Texas Freight Network Technology and Operations Plan

User Needs Assessment Report

Final: December 2020
## Contents

1.0 Executive Summary ...................................................................................................... 1  
   1.1 *Purpose of the User Needs Assessment* ................................................................. 1  
   1.2 *Freight Technology Areas* .................................................................................... 1  
   1.3 *User Needs Assessment* ...................................................................................... 2  
   1.4 *Next Steps* .......................................................................................................... 3  

2.0 Introduction ................................................................................................................... 4  
   2.1 *Project Overview* .................................................................................................. 4  
   2.2 *Texas Multimodal Freight Network* ...................................................................... 5  
   2.3 *Purpose of the Gap Identification and User Needs Assessment* ......................... 8  
   2.4 *Stakeholder Outreach* ........................................................................................ 9  
   2.5 *Organization of the Report* ................................................................................ 10  

3.0 Traffic Management .................................................................................................... 12  
   3.1 *Needs and Gaps* .................................................................................................. 12  
   3.1.1 Regional and Statewide Traffic Management .................................................. 12  
   3.1.2 Border Traffic Management ............................................................................ 14  
   3.1.3 ITS Inventory .................................................................................................. 15  
   3.1.4 Evacuation Traffic Operations ....................................................................... 19  
   3.1.5 Integrated Corridor Management ................................................................... 20  
   3.1.6 Truck Priority Signals ..................................................................................... 20  
   3.1.7 Stakeholder Feedback ...................................................................................... 21  
   3.2 *User Needs Assessment* .................................................................................... 21  

4.0 Advanced Traveler Information Systems ....................................................................... 25  
   4.1 *Needs and Gaps* .................................................................................................. 26  
   4.1.1 DriveTexas ....................................................................................................... 26  
   4.1.2 Smart Work Zone ............................................................................................ 27  
   4.1.3 Truck Parking Availability Systems ................................................................ 27  
   4.1.4 Border Wait Time System ............................................................................... 28  
   4.1.5 Stakeholder Feedback ...................................................................................... 30  
   4.2 *User Needs Assessment* .................................................................................... 32  

5.0 Dynamic Route Guidance ........................................................................................... 36  
   5.1 *Needs and Gaps* .................................................................................................. 36  
   5.1.1 State of the Practice ....................................................................................... 36  
   5.1.2 Stakeholder Feedback ...................................................................................... 37  
   5.2 *User Needs Assessment* .................................................................................... 37  

6.0 Data Integration and Analytics ................................................................................... 39  
   6.1 *Needs and Gaps* .................................................................................................. 39  
   6.1.1 TxDOT Data and Information Technology Initiatives ...................................... 39  
   6.1.2 TxDOT Statewide Traffic Analysis and Reporting System ............................... 40  
   6.1.3 Texas Department of Motor Vehicles Oversize/Overweight Permitting System .................................................................................................................. 41  
   6.1.4 Stakeholder Feedback ...................................................................................... 41  
   6.2 *User Needs Assessment* .................................................................................... 42  

7.0 Enforcement and Inspection ....................................................................................... 45
### Exhibits

