have designed programs to disseminate this information in a timely fashion that is cheap and convenient for truck drivers. An example is the Wyoming DOT Commercial Vehicle Operator Portal. The portal is free to users after registering, and delivers 72-hour forecasts for weather and road conditions on major corridors throughout the state.¹ These data are supplied by WYDOT staff trained in meteorology. Alternately, Vermont harnessed an existing social media platform, Twitter, to disseminate information on road delays. The Vermont 511 system, which was lauded by interviewees as a successful innovation, uses a Twitter feed to release updates on road delays, inclement weather, and other conditions.


Emerging Practice: Targeting Information to Users

- The Vermont 511 system uses a targeted Twitter feed to release updates on road delays, inclement weather, and other conditions.
- Minnesota DOT developed a new app, specific to truckers, which can be used to alert truckers of conditions on their chosen route.
- Thirteen states utilize data from Waze to assist with vehicle routing.
- Geostamp, DrayQ, and Metropia provide information on delay at border crossings and ports.
other conditions. Both strategies could be valuable to NYSDOT, with the former being more comprehensive and the latter having the benefit of lower cost. Information can also be provided with specialized applications. For example, the Minnesota DOT developed a new app, specific to truckers, which can be used to alert truckers of conditions on their chosen route.\textsuperscript{2} Private companies are also engaging in this space, with recent announcements by the Weather Company to provide a mobile phone app with localized weather forecasts and emergency alerts tailored to trucking needs.\textsuperscript{3}

Efforts could also be geared toward giving information to shippers and fleet managers. Current fleet routing optimization software does not include information on real-time road conditions, but if data were provided in the correct format, then these programs may be able to integrate it, thus helping limit instances of trucks being dispatched on congested routes and furthering the congestion.

The private sector also provides options to fleet managers for optimizing fleet performance. For example, companies such as Omnitracs and Telogis have developed fleet management tools that, in conjunction with on-board monitoring technology, can provide managers with information on vehicle locations, usage, idling time, and other operational parameters. In general, real-time suggestions on routing based on weather, road condition, and traffic conditions are more useful for regional travel than for local drayage applications, since drayage operators are often intimately familiar with a given region.\textsuperscript{4}

Big data collected by private companies can also be of use to state DOTs. Thirteen states and many other local governments have all harnessed private sector data from Waze, a routing application that suggests routes based on traffic conditions, under the Connected Citizens Program.\textsuperscript{5} For example, Florida DOT made a two-way data-sharing agreement with Waze where both parties benefitted from an additional data source. Waze uses DOT location data on construction sites, events, toll facilities, speed limits, evacuation routes, and emergency shelters to improve its routing algorithms, and the Florida DOT can access Waze data to assist in managing traffic and to identify certain events.\textsuperscript{6} Waze data can also be used to fill federal requirements for DOTs to supply real-time traffic and weather information for routes in their jurisdiction, thus removing the need for additional instrumentation.

Innovation is also underway in methods for distributing information on wait times and traffic at congestion points such as ports and borders. For example, the Port of Oakland has developed a mobile phone app called DrayQ that provides truck drivers information on wait times to enter terminal gates, and estimates on the expected time to complete a transaction. Fliers to promote the application were

\begin{itemize}
\item \textsuperscript{3} Truckinginfo. 2017. New Weather App for Truck Drivers Boasts Aviation-Style Forecasting. \textit{Retrieved from:} goo.gl/m17aVH
\end{itemize}
handed out to truckers at the port, and over 150 people signed up in the first few days. A similar app, called GeoStamp, is being used by many shipping companies and operators at the Los Angeles-Long Beach port. The GeoStamp app shows loading and congestion information within the port area, and is used by truckers for real-time information, as well as by terminal operators who look at aggregate data to determine patterns, bottlenecks, and areas for improvement. Some best practices for implementing these sorts of information systems are to promote them to local truckers and to show estimates of wait times.

Another example is the PANYNJ’s e-Alerts system, which is a free subscription service that notifies customers of incidents or events that may delay or otherwise affect their trips or business at various PANYNJ facilities. When customers register, they receive free alerts directly to their phone or email account and they are able to select the facilities as well as the time ranges they wish to monitor. Alerts range from delays and service changes on PATH to delays at PANYNJ crossings and marine port road closures or changes to port terminal schedules.

National borders present unique challenges for transportation. On the southern border of the United States, the city of El Paso has recently partnered with Metropia, a routing/traffic information company, to improve border wait times. The Metropia app will give users information on current wait times, as well as projected wait times for all times of the day, thus empowering border crossers to choose optimal crossing times, and flattening out the traffic overall. The partnership will also assist in dispersing the border travel across the six crossings. The application is currently in beta testing and is free to be used by any entity. A similar application might be useful in some of New York’s major truck crossings at the Canadian border, although the effectiveness of the El Paso program is still being demonstrated.

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Emerging: Improved Traffic Incident Management

- Drones are being used for aerial accident scene surveillance.
- Colorado DOT uses information to contract towing units for heavy trucks at strategic locations along key corridors during high traffic or when storms were expected. The program used GPS data for all towing units to provide real-time information before, during, and after towing.

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Several technologies can also be leveraged to improve TIM methods and support more efficient traffic flow for freight vehicles. The 2010 *FHWA TIM Handbook* identifies the following established technologies that can be harnessed for TIM purposes:

- Closed-circuit television (CCTV) can provide multiple agencies with a shared operating picture of an incident scene. CCTV can monitor normal traffic conditions, verify the existence of an incident, and provide a view of progress toward clearance of the incident.
- Traffic detectors (which may already be in use for other reasons) can be used to identify oddities in traffic flow in real-time.
- Ramp meters can be used to increase freeway volumes, trip reliability, and freeway speeds, while decreasing travel time and the number of crashes. Transportation management centers can use data from lane and ramp metering to control flow into an incident scene and to facilitate a more rapid response of an emergency vehicle to an incident scene.
- Lane control signals can alert motorists of an incident in a specific travel lane or in a lane within a tunnel. Lane control signals provide motorists with advance warnings about impending lane closures, and are particularly valuable where physical separations exist at the entrance to a tunnel.
- Traffic modeling tools can help decision-makers evaluate implications and tradeoffs associated with various operational decisions, such as completely closing a highway to provide responders with time and space to clear an incident versus simply reducing traffic throughput by diverting a portion of this traffic to alternative routes.
- Adaptive signal controls can respond to and reduce traffic congestion, either on the primary route or on detour routes during incidents.
- Variable or dynamic message signs can be used to alert motorists about incidents, direct them to alternative routes, or provide estimated travel time past an incident.