Exhibit 1: Example of a User Need Assessment ................................................................. 3  
Exhibit 2: Overview of Texas Multimodal Freight Network Assets ...................................... 6  
Exhibit 3: The Texas Multimodal Freight Network ............................................................... 7  
Exhibit 4: Distribution of Stakeholder Types for Public/Private Sector Outreach ............... 10  
Exhibit 5: TxDOT Traffic Management Centers ................................................................. 13  
Exhibit 6: TxDOT CCTV Cameras - Statewide ................................................................. 16  
Exhibit 7: TxDOT Dynamic Message Signs - Statewide ..................................................... 17  
Exhibit 8: TxDOT Traffic Detectors - Statewide ................................................................. 18  
Exhibit 9: Stakeholder Feedback on Traffic Management ............................................... 21  
Exhibit 10: User Needs Assessment for Traffic Management ......................................... 22  
Exhibit 11: DriveTexas Website - Statewide ................................................................. 26  
Exhibit 12: Commercial Ports of Entry with Border Wait Time Information ..................... 29  
Exhibit 13: Stakeholder Feedback on Advanced Traveler Information Systems ............... 30  
Exhibit 14: User Needs Assessment for Advanced Traveler Information Systems ............ 33  
Exhibit 15: Stakeholder Feedback on Dynamic Route Guidance ....................................... 37  
Exhibit 16: User Needs Assessment for Dynamic Route Guidance .................................... 37  
Exhibit 17: TxDOT STARS II Website ............................................................................. 40  
Exhibit 18: Stakeholder Feedback on Data Integration and Analytics ............................... 41  
Exhibit 19: User Needs Assessment for Data Integration and Analytics ............................ 43  
Exhibit 20: Texas Department of Public Safety Inspection Sites ..................................... 46  
Exhibit 21: TxDOT Weigh-In-Motion and Other Permanent Count Stations - Statewide ... 49  
Exhibit 22: Stakeholder Feedback on Enforcement and Inspection ..................................... 51  
Exhibit 23: User Needs Assessment for Enforcement and Inspection ............................... 51  
Exhibit 24: Stakeholder Feedback on Connected and Automated Freight Vehicles .......... 55  
Exhibit 25: User Needs Assessment for Connected and Automated Freight Vehicles ....... 56  
Exhibit 26: Stakeholder Feedback on Intermodal Terminal Operations ............................. 60  
Exhibit 27: User Needs Assessment for Intermodal Terminal Operations .......................... 61

### Appendix A Exhibits

Exhibit A.1: User Needs Assessment for all Freight Technology Areas .............................. 66
## Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>AIITMS</td>
<td>Artificial Intelligence Integrated Transportation Management System</td>
</tr>
<tr>
<td>Alameda CTC</td>
<td>Alameda County Transportation Commission</td>
</tr>
<tr>
<td>API</td>
<td>Application Programming Interface</td>
</tr>
<tr>
<td>ATMS</td>
<td>Advanced Traffic Management System</td>
</tr>
<tr>
<td>ATIS</td>
<td>Advanced Traveler Information System</td>
</tr>
<tr>
<td>ATR</td>
<td>Automatic Traffic Reader</td>
</tr>
<tr>
<td>AV</td>
<td>Automated Vehicle</td>
</tr>
<tr>
<td>Caltrans</td>
<td>California Department of Transportation</td>
</tr>
<tr>
<td>CAT</td>
<td>Cooperative Automated Transportation</td>
</tr>
<tr>
<td>CAV</td>
<td>Connected and Automated Vehicle</td>
</tr>
<tr>
<td>CBP</td>
<td>Customs and Border Protection</td>
</tr>
<tr>
<td>CBTC</td>
<td>Communication Based Train Control</td>
</tr>
<tr>
<td>CCTV</td>
<td>Closed-Circuit Television</td>
</tr>
<tr>
<td>CDL</td>
<td>Commercial Driver License</td>
</tr>
<tr>
<td>CMV</td>
<td>Commercial Motor Vehicle</td>
</tr>
<tr>
<td>CTR</td>
<td>University of Texas at Austin Center for Transportation Research</td>
</tr>
<tr>
<td>CTT</td>
<td>Comparative Travel Time</td>
</tr>
<tr>
<td>CV</td>
<td>Connected Vehicle</td>
</tr>
<tr>
<td>DART</td>
<td>Dallas Area Rapid Transit</td>
</tr>
<tr>
<td>DMS</td>
<td>Dynamic Message Sign</td>
</tr>
<tr>
<td>DOT</td>
<td>Department of Transportation</td>
</tr>
<tr>
<td>ELD</td>
<td>Electronic Logging Device</td>
</tr>
<tr>
<td>FAST</td>
<td>Freeway and Arterial System of Transportation</td>
</tr>
<tr>
<td>FNTOP</td>
<td>Freight Network Technology and Operations Plan</td>
</tr>
<tr>
<td>FRATIS</td>
<td>Freight Advanced Traveler Information Systems</td>
</tr>
<tr>
<td>GIWW</td>
<td>Gulf Intracoastal Waterway</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System</td>
</tr>
<tr>
<td>HAZMAT</td>
<td>Hazardous Material</td>
</tr>
<tr>
<td>HCRS</td>
<td>Highway Conditions Reporting System</td>
</tr>
<tr>
<td>I-35</td>
<td>Interstate 35</td>
</tr>
<tr>
<td>ICM</td>
<td>Integrated Corridor Management</td>
</tr>
<tr>
<td>ITS</td>
<td>Intelligent Transportation System</td>
</tr>
<tr>
<td>ITD</td>
<td>Information Technology Division</td>
</tr>
<tr>
<td>ITS</td>
<td>Intelligent Transportation Systems</td>
</tr>
<tr>
<td>JFITC</td>
<td>Joe Fulton International Trade Corridor</td>
</tr>
<tr>
<td>MAASTO</td>
<td>Mid America Association of State Transportation Officials</td>
</tr>
<tr>
<td>MDOT</td>
<td>Michigan Department of Transportation</td>
</tr>
<tr>
<td>MPO</td>
<td>Metropolitan Planning Organization</td>
</tr>
<tr>
<td>ODOT</td>
<td>Ohio Department of Transportation</td>
</tr>
<tr>
<td>OEM</td>
<td>Original Equipment Manufacturer</td>
</tr>
<tr>
<td>OS/OW</td>
<td>Oversize/Overweight</td>
</tr>
<tr>
<td>PAAC</td>
<td>Port Authority Advisory Committee</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>PANYNJ</td>
<td>Port Authority of New York and New Jersey</td>
</tr>
<tr>
<td>POCCA</td>
<td>Port of Corpus Christi Authority</td>
</tr>
<tr>
<td>RFID</td>
<td>Radio-Frequency Identification</td>
</tr>
<tr>
<td>RIMS</td>
<td>Regional Incident Management System</td>
</tr>
<tr>
<td>RSU</td>
<td>Roadside Unit</td>
</tr>
<tr>
<td>RTC</td>
<td>Regional Transportation Commission</td>
</tr>
<tr>
<td>SANDAG</td>
<td>San Diego Association of Governments</td>
</tr>
<tr>
<td>STARS II</td>
<td>Statewide Traffic Analysis and Reporting System</td>
</tr>
<tr>
<td>SWZ</td>
<td>Smart Work Zone</td>
</tr>
<tr>
<td>TFMP</td>
<td>Texas Freight Mobility Plan</td>
</tr>
<tr>
<td>THFN</td>
<td>Texas Highway Freight Network</td>
</tr>
<tr>
<td>TMC</td>
<td>Traffic Management Center</td>
</tr>
<tr>
<td>TMFN</td>
<td>Texas Multimodal Freight Network</td>
</tr>
<tr>
<td>TRANSCOM</td>
<td>Transportation Operations Coordinating Committee</td>
</tr>
<tr>
<td>TMS</td>
<td>Truck Management System</td>
</tr>
<tr>
<td>TOC</td>
<td>Traffic Operations Center</td>
</tr>
<tr>
<td>TPAS</td>
<td>Truck Parking Availability System</td>
</tr>
<tr>
<td>TTI</td>
<td>Texas A&amp;M Transportation Institute</td>
</tr>
<tr>
<td>TxDMV</td>
<td>Texas Department of Motor Vehicles</td>
</tr>
<tr>
<td>TxDOT</td>
<td>Texas Department of Transportation</td>
</tr>
<tr>
<td>TxDPS</td>
<td>Department of Public Safety</td>
</tr>
<tr>
<td>TxFAC</td>
<td>Texas Freight Advisory Committee</td>
</tr>
<tr>
<td>UAV</td>
<td>Unmanned Aerial Vehicle</td>
</tr>
<tr>
<td>UAS</td>
<td>Unmanned Aircraft Systems</td>
</tr>
<tr>
<td>USDOT</td>
<td>United States Department of Transportation</td>
</tr>
<tr>
<td>VTOL</td>
<td>Vertical Take-off and Landing</td>
</tr>
<tr>
<td>V2I</td>
<td>Vehicle-to-Infrastructure</td>
</tr>
<tr>
<td>V2V</td>
<td>Vehicle-to-Vehicle</td>
</tr>
<tr>
<td>VC</td>
<td>Vehicle Classification</td>
</tr>
<tr>
<td>VWIM</td>
<td>Virtual Weigh-in-Motion</td>
</tr>
<tr>
<td>WIM</td>
<td>Weigh-in-Motion</td>
</tr>
<tr>
<td>WSDOT</td>
<td>Washington State Department of Transportation</td>
</tr>
</tbody>
</table>
1.0 Executive Summary

1.1 Purpose of the User Needs Assessment
Texas Department of Transportation (TxDOT) is undertaking a comprehensive freight technology planning effort called the Freight Network Technology and Operations Plan (FNTOP). The FNTOP intends to outline potential strategies to guide technology- and operations-related investments on the Texas Multimodal Freight Network (TMFN). The primary goal of this project is to develop a comprehensive plan based on a detailed assessment of current and future needs, challenges, gaps, and opportunities that inform these strategies and lead to a stand-alone Implementation Plan.