In New York State, all of the approaches identified above are used. For example, the Adaptive Control Decision Support System (ACDSS) was deployed by NYCDOT, with support from NYSERDA. This system is an advanced real-time, signal optimization system that integrates online simulation with actual field traffic controllers and detectors. ACDSS has been successfully deployed in a 110-square-block area in Midtown Manhattan, where has resulted in a 10 percent improvement in speeds in this area overall. Additionally, newer technology such as drones may also prove to be a powerful tool for TIM. For example, unmanned aerial drones, equipped with cameras and other sensor equipment can be utilized for surveillance of infrastructure, assessment of traffic flow, and investigation of dangerous or inaccessible accident locations.

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Traditional methods of TIM, such as heavy truck towing contracts, can also be bolstered by technology. Previous towing contract programs have been successful. The Colorado DOT Heavy Tow Program was reported to benefit the state from a cost-benefit perspective at a 20:1 return. The CDOT program worked by contracting towing units for heavy trucks at strategic locations along key corridors, either during high traffic or when storms were expected. The program used GPS data for all towing units to provide real-time information before, during, and after towing. In the future, traffic and weather data could be used to trigger directions to the operators automatically.

**Active Traffic Management**

Transportation agencies also are using technology to better manage and operate transportation systems as coordinated networks. The concept of Integrated Corridor Management (ICM), developed by the USDOT, is the process by which transportation networks will realize significant improvements in the efficient movement of people and goods through institutional collaboration and proactive communication and integration of operations along major corridors, which may include interstates, arterials, and transit services. Through an ICM approach, transportation agencies manage the corridor as a multi-modal system and make operational decisions using real-time data to optimize performance across the corridor as a whole. Technology is valuable in the ICM process, both in supplying data and in evaluating it to make decisions. To assist in developing real-time responses to instances of traffic, multiple regions have developed decision support systems that gather ITS data and generate response plans. These responses are ranked by effectiveness and operating agencies can then opt to implement the plan, which can then be automatically implemented technologically through an integrated system.

As part of a response to specific conditions or as a routine exercise, data on traffic conditions can be disseminated to truck drivers and shipping companies through an ICM approach. In one ICM program, a smartphone app was developed for truckers, which could allow them to receive updated information on road and traffic conditions, and separate data tools were used to give information to dray companies on driver itinerary and load status. Programs in Chicago and Kansas using these types of systems found benefits in the form of fuel savings, reduced empty travel, and emissions.

To maximize the usefulness of the provided data, it ideally ought to include considerations of weight and size restrictions on roads, so that any proposed routes will be feasible for drivers. Getting accurate origin-destination data can be challenging given the competitive nature of the trucking industry, but aggregate data that can help inform a decision support system can be obtained from the American Transportation Research Institute’s Freight Performance Measures Database, developed in partnership with FHWA. The exact nature of which parties are involved in data sharing will vary, and there is no one-

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13 See footnote 10.
16 Ibid.
size-fits-all approach to forming an ICM-based data agreement, but including as many stakeholders as possible is generally advisable.  

Examples of individual technology service packages that could be deployed in ICM strategies could include network surveillance, traffic signal control, interactive traveler information, and others. These would all benefit from advances in data collection, data transmission (volume and speed), analysis (e.g., image processing), and algorithms for the rapid allocation of resources (e.g., emergency response).

Giving signal priority to freight vehicles can improve shipment efficiency and reduce emissions. A pilot program to harness connected and autonomous vehicle technologies sought to implement signal priority systems in Miami, where the perishable freight industry is a major contributor to the economy. The pilot, which is still underway, will eventually use CV technology to connect freight vehicles to traffic signals through the back-end systems at the local traffic management center. Once the vehicles are set up, the pilot will test the travel times with and without the system in place. A preliminary test found that guaranteed signal priority on a certain route cut travel time by approximately 70 percent.

While the Miami pilot program also includes vehicle autonomy, the signal priority applications are not dependent on vehicles driving autonomously, and if successful, the pilot could be a model for New York and other regions, assuming the proper equipment was installed on freight vehicles. Implementing signal priority at scale will require infrastructure investment, but the expected value of the system, particularly for corridors with high freight movement, makes it a valuable long-term strategy.

Active Demand Management

Private sector initiatives to implement dynamic pricing on shipments have the potential to flatten demand. For example, project44, a Chicago-based company, has introduced a central dynamic pricing platform connecting shippers and third party logistics companies, allowing brokers to adjust prices in real-time based on demand. Many other companies are experimenting with similar approaches to implement real-time pricing that allows for rapid market response to demand change.

Shifting deliveries to hours outside of normal commuting hours has a litany of benefits, including reduced traffic (for all), faster shipment times, lower fuel use and emissions, and more easily available parking. To encourage off-hour deliveries, authorities have the option of regulatory approaches, incentive approaches, or implementing a voluntary program. The New York City Off-Hours Delivery Pilot

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17 Ibid.
Program used a combination of the latter two options by encouraging companies to sign up for the pilot program, and then provided financial incentives to shipment receivers to design deliveries for between the hours of 7:00 PM and 6:00 AM. The program was deemed successful by many participating parties. Many receivers opted to continue to schedule off-hour deliveries even after the incentives in the pilot program ended.\(^{22}\) Research on the effectiveness of various approaches to incentivizing off-hour deliveries determined that programs similar to that in New York City, rather than with congestion pricing or traffic restrictions, have been most effective.\(^{23}\) Further, since many of the obstacles to off-hour shipment are related to issues of delivery, access to the drop-off point, or business constraints of the receiver, a program targeting receivers is a logical approach. Technology can play an important role in allowing receivers to feel comfortable with deliveries at off hours when their facilities may be empty, through cameras, shipment tracking, or locking devices that can be opened only by a designated shipper.

Simply providing real-time information on traffic flows is another way to implement demand management and flatten demand for trucking operations on specific segments, thus reducing congestion. Private data companies such as Waze and HERE both offer real-time congestion data that can be used by freight operators. Additionally, HERE and Waze also use historical data to forecast expected wait times. Efforts to increase usage of real-time traffic data could further flatten demand.

**Active Parking Management**

Technology can help alleviate parking congestion for freight vehicles by improving the utilization of existing parking facilities. Several projects have sought to develop applications that could provide real-time information on parking availability to truck drivers, as well as forecasting predicted availability. By improving knowledge of nearby parking options, it reduces the frequency in which drivers may be forced to drive beyond HOS requirements in search of available parking or park in an unsafe area. Parking information can also improve routing efficiency in instances where drivers are unfamiliar with an area and are unsure where to search.

Several Midwest states are starting a Regional Truck Parking Information and Management System (TPIMS), funded through a federal TIGER grant and state funds. The system will establish a network of safe parking areas that leverage sensor equipment to broadcast real-time availability. Final plans for the program are still underway, with launch expected in September 2018.\(^{24}\) A Minnesota DOT study affirmed that an automated parking tracking system was effective; sensors determining parking availability were correct nearly 100 percent of the time.\(^{25}\)

Other initiatives have sought to leverage data input from parking providers. For example, the California STP program grants real-time parking information to truckers via smartphone. A subsequent program by


\(^{23}\) See Footnote 22.


the California Air Resources Board—Reduced Emissions through Efficiency Parking for Trucks (REEPT)—enables real-time parking availability information and reservations and connects ports to truckers to notify them of spaces. REEPT also integrates traffic information from the third party provider HERE, which allows the app to not just display parking options, but to recommend parking locations based on traffic and HOS requirements. Both California programs focused on a corridor where a trucker survey revealed that 72 percent of drivers thought the system would be useful, and many indicated that they kept driving past HOS requirements because they could not find parking. A similar program in Michigan has been able to use video monitoring and sensors to communicate parking availability accurately to variable message signs up to 50 miles away from parking locations, allowing drivers to make informed parking decisions. Ideally, parking information services would not only show availability, but also allow drivers to make reservations in a convenient manner. Programs such as TPIMS do currently allow for this, but REEPT does by partnering with parking providers.

Other third party applications have also become available. For example, NATSO developed a free mobile app called “Park My Truck,” which allows any parking provider to report parking availability through the app. Other apps, such as Trucker Path, include parking availability in addition to weigh station and fuel stop location information. Lessons learned from these programs include that reservations are possible and valuable through partnerships with parking providers, and that sensory equipment is a viable method for disseminating real-time availability of parking spaces. In addition, it is valuable that parking information be provided directly to truck drivers.

It can also be valuable to provide information on emergency parking for trucks that can be utilized during extreme weather. The Maryland DOT has published an online map with information on available parking, with clean delineation of regular versus emergency parking options. The Maryland DOT also delivers this data through a mobile phone app. Ideally, this data would be packaged in a manner that allowed it to be integrated into third party applications.

Emerging Practice: Active Parking Management

- Eight Midwestern states are deploying the Regional TPIMS that establishes a network of safe parking areas that leverage sensor equipment to broadcast real-time availability.
- The California STP program, NATSO, and other organizations grant real-time parking information to truckers via smartphone.
- The California ARB REEPT also provides real-time parking availability info and most importantly, reservations.

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28 See footnote 14.
Safety and Security

Truck Safety on Roadways

Several technologies have potential to improve truck safety, such as CV infrastructure and leveraging big data to distribute size and weight warnings. V2I technology can take the form of warnings for unsafe curve speeds, potential red light violations, and unsafe weather-related conditions. In particular, curve speed warnings (CSWs) are especially valuable, and it is estimated that if widely deployed, they could prevent 169,000 crashed and 5,000 fatal crashes per year.\(^\text{30}\)

Curve speed warnings are being deployed as part of the Tampa-Hillsborough Expressway Authority Connected Vehicle Pilot. V2I can also facilitate size and weight warnings for freight vehicles in instances where they are approaching infrastructure (bridges, overpasses, etc.) that cannot support their size or weight. Since these technologies are still in their incipient phase, it is premature to propose best practices relating to the details of their implementation, but their potential suggests that piloting them is in itself a valuable investment. NYSDOT recently provided data on roll over hazard locations to Drivewayze in the hopes that curve speed warnings could be made available to the users of the Drivewayze technology platform, although this has yet to be implemented.

Safety improvements can also be garnered by sharing information on freight-specific route restrictions, such as instances of weight or height limits. The previously mentioned HERE database also includes information on truck-specific routing limitations, including weight and height limits, legal restrictions, the location of various warning signs pertaining to trucks, and other information. State DOTs have invested in means to provide similar data. For example, the Virginia DOT has a website where users can browse and zoom in on a state map and see truck-specific restrictions on various routes.\(^\text{31}\) It is unclear whether state-sponsored efforts to distribute this information are valuable in the presence of other private sector applications that can seamlessly integrate the restriction data into trip planning.

Regardless, providing this data in a streamlined fashion so that it can either be used directly by shippers or leveraged by third party data providers will help improve routing efficiency. In the future, drivers entering unsafe and/or illegal areas could receive real-time warnings via V2I connections. Road infrastructure could automatically translate warnings to incoming vehicles that had a data signature indicating a vehicle type that would be unsafe or illegal in a given area.

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Regulatory, Enforcement, and Security Technology

Automated permitting significantly streamlines the permitting process. NYSDOT is currently implementing the HOOCs system to automate permitting in New York. Examining how other states have done this may provide examples of best practices. For example, the Illinois Transportation Automated Permitting (ITAP) program has been identified as a model program. ITAP is an online system that allows carriers to log in, apply for a permit, obtain routing, and receive permission to move over state highways in minutes. In 2016, more than 230,000 permits were issued by the Illinois Department of Transportation, with 98.75 percent of those permits being fully automated.\(^{32}\) The Specialized Carrier and Rigging Association has documented that while 30 states have automated permitting systems, only 21 state auto-issue permits up to the threshold of 14 feet wide, 14 feet 6 inches tall, 110 feet long and 150K lbs.\(^{33}\) These states with high auto-issue thresholds are shown in gray below.

![Automated Permitting Systems with High Auto-Issue Thresholds in U.S. States](image)

Even states that have automated systems may still have a significant share of permits issued manually.

Efforts to automate and streamline WIM enforcement are also bolstered by technology. By using a license plate reader camera in conjunction with methods of detecting physical attributes, plate information can be cross-referenced to other known data related to the specific vehicle assigned to the license plate. An experimental demonstration of this technology by the Minnesota DOT found that the images would be valuable for identifying vehicles to present probable cause in court, but character recognition in their LPR system was “too low to use for other efforts such as targeting carriers.”\(^{34}\)

Screening vehicles to assess their credentials prior to enforcement is an important tool to improve the efficiency of the enforcement process. License plate readers (LPRs) are used throughout New York for a

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variety of purposes, including collecting data and screening vehicles at border crossings and weigh stations. While the technology has improved significantly in recent years, LPRs are still not able to read a significant number of the license plates in the traffic stream. Efforts to improve license plates to facilitate machine reading could make LPR technology more effective and possibly allow for wider scale use. Consideration of approaches used in Canada and other states could be useful for NYSDOT. Specialty plates with alternate backgrounds are harder to read than standard plates. Retro-reflective material for license plates is also helpful.