As part of this effort, the FNTOP is developing a list of User Needs that trace to the strategies recommended for implementation. User needs are statements that help define and align the design problem in question and are developed based on:

- Gaps identified between the current state of freight technology in Texas and the state of the practice;
- Coverage gaps in the Texas Intelligent Transportation System (ITS) program in both rural and urban applications; and
- Needs identified by stakeholders as part of an extensive stakeholder outreach campaign.

Their purpose is to capture and document what is to be achieved as part of the system design in a framework that describes goals (e.g. the system will help certain challenges), as opposed to prescriptive solutions (e.g. the system will be ‘x’ solution). These gaps and needs are translated into the user needs documented within this report.

1.2 Freight Technology Areas
This document divides the gap and user needs assessment among seven key freight technology areas that were previously established in the FNTOP State of the Practice Assessment Report:

- Traffic Management;
- Advanced Traveler Information Systems (ATIS);
- Dynamic Route Guidance;
- Data Integration and Analytics;
• Enforcement and Inspection;
• Connected\(^1\) and Automated Freight Vehicles; and
• Intermodal Terminal Operations.

It is important to note that many user needs do not rigidly apply to only one freight technology area. Although gaps and user needs have been inventoried into their most applicable freight technology area, many can apply to other freight technology areas as well. For example, a need for better quality travel data would most appropriately fit the ATIS topic, but could also indirectly support Data Integration and Analytics or Traffic Management. It is also expected that some strategies—developed later as part of a separate document—would support user needs among several freight technology areas.

### 1.3 User Needs Assessment

A User Needs Assessment was conducted for each freight technology area and presented in tabular format, both within the report and as part of a separate table in Appendix A. An example of this format is shown below in Exhibit 1. The user needs are based on the needs and gap analysis completed for each freight technology area. Each proposed user need is given a priority level, based on initial feedback received from stakeholders and TxDOT, as well as based on an initial assessment of value.

Note that the naming convention for the user needs uses a letter code to note the freight technology area in which it falls: (T)raffic Management, (A)dvanced Traveler Information Systems, (D)ynamic Route Guidance, (D)ata (I)ntegration and Analytics, (E)nforcement and Inspection, (C)onnected and Automated Vehicles, and (I)ntermodal Terminal Operations. In Exhibit 1, UN-DI1 represents the first user need for the (D)ata (I)ntegration and Analytics freight technology area. Each user need is associated with a goal from the 2018 Texas Freight Mobility Plan (TFMP) and is also prioritized as follows:

- **High** – The need is a “must-have” and should be considered essential to the development of the FNTOP.
- **Medium** – The need is a “should-have” or desirable capability for which there is considerable interest, but it is not necessarily critical to TxDOT.
- **Low** – The need is a “nice-to-have” or not viable in the near-term.

---

\(^1\) The Connected Vehicle (CV) program refers to both vehicles and infrastructure. TxDOT’s role in the CV program supports the connected infrastructure.
**Exhibit 1: Example of a User Need Assessment**

<table>
<thead>
<tr>
<th>ID</th>
<th>Preliminary User Needs</th>
<th>2018 TFMP Goals</th>
<th>Priority</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>UN-DI1</td>
<td>Need for more integrated data sharing between public and private partners to provide better freight-specific data.</td>
<td>Economic Competitiveness, Customer Service Mobility and Reliability</td>
<td>High</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
</tbody>
</table>

### 1.4 Next Steps

This User Needs Assessment document serves as documentation of the denoted user needs that will support the challenges, needs, and gaps that can be improved by the FNTOP. This document provides the necessary information to help support the selection and development of strategies in the next task by answering the below questions:

- **Do the proposed strategies help fill gaps in the existing TxDOT freight technology program?** Any gap identified between the existing TxDOT program and the options available as part of the state of the practice is documented herein as a potential user need. Contrasting a proposed strategy against the existing ITS program would help gauge whether the investment is necessary, attainable, and cost-effective.