Automated and wireless roadside inspection of commercial vehicles could provide significant savings for industry and allow for more comprehensive inspections of heavy-duty vehicles. Automated, electronic inspections can combat data sufficiency challenges in traditional roadside compliance programs, which struggle to have enough data to assess vehicles. With the exception of load-securement, assessing drug and alcohol use and noting whether a driver is wearing the seatbelt, most of the key vehicle and operator condition criteria lend themselves to on-board electronic monitoring and diagnostic assessment. Further, new “e-Inspection” methods, as proposed by Drivewyze, can expand freight vehicle enforcement capabilities to include real-time driver and vehicle safety checks while vehicles remain in motion.

Programs demonstrating the viability of wireless roadside safety inspections are underway. While the technology is too new to yield best practices, the following program represents a strong approach to studying the new technology. The Federal Motor Carrier Safety Association (FMCSA) is funding the Wireless Roadside Inspection pilot (sometimes called the Trusted Truck® pilot). This program is currently piloting wireless inspection technology to test the feasibility of “electronically assessing truck and motor coach driver and vehicle safety at least 25 times more often than is possible using only roadside physical inspections.” FMCSA’s Trusted Truck® research pilot has accomplished the following:

- Phase I transmitted real-time truck brake condition data to the roadside inspection officer.
- Phase II research added functionality including initial implementation of the Trusted Truck® Management Center (TTMC), upgrading roadside communications, and increasing the number of safety-related items included in the wireless roadside inspection to include tractor and trailer weight, trailer tire pressure and temperature, trailer ID, and shipment data. They also demonstrated a “trusted” vehicle bypassing a roadside inspection using the TTMC as the method of delivering the inspection results.
- Phase III of FMCSA’s Wireless Roadside Inspection research is currently testing trucks equipped with electronic logs and telematics devices that transmit operator hours of service (HOS) and credentials to the roadside for inspection without the necessity of stopping. There are currently at least 20 Phase III test sites located along roadways in Kentucky, Tennessee, Mississippi, North Carolina, and Georgia.

Drivewyze is also currently testing a technology to transmit most of the information in a Level 3 roadside inspection in a four-state field test in Virginia, Maryland, Delaware, and Pennsylvania. This is being done in cooperation with enforcement departments in those states. The pilot works by equipping trucks with

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electronic logging devices capable of transmitting information to the roadside and to the Drivewyze PreClear bypass system. The technology can pre-populate almost all of the data elements on the Level 3 inspection form. The inspection officer then can walk up to the truck with an inspection form that is nearly completely filled out, and assess drug and alcohol use and whether the driver is wearing a seat belt. The inspector then presses a button to complete the inspection, greatly increasing the efficiency of the process. Drivewyze includes the capacity to automatically screen for compliance.

Under current rules, it is not possible to file a Level 3 roadside inspection completely without officer interaction with the driver. The Commercial Vehicle Safety Alliance (CVSA) guidelines for such inspections require that officers walk up to the vehicle, greet the driver, and assess drug and alcohol use and whether a driver is wearing a seatbelt. Given advances in technology, there may be a need for a different CVSA inspection procedure for electronic inspections. Currently CVSA has a committee considering what should be included in the e-inspection and how such inspections might be incorporated into FMCSA’s Compliance, Safety, Accountability safety-scoring program. Regardless of what CVSA may ultimately propose, automating inspections will bring efficiency benefits, and NYSDOT should look to prior pilot programs for insight as to how to implement these technologies.

New vehicle safety technologies provide additional capabilities that can be used to automate inspections. For example, on new vehicles the electronic stability control system knows how much the vehicle weighs. Information on the trailer weight is transmitted to the tractor and thus the Controller Area Network (CAN) Bus in the tractor knows the vehicle weight. This information can be queried electronically by enforcement to automate truck weight enforcement.

One barrier to the use of automated inspections is government rules concerning the use of information technology. For instance with electronic on-board recorders, some enforcement agencies cannot plug thumb drives into their systems. Some local police agencies do not allow Bluetooth linking. There is little standardization of rules for information technology and security. For instance, police and fire departments in the same town can have different protocols.

There are also opportunities to streamline enforcement at border crossings. There could be a move to standardize E-seal technology to allow inspection of the trailer when needed by law enforcement. Currently if the driver does not have the key fob to open the electronic seal, it cannot be inspected. If the driver does have the key fob, then they can open it up and put things in the trailer. There is currently a pilot program in Detroit to test a new E-Seal technology for ensuring the security of the trailer and its cargo, but facilitating inspections. Academic research suggests that E-seal technology increases supply chain efficiency and improves security, and it was also recommended by interviewees as a valuable approach to improving security.

36 Dills, Todd. 2016. FMCSA may add eighth BASIC to CSA system to satisfy carrier incentive program requirements. Commercial Carrier Journal. Published April 25, 2016.
Automated and Connected Vehicle Technologies to Improve Safety and Efficiency

Emerging CV technologies have potential impacts not just for safety, but also for efficiency. The three FHWA CV pilot projects represent some of the best examples of the application of this technology. In particular, the Wyoming Pilot has a strong freight focus. The Wyoming DOT expects to equip nearly 400 trucks with on-board units and install around 75 roadside units to enable V2V and V2I communication along I-80 by late 2017. CV technology will optimize freight by enabling new modes of operation, such as truck platooning, efficiency-improving automated manual transmissions, and service features like the ability to control a tractor from outside the cab with a tablet for difficult parking scenarios—all of which are expected to be available in the near future.

Platooning has the potential to reduce fuel costs and emissions by reducing the aerodynamic drag of vehicles, particularly larger vehicles in highway settings. Exact reductions in fuel economy will depend on vehicle make and the number of vehicles in a platoon, but studies of three-truck platoons found energy savings of approximately 10 percent among all trucks overall.\(^{38}\) Platooning in tight formations might be dependent on the development of autonomous driving capability for safety reasons, but it may still be one of the earlier CV applications to come to market since it does not require high adoption rates to be effective, unlike some V2V applications.\(^ {39}\)

Vehicle automation, in the long-term, has the potential to improve vehicle safety substantially, as the majority of crashes are from human error. Several states have begun testing of AVs either by allowing private sector tests, or by directly engaging in the testing. Maryland, for example, has applied to the USDOT to designate certain corridors as AV testing grounds. Already, there have been multiple demonstrations of autonomous driving for freight. For example, in May of 2015, Daimler Trucks was granted a road license for a self-driving heavy-duty truck. While still in its pilot phase, the implications of Daimler’s *Freightliner Inspiration* are significant and provide many of the same advantages as autonomous cars.\(^ {40}\) In October 2016, OTTO, an Uber-owned AV trucking operation, completed a 120-mile commercial trip on I-25 to deliver a beer load to an Anheuser-Busch InBev warehouse in Colorado Springs, Colorado.\(^ {41}\) By playing an active role in facilitating AV testing, public sector officials can best position themselves to keep apprised of best practices for AVs, infrastructure needs, and other issues. For example, in Maryland’s application for an AV testing corridor, data sharing with private entities to inform agency operations was a key aspect of the proposal. The potential for the technology to invoke

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substantial benefits suggests that taking an active role in accelerating and steering its development, through pilot programs and testing, is a valuable choice.

Some states are already beginning to plan for the deployment of automated vehicles. The Colorado DOT has proposed a road classification system with six levels that relate to the roadway’s ability to support connected and automated vehicles:

- **Level 1**: Unpaved and/or non-striped roads designed to a minimum level of standard of safety and mobility.
- **Level 2**: Paved roads designed to the American Association of State Highway and Transportation Official’s (AASHTO’s) standards with Manual on Uniform Traffic Control Device signage. There is no ITS equipment or infrastructure to collect CV data (Dedicated Short Range Radio). Access to cellular date service may be available.
- **Level 3**: There is ITS equipment operated by a Traffic Operation Center (TOC) and/or, one-way electronic data share between DOT/vehicle/user and/or, mixed use lanes.
- **Level 4**: Roadway or specific lane(s) has adaptive ITS equipment (i.e., smart signals hold for vehicles, highway lighting that turn on for vehicles) with TOC override only, and/or two-way data share between DOT/vehicle/user, and/or lanes designated for vehicle Levels 3 & 4 only.
- **Level 5**: Advance Guide-Way System roadway or specific lane(s) designed for vehicle Level 4 only with additional features that may include inductive charging, advance/enhanced data sharing, etc. Additionally, no roadside signs are needed as all roadway information is direct to vehicles’ on-board systems.
- **Level 6**: All lanes on a roadway designed for only vehicle Level 4 systems—no signs, signals, or striping is needed.

It may be useful for NYSDOT to consider if there is a need for any type of roadway classification system to facilitate the deployment of autonomous trucks or regulate their use. This classification could include information on communications connectivity, lane striping, truck operations restrictions, or other information.

**Supply Chain Efficiency**

Technological advancements are reshaping the connections and individual modes composing the supply chain. While there is rapid proliferation of proprietary tools to address certain elements of the supply chain, there is not necessarily an incentive for the market to create open source systems or interoperable systems. As such, government action may be necessary to maximize the efficiency of these technologies.  

**Last-Mile Delivery Technology Policies and Strategies**

Curb parking management is becoming especially important due to trends of urbanization and online shopping, which increase the demand for street space. Multiple cities are taking policy and technological approaches to improve the functionality of existing curb space. The Washington, DC District DOT (DDOT) introduced multi-space meters that can be used for dynamic pricing of parking, and also included

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42 See Footnote no. 25
metering of loading zones so as to be able to actually enforce rules on time limits in those zones. The latter effort was in response to concerns that the 15-minute limits on those zones were not being obeyed. As part of the Seattle DOT’s Freight Plan, they are investigating options for better utilizing their drop-off spaces, and for garnering new ones. One proposed idea is to allow delivery trucks to use spaces in off-peak hours that are currently reserved for other applications.

The National Association of City Transportation Officials has argued for the importance of applying technology to curbside management. They note, “With systematic implementation of existing technology, cities could charge for the amount of time a vehicle uses the curb, and account for and broadcast the availability of curbside spaces. These changes would quickly lead to better use and availability of curb space…. A real-time curbside management system could work on an instant reservation basis, where specific vehicles can automatically reserve times lots a few minutes in advance of arrival at a site, with the free market determining what they pay for the amount of flex zone time they use.”

Drones are also likely to have important impacts on package delivery in urban areas. For example, the Swiss company Swiss Post Ltd. and German automaker Mercedes-Benz have both started coordinating (independently) with California aerial drone manufacturer Matternet to test the feasibility of using aerial drones for package delivery through an integrated delivery service. Delivery by drones has many applications, including “delivery to peripheral areas” and for transporting emergency supplies. Additionally, major retailers like Amazon and UPS are preparing to begin using drones for delivery purposes. One UPS concept used delivery drones in conjunction with conventional delivery trucks, where the aerial drones shuttle packages from the truck to nearby doorsteps. While the technology for delivery by aerial drones is available, concerns over safety and logistics still need resolving, and regulations are under development. Given this, alternate forms of drones are also being developed for delivery purposes. For instance, companies such as Starship Technologies are already testing small, sidewalk-using, terrestrial delivery drones in U.S. cities. These drones operate with partial autonomy,
meaning that they can be remotely piloted for portions of routes if necessary, but otherwise operate independently.

Sidewalk drones are not explicitly prohibited in most places, but some states have passed laws to promote their use. Ohio, Florida, Wisconsin, Idaho, and Virginia have passed state legislation to explicitly allow the use of sidewalk delivery drones statewide. San Francisco is reported to be considering a ban on the use of drones on sidewalks in the city.

Alternative Modal Technologies
Technology can facilitate data sharing between public and private sectors, and between the various modes of freight transport, including rail, road, and sea transport.

**Big Data and Supply Chains** – There is a great opportunity to obtain and share large quantities of data with the private sector. For example, the Alabama DOT has worked with the private sector to collect data on corridor supply chains out of Mobile. They went to the customers of the port of Mobile and connected with 80 percent of the companies. They have developed a more detailed understanding of two-thirds of the traffic in the region and how it will affect highways in the future. Their approach to obtaining and using large quantities of freight data are innovative and potentially useful for application in New York.

**Supply Chain Performance Data** – More comprehensive data are needed on the performance of supply chains more generally. Planners and policymakers need to understand supply chains to characterize the dynamics that drive freight movement. While public agencies have invested in developing commodity flow databases and forecasts, such as the Freight Analysis Framework (FAF), information on how industry supply chains are organized, and may change in the future is more difficult to obtain. The organization of industry supply chains affect freight movement through decisions about sourcing, transportation, mode choice, warehousing, inventory management, and distribution.