- **Do the proposed strategies support the needs identified by the stakeholders?** Stakeholder needs are a good indicator of where a particular service is absent in the field. Even if not to the degree of technology found in the state of the practice, stakeholder feedback can provide a good assessment of where the freight community collectively feels there are deficiencies that could be improved.

- **Do the proposed strategies align with the prioritization established by TxDOT and its stakeholders?** As part of this plan, the user needs will be aligned with the prioritization established by TxDOT and its stakeholders. This prioritization will help balance the needs and gaps to select strategies that offer near-term implementation options, as well as provide opportunities for TxDOT to advance the state of the practice.
2.0 Introduction

2.1 Project Overview

The FNTOP is anticipated to be the most comprehensive freight technology planning effort in the U.S. The FNTOP intends to outline potential strategies to guide technology- and operations-related investments on the TMFN. This effort includes a review of current and future transportation challenges and opportunities and user needs gathered through focused public and private sector engagement. The FNTOP is anticipated to be an invaluable resource to help public agencies and the private sector effectively plan for future deployments of freight technologies, working in partnership with the private sector across all modes of freight transportation.

The primary goal of this project is to develop a comprehensive plan based on a detailed assessment of current and future needs, challenges, gaps, and opportunities that inform strategies and a stand-alone Implementation Plan. The main objectives of this project include:

- Identify and assess technological and operational strategies being used on the TMFN or could be used in the future to improve safety, mobility, and facilitate economic competitiveness;
- Identify and assess TxDOT’s needs, challenges, and opportunities in terms of physical ITS hardware (e.g., traffic detectors, closed-circuit television [CCTV] cameras, dynamic message signs [DMSs], connected vehicle [CVs] roadside units [RSUs], etc.) and related infrastructure, digital framework and related infrastructure, operations, staffing and expertise, and statewide, corridor, urban, and rural needs and partnerships;
- Assess the TMFN’s current and future technological and operational needs, as well as its readiness and adaptability potential associated with the impacts of existing and emerging technologies;
- Develop strategies, policies, programs, and projects to address technological and operational needs; and
- Develop an Implementation Plan and a set of Concept of Operations documents, with each focused on a near-term freight network technology “early win” deployment concept.

The FNTOP and Concepts of Operations would guide Texas’s strategic development and deployment of innovative multimodal freight transportation technologies, techniques, research, and methods.
2.2 Texas Multimodal Freight Network

The TMFN consists of the state’s freight assets that are most important for moving the largest volumes of freight and that serve the state’s key freight intensive industries. Per the 2018 TFMP\textsuperscript{2}, these assets cover:

- **Highways:** Highways are the predominant mode for freight movement within the state, providing first and last mile connections to rail facilities, maritime ports, airports, and pipelines, as well as serving long haul trips destined throughout the state and beyond. Texas has over 313,000 miles of public roadways – making it the state with the most extensive highway network. Of these, 21,861 miles are on the Texas Highway Freight Network (THFN), with 745 miles designated as Critical Rural Freight Corridors and another 372 miles designated as Critical Urban Freight Corridors. In 2016, trucks accounted for 54 percent of total tonnage moved in Texas. Intrastate trucking and tonnage is anticipated to grow significantly as more residents, businesses, and freight locate within the state.

- **Railroads:** With 10,539 track miles (all on the TMFN), Texas has more miles of rail and more railroad employees than any other state. Texas contains five of the seven rail crossings between the U.S. and Mexico, providing critical connections for trade between the two countries. Texas’ 49 shortline railroads serve as first or last mile railroads for Texas’ three Class I railroads (BNSF Railway, Kansas City Southern, and Union Pacific), Texas’ maritime ports, and many of the state’s rail-served industries.