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**Emerging Practice: Data Sharing**
- The Alabama DOT has worked with the private sector to collect data on corridor supply chains out of Mobile. They connected with 80 percent of the companies in the port of Mobile, and developed a more detailed understanding of two-thirds of the traffic in the region and how it will affect highways in the future.
- Develop supply chain performance measures
- Work with private sector app developers and firms to share real-time location and trip data between drayage companies, drivers, and ports.
- Promote port automation.
New applications of Information and communication technologies and existing databases can produce valuable information for freight planning. A freight fluidity index, which measures the end-to-end performance (or shipment transit time) across the supply chain, is an example of a supply chain measurement that will require new data. This performance measure includes dwell time at ports and intermodal yards, and transit times across the multiple modes of transportation used to move a shipment. This performance measure is important because it captures the performance of the freight transportation system that is experienced by shippers and receivers. Much of the data needed for a freight fluidity index is held privately and thus new approaches for collaborating and sharing data with the private sector may be required to develop this performance measure.

Case study applications of the freight fluidity index have been developed by FHWA for the following:

- Automobile manufacturing in Tennessee;
- Retail consumer goods moving from the Ports of Los Angeles/Long Beach and Seattle/Tacoma via Chicago to metropolitan New York;
- Panasonic electronics between manufacturing and assembly facilities in San Diego and Tijuana;
- Soybean exports moving from Illinois farms to Louisiana ports; and
- Perdue processed chicken moving from the DelMarVa region to Mid-Atlantic markets.

Significant automation is underway inside ports in the U.S. For instance, the Port of Los Angeles and TraPac have already invested $693 million in four dozen self-driving cranes and automated carriers, plus related infrastructure. The Port of Rotterdam began implementing port automation back in the 1990s and has an operation in which all stacking cranes and transport vehicles are automated. All U.S. Ports have significant opportunities for automation, although union contracts may limit the application of new technologies in many cases.

A combination of smartphone applications, monitoring devices, and data-sharing software allows for improved logistics at ports and between modes. In particular, programs to share real-time location and trip data between drayage companies, drivers, and ports, have shown many benefits.

One such program, FRATIS, applied to drayage logistics within terminals. In Dallas, a FRATIS prototype program included an optimization algorithm, terminal wait time, route specific data with suggested navigations based on weather and traffic, and provided advanced notice to terminals. Data on arrivals and terminal wait time was generated by leveraging smartphone technology; Wi-Fi and Bluetooth readers at the container yard would report the timing of when mobile phones in truck cabs passed by. Results of this pilot included a reduction in the number of bobtail trips by 10 percent, terminal queue...
time by 20 percent, travel time by 15 percent and fuel consumption by 5 percent. In an application of FRATIS in LA, average daily miles per order fell by 35 percent, time per order by 15.3 percent, and stop time per order by 10.4 percent.

Private companies (e.g., Cargomatic) are also now focused on the drayage industry, and are performing similar functions. Cargomatic has partnered with the Port of Los Angeles to engage in a new effort to improve cargo location information within terminals and implement a new logistics strategy. Rather than giving truckers shipping order information prior to arriving at the port, the Cargomatic Free Flow method gives truckers the first available container rather than sorting through multiple containers to find a specific one.

In New York, PANYNJ has rolled out the Truck Management System, which is being implemented at the agency’s marine terminals. Beginning in January 2017, Global Container Terminal Bayonne (GCT-B) was the first terminal in the Port of New York and New Jersey to implement a Truck Management System (TMS), which allows truckers to make an appointment for the pick up or delivery of their containers within a specified period of time as opposed to the industry standard which is a first-come, first-served on-demand basis. The use of appointments has helped both the terminal and the drayage truck community to become more efficient with less truck dwell time within the terminal. Since implementation of the system, turn time has been reduced by 45 percent and trucker turn-time averages 45 minutes for a single transaction and 60 minutes for a dual transaction. At least two additional terminals in the Port of New York and New Jersey are expected to begin implementing the TMS in 2018.

Another system to provide information to port users is the Port of New York and New Jersey’s TIPS (Terminal Information Portal System) tool. Launched in 2015, the TIPS tool is an element of the Port Truck Pass (www.porttruckpass.com) system. TIPS is a single consolidated web portal for all six container terminals in the Port of New York and New Jersey. From this portal, a trucker, service provider, or beneficial cargo owner/shipper can obtain information on import container availability, export booking status, vessel schedules (e.g., cutoffs, and first available day), and empty container return location. In addition, a user can create “watch lists” of their containers regardless of what terminal they are being handled at, and receive notifications with the status of their container or booking changes (e.g., holds placed/released and balance updated). Once a user determines that status of their import container or export booking, they can toggle over to the Truck Management System to make an appointment for container pick up or delivery.

Evolution in Supply Chain, Third Party Logistics that Might Impact Trucking, On-Road Needs
The shift toward online retailing has been accelerating in recent years. Between 2010 and 2016, Amazon’s sales in North America quintupled from $16 billion to $80 billion. The National Retail

Federation expects that online retail will grow 8 to 12 percent in 2017, more than three times faster than the retail sector as a whole. There are 65–80 million Amazon Prime members. Amazon Prime provides free two-day shipping for online purchases.54 The convenience of online and mobile shopping is slowly changing shopping habits, moving a larger share of retailing online. This shifts travel from personal vehicles and public transportation to freight modes, and is also sparking the development of entirely new modes of freight transportation. For urban goods movement, one of the most pressing issues for transportation policy makers is the lack of space for trucks to park and deliver goods downtown.