- **Ports and Waterways:** Texas handles the second highest volume of total maritime tonnage of any state in the nation with 21 maritime ports and the Gulf Intracoastal Waterway (GIWW) system, and is the leading state for international maritime tonnage. Maritime port and waterway access is necessary to attract and support many businesses, including the petrochemical sector, one of the state’s most important industries. Nine of Texas’ 12 deepwater ports, and one of its nine shallow-draft ports are included on the TMFN. Texas’ 379-mile portion of the GIWW, referred to as Marine Highway 69, is also a part of the TMFN. Marine Highway 69 handles two-thirds of the waterway’s traffic and moves approximately 86 million short tons of cargo annually.

- **Airports:** In 2016, six of the top 50 cargo airports in the U.S. (in terms of landed weight) were located in Texas. Out of Texas’ 24 commercial airports, seven are included on the TMFN. Air cargo tonnage is expected to grow at a higher rate than any other mode due to market changes such as the increase in e-commerce and the associated expectations for one- or two-day shipping.

• **Pipelines:** Texas has the most extensive pipeline network in the nation, with 426,000 total miles (59 percent intrastate and 41 percent interstate), carrying 826.6 million tons of cargo in 2016.

• **International Border Crossings:** Texas’ 20 commercial international border crossings are also all on the TMFN. Of those, 15 process commercial vehicle crossings, and the other five are rail crossings.

Exhibit 2 provides an overview of the assets designated as a part of the TMFN – namely key roadways, railroads, maritime ports and waterways, airports and international border crossings. Exhibit 3 maps out where these assets are located in Texas. The TMFN is important because it includes the key corridors that facilitate the efficient and safe movement of goods in Texas and are most critical for focused investment.

**Exhibit 2: Overview of Texas Multimodal Freight Network Assets**

- **Roadway Centerline Miles:**
  - 313,000 miles on the Texas Highway Freight Network
  - 21,661 miles on the Texas Highway Freight Network
  - 745 miles of Critical Rural Freight Corridor
  - 372 miles of Critical Urban Freight Corridor
  - Transporting 1.2 billion tons

- **Railroads:**
  - 10,539 miles of railroads on the TMFN
  - 3 Class I railroads
  - 49 Class II or shortline railroads
  - Transporting 441 million tons

- **Waterway System:**
  - 21 ports and the Gulf Intracoastal Waterway System
  - 12 deepwater ports
  - 9 included on TMFN
  - 9 shallow draft ports
  - 1 included on TMFN
  - 379 miles of GWW, all on TMFN
  - Transporting 598 million tons

- **Airports:**
  - 24 commercial airports
  - 1 air cargo airports on TMFN
  - Transporting 1.8 million tons

- **Pipeline:**
  - 426,000 miles of pipeline
  - 59% intrastate
  - 41% interstate
  - Transporting 837 million tons

- **Border Crossings:**
  - 20 commercial international border crossings, all on the TMFN
  - 15 commercial vehicle crossings
  - 5 rail crossings
  - Facilitating 73.5 million tons

Source: Texas Department of Transportation, Texas Freight Mobility Plan 2018 – Executive Summary, March 7, 2018.
Exhibit 3: The Texas Multimodal Freight Network

The Texas Multimodal Freight Network

Legend
- Texas Highway Freight Network
- Primary Highway Freight System
- Critical Urban Freight Corridor
- Critical Rural Freight Corridor
- Class I Railroad
- Shortline Railroad
- Truck Border Crossing
- Rail Border Crossing
- Intermodal Airports
- Deep Draft Port
- Shallow Draft Port
- Gulf Intracoastal Waterway

Source: Texas Department of Transportation, Texas Freight Mobility Plan 2018 – Executive Summary, March 7, 2018.
2.3 Purpose of the Gap Identification and User Needs Assessment

As part of the FNTOP, it is important to identify where technological and operational gaps exist. Understanding these gaps helps identify potential user needs that can inform the viability of a particular strategy, developed as part of later efforts. This document identifies gaps between the current state of freight technology and operations in Texas and the current state of the practice (encompassing all sectors and industries, beyond Texas) for freight technology and operations. It draws upon information provided as part of the FNTOP Inventory of Existing Conditions Report (developed in Task 2.2) and the FNTOP State of the Practice Assessment Report (developed in Task 2.1) to identify these gaps. Additionally, this document adds new information discovered subsequent to these documents.