In response to the rising number of package deliveries for an increasingly wide range of purchases, Amazon has set up a system called Amazon Locker, where users can order packages sent to specific locations and then pick them up at a convenient time. These “lockers” offer the benefits of security as well as convenience; users can pick up packages at a time of their choosing after receiving and email that their package has arrived. Others have proposed that DOTs could take up a similar program, and implement safe drop-off locations, perhaps at bus stops or other commonly traveled public locations.55

Several new models of deliveries are in various stages of entering the market. First, companies such as Uber, which predominantly focuses on passenger transportation, have also begun harnessing their driver fleets for delivering goods and services. Uber is already running a lunch delivery service, UberEATS, in New York and several other cities, and the service is rapidly expanding. Uber also launched UberRUSH in New York to provide on-demand bike courier service. Furthermore, in Washington, DC, Uber can provide rapid delivery of household supplies, and the company is reported to be in talks to set up same-day delivery for various retailers.56

In addition to new delivery models, third party logistics operators are also changing the nature of the freight market. Applications such as Convoy, Haulhound, FreightRover, Transfix and Uber Freight aim to streamline the process of pairing shippers with carriers, thus optimizing the freight shipment matching process and reducing the share of empty “deadhead” miles in the freight system. Transfix allows shipping managers to find carriers through a web application, track shipments and receive alerts if the status of a shipment changes, and use analytics tools to determine efficiency. The Uber Freight business unit has also built an app that matches trucking companies with available loads in a non-asset based logistics model similar to their passenger delivery service. In the urban realm, some speculate that Uber could dominate freight services in large part because it employs a business model with low fixed costs compared to UPS or FedEx, which own and maintain their own vehicle fleets.57

55 See footnote no. 40.
57 Ibid.
Environment and Energy Efficiency
This section discusses several technologies and operational strategies that can be used to reduce environmental impacts of trucking operations. Many of the previously mentioned technologies that yield benefits to other areas, such as efficiency, cost, and safety, also have environmental benefits. In particular, all of the previously mentioned options for improving supply chain and routing efficiency are also prone to reduce emissions. Those strategies are left out of this section to avoid duplicity, but it should be noted that they also are valuable from an environmental perspective.

Engine and After-Treatment Technologies – Targeting Criteria Pollutants
This suite of technologies focuses on reducing criteria pollutant emissions (primarily NOx or particulate matter [PM]) from trucks. It includes exhaust retrofit devices such as diesel oxidation catalysts (DOCs), flow-through filters (FTFs), diesel particulate filters (DPFs), and lean NOx catalysts. With the introduction of trucks that comply with the EPA model 2007/2010 emission standards, exhaust retrofits are now appropriate only for older trucks. These retrofits can have a huge impact on emissions; technologies verified by EPA and CARB are estimated to reduce PM by 20 to 40 percent, hydrocarbons by 40 to 70 percent, and carbon monoxide by 40 to 60 percent.58

As an example of a program to implement DOCs, in 2012, California implemented the latest amendments to its On-Road Heavy-Duty Diesel Vehicles (In-Use) regulations, which require all new trucks with a Gross Vehicle Weight rating of 14,000 pounds or more to meet new PM filter requirements; note that different regulations apply to marine container-transport drayage trucks transportation marine containers.59 Starting in 2015, older engines began to be replaced. By 2023, almost all trucks will be required to meet or exceed 2010 engine standards. In the Initial Statement of Reason for the regulation amendment, CARB estimated that these new requirements will reduce NOx emissions by 15 percent and PM2.5 emissions by 50 percent between 2015 and 2023.60

FTF technology has been pushed by ports. For example, the Ports of Philadelphia and Wilmington received a $350,000 DERA grant (with matching funds of $322,150) to retrofit 62 drayage trucks with partial FTFs and DOCs, as well as replacing two trucks with cleaner models.61

DPFs have been pushed through vehicle standards. In California, heavy-duty truck standards are sufficiently strict such that they can only be met by retrofitting trucks with DPFs. To help fleets comply with these restrictions and overcome initially high device costs, California offers financial assistance

through the On-Road Heavy-Duty Voucher Incentive Program (VIP) and the Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project (HVIP).

**Accelerated Retirement of Old Trucks**

New trucks, specifically those made after 2010 that are subject to increasingly stringent emissions standards, have much lower rates of criteria pollutants compared to older models; trucks made after 2010 typically produce less than 20 percent of those made before 2009.

Because the capital costs for vehicles meeting the newest emission limits can be prohibitively high for many small fleets or individual owner-operators, many agencies are providing incentives for early retirement of trucks. These programs have been successfully implemented in a number of regions. Since 2008, Diesel Emission Reduction Act (DERA) grants have been distributed to a number of truck replacement programs throughout the country; replacement incentives have been directed toward both heavy-duty drayage trucks and medium-duty delivery trucks. In the Second Report to Congress, EPA reported distributing nearly $470 million between 2008 and 2010 to retrofit, replace, or repower over 50,000 vehicles and pieces of equipment.

Efforts to accelerate truck fleet turnover have also been undertaken states, city governments, and ports. For example, in 2014, the Texas Commission on Environmental Quality announced the availability of $3.1 million for replacing older drayage trucks to reduce regional PM and NOx emissions. At the city/regional level, NYCDOT implemented rebate systems for individual truck owners who scrap old trucks and buy new ones. For these programs to be effective there must be proof that the retired truck will not re-enter the system. To best optimize the scope and reach of the program, many authorities are using a voucher system, whereby dealers reduce purchase prices for qualifying buyers, and then are later reimbursed by the state.

Numerous ports have also pushed for fleet turnover through either incentives or regulation. For example, from 2010 until now, PANYNJ offered assistance through its Truck Replacement Program (TRP) to replace model year 2003 and older engines with trucks with model year 2004 and new engines. Grants cover up to 50 percent or $25,000 of new truck costs. The TRP has helped replace more than 600 older trucks servicing the ports. The Port of Seattle and the Puget Sound Clean Air Agency are providing $20,000 to owners to scrap and replace trucks with model year 2007 or newer engines. Sixty of the 180 currently funded incentives will be specifically directed toward low-income owner-operators

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62 See list of projects funded on the DERA National Projects website at [http://www.epa.gov/cleandiesel/projects-national.htm](http://www.epa.gov/cleandiesel/projects-national.htm)
65 For example, see [https://www.californiahvip.org/about-the-project](https://www.californiahvip.org/about-the-project)
67 Port of Seattle Clean Truck Program website at [http://www.portseattle.org/Environmental/Air/Seaport-Air-Quality/Pages/Clean-Trucks.aspx](http://www.portseattle.org/Environmental/Air/Seaport-Air-Quality/Pages/Clean-Trucks.aspx)
or small businesses. Ports in California implemented model year requirements for drayage trucks at their facilities, and were supported by statewide regulations that acted as a backstop to push the industry.

**Engine and Powertrain Technologies – Electricity and Other Alternative Fuels**

New York State has already taken valuable steps to this effect by offering assistance through its own Truck Hybrid Incentive Program (NYT-VIP), administered by New York State Energy Research and Development Agency (NYSERDA) and funded by NYSDOT Congestion Mitigation and Air Quality funds. In addition to helping purchase electric, hybrid, and natural gas trucks and buses, this $19 million program provides $4 million to private and non-profit fleets operating in New York City to help purchase and install emission reduction equipment, including DPFs, in medium- and heavy-duty trucks.\(^{68}\) Incentives are released on a staggered schedule and include:

- Vouchers for public, private, and non-profit fleets for 80 percent of the incremental cost, up to $60,000, for the purchase or lease of all-electric Class 3 through 8 trucks operating 70 percent of the time and garaged in any nonattainment or maintenance area of New York State;
- Vouchers for private and non-profit fleets for 80 percent of the incremental cost, up to $40,000 for the purchase of compressed natural gas, hybrid electric and all-electric Class 3 through 8 trucks operating 70 percent of the time and garaged in New York City; and
- Vouchers for private and non-profit fleets that cover up to 80 percent of the cost of purchasing and installing emission reduction equipment for Class 3 through 8 diesel vehicles that are operated 70 percent of the time and garaged in New York City.

There are several plug-in hybrid electric trucks in development and the demonstration phase today. For instance, in the LHD market, Bright Automotive is developing a Class 3 plug-in hybrid cargo van with a parallel hybrid architecture. AT&T, Frito-Lay, Coca-Cola, Staples, Kansas City Power & Light, and Pacific Gas and Electric Company currently include plug-in hybrid electric vehicles in their fleets.\(^{69}\) There are also all-electric trucks in development by companies such as Tesla and Mercedes, though these have not yet been deployed commercially.

**Vehicle Technologies – Targeting Fuel Efficiency**

Several design and technological components of freight vehicles have impacts on fuel efficiency and on emissions. Fuel economy can be improved through retrofits to the truck, such as adding boat tails to the rear of the truck, or using low-rolling resistance wide-base tires. Both of these adjustments can improve fuel efficiency by approximately 3 percent, each.\(^{70}\) The US EPA provides input through its SmartWay program on which tires qualify as being most suited for improving fuel efficiency. Since these technologies are widely applied by the market, government efforts to incentivize them have been minimal.

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Further, simple steps such as properly inflated tires can make a large impact on fuel efficiency, and only 33 percent of new trucks came fitted with tire pressure systems in 2013.\textsuperscript{71} The EPA has considered self-inflating tire technology to be a viable means of satisfying federal fuel efficiency requirements, but no state governments have undertaken incentive programs directly targeting this technology specifically.

Reducing emissions from idling is also possible with the introduction of auxiliary power units (APUs) that allow for providing power to the truck cab while the engine is turned off. APUs are common in the trucking industry. The federal government has played a role in encouraging APUs and lower emission from idling through the EPA SmartWay program, and California passed legislation in 2008 that fined truck drivers for leaving idling engines on for over five minutes. Many states and localities have passed laws to reduce unnecessary idling. Overall, the industry trend toward implementing APUs for business reasons makes this a relatively mature technology.

**Clean Truck Corridor Infrastructure**

In Europe, several DC fast-charging networks are being constructed by private ventures, including the Ionity network, Ultra-E, Mega-E, the Tesla Supercharger network and others. Tesla is collaborating with Anheuser-Busch, PepsiCo, and United Parcel Service to build on-site charging terminals to promote Tesla's new electric truck in the United States. The number of public fast charging stations in the U.S. is also expect to expand significantly in 2018. The availability of an installed charging network for freight vehicles will help to expedite deployment.

Overhead catenary systems have the potential to electrify many miles of trucking by overcoming some of the issues of electric trucks (range and battery cost). Catenary systems consist of overhead power lines that track above roads, offering vehicles power as they move along the overhead lines using a vehicle component known as a pantograph, allowing trucks to run only on electricity until off the catenary road. These are currently unavailable for commercial trucks, but have been used for transit systems for decades. In August 2014, South Coast Air Quality Management District awarded a $13.5 million contract to Siemens to develop a pilot trial of a two-mile catenary truck system near the ports of Los Angeles and Long Beach. This pilot system is now operating. The project includes modifying three trucks to have a pantograph that can connect with and disconnect from the overhead wires at 56 miles per hour. The test trucks include a battery-electric truck, a compressed natural gas hybrid truck, and a diesel-hybrid truck. Testing of the “eHighway” program is currently underway and is expected to be completed in 2018.\textsuperscript{72} If scaled, catenary systems could provide a means for electrifying high percentages of truck miles if built on highly trafficked corridors, while the trucks themselves were still hybrid-powered. However, the first freight catenary systems are still in their incipient phase, so feasibility and best practices are still to be determined. In particular, there is concern over their energy usage and weather it would be feasible to power such a system at scale.

Wireless conduction could also serve as means to electrify freight transportation through infrastructure. In-road charging works best for vehicles that travel on fixed routes with regular stops, given the high investment costs of implementing the systems in roads. For this reason, it has been used for transit bus

\textsuperscript{71} North American Council for Freight Efficiency, 2013.

applications. A bus system in Turin, Italy is claimed to recover 10 to 15 percent of battery charge during each stop for passengers.\textsuperscript{73} This system could be applied to trucks that have frequent loading or unloading stops on a consistent route, such as a delivery truck. To work in a freight movement context with a wider range of routes and stops, a hybrid truck with an on-board fuel source would likely be required. There is also technology allowing for in-road contact-less linear power. Unlike wireless conduction in the above example, this technology allows vehicles to be in motion and be charged. Like other corridor technology, this is still in a research development phase. The high per-mile infrastructure costs associated with all these systems make it likely that their use will be limited to pilot tests in the near future.

Appendix D: Interview Guides

Questions for Freight Stakeholders

The purpose of this project is to develop a set of recommendations for technology actions, strategies, and policies that NYSDOT can pursue to support improved freight-related operations statewide.

1. What broad trends do you see in your marketplace?
2. What are your greatest problems, needs, or priorities? Are there technological solutions to these?
3. What current freight-related technologies are being considered/piloted/discussed within your organization? These might include technologies related to the following:
   a. Mobility and Safety – including improved vehicle routing, safety applications, parking, travel info and CV related technology
   b. Technologies to Reduce Emissions and Fuel Consumption – including idle reduction technology, retrofits, replacements, and alternative fuels
   c. Automated or Connected Truck Applications – including platooning
   d. Changes in Freight/Supply Chain – including intermodal coordination, freight telematics, drones
   e. Security, Regulatory Compliance and Enforcement – including automated inspections, credential verification, border crossings automation
   f. Other New Technologies – what else is important?
4. What are the greatest technological opportunities for your organization?
5. What opportunities are there for coordination with NYSDOT on any of these technologies?
6. What are the barriers to technological innovation?
7. What are the most significant programs, projects, or priorities that should be considered for inclusion in the state freight plan? If you had a bucket of money, which projects would you put it in?