This document also inventories stakeholder opinions and needs that have been collected as part of the FNTOP’s stakeholder outreach efforts. The intent is to capture prioritized opinions and needs from a cross-section of public and private sector stakeholders. Similar to the gap assessment, this feedback will help inform potential user needs that are not being addressed by current freight technology and operations efforts. The below illustration shows the flow of activities, with the User Needs Assessment informing the Formulation of Strategies based on input gathered to date.

This document concludes with a comprehensive list of user needs that are prioritized based on relevance, plausibility, and alignment with TFMP’s goals and objectives. As part of the outreach effort, TxDOT and its stakeholders will have opportunities to discuss and refine the prioritization. The final prioritization will identify which of the final strategies—with each strategy tied to user needs—are more desirable for supporting the TFMP’s goals and objectives.

This document divides the gap and user needs assessment among seven key freight technology areas previously established in the FNTOP State of the Practice Assessment Report:

- Traffic Management;
- Advanced Traveler Information Systems;
- Dynamic Route Guidance;
- Data Integration and Analytics;
- Enforcement and Inspection;
- Connected and Automated Freight Vehicles; and
- Intermodal Terminal Operations.

It is important to note that these freight technology areas are not rigidly bounded. Although gaps and user needs have been inventoried into each freight technology area, many can apply to other freight technology areas as well. Additionally, since some freight technology areas—namely Traffic Management and Advanced Traveler Information Systems—are more representative of TxDOT’s current traffic operations program for freight than others, these freight technology areas may receive more analysis or stakeholder discussion as part of this report. While TxDOT is a multimodal agency, most of its owned infrastructure and real-time operation responsibilities involve highways. Many gaps focus on opportunities for TxDOT to improve its current program, although this document aims to be comprehensive by identifying gaps where other state agencies have found collaborative opportunities with other groups.

2.4 Stakeholder Outreach

As part of the FNTOP, TxDOT has reached out to a diverse group of stakeholders. The goal of this outreach was to solicit feedback and opinions on the current state of freight operations in Texas and the vision for the application of technology to support future freight operations. This outreach included public sector stakeholders (internal and external to TxDOT; federal, state, and local) and private sector stakeholders. A brief inventory of outreach activities is provided below:

- **TxDOT Stakeholder Groups (Central Offices)** – This effort began in August 2019 and included key personnel from many TxDOT Divisions, including Transportation Planning and Programming Division, Information Technology Division, Traffic Safety Division, Travel Information Division, Right-of-Way Division, Rail Division, Maintenance Division, Maritime Division, and Strategic Planning Division.

- **Freight Network Technology Regional Outreach** – This effort included discussing the FNTOP at the Cooperative Automated Transportation (CAT) Meeting, the Port Authority Advisory Committee (PAAC) Meeting, Houston TranStar Stakeholder Meeting, Dallas/Fort Worth Stakeholder Meeting, and a dedicated small group breakout session at the 2019 Texas Mobility Summit in San Antonio.

- **Public/Private Sector Stakeholder Outreach** – This effort began in January 2020, is ongoing, and consists of one-on-one phone and in-person interviews with stakeholder representatives in multiple freight modes, freight companies, railroads, Original Equipment Manufacturers (OEMs), startups, industry groups, telecommunications companies, research institutes, Metropolitan Planning Organizations (MPOs), cities,
federal government, and others. A complete breakdown of stakeholder groups for this task is shown in Exhibit 4.

**Exhibit 4: Distribution of Stakeholder Types for Public/Private Sector Outreach**

2.5 **Organization of the Report**

The remainder of this report is organized into the following sections:

- **Section 3 – Traffic Management.** This section evaluates potential gaps and discusses stakeholder needs on the topic of Traffic Management.

- **Section 4 – Advanced Traveler Information Systems.** This section evaluates potential gaps and discusses stakeholder needs on the topic of Advanced Traveler Information Systems.

- **Section 5 – Dynamic Route Guidance.** This section evaluates potential gaps and discusses stakeholder needs on the topic of Dynamic Route Guidance.

- **Section 6 – Data Integration and Analytics.** This section evaluates potential gaps and discusses stakeholder needs on the topic of Data Integration and Analytics.

- **Section 7 – Enforcement and Inspection.** This section evaluates potential gaps and discusses stakeholder needs on the topic of Enforcement and Inspection.

- **Section 8 – Connected and Automated Freight Vehicles.** This section evaluates potential gaps and discusses stakeholder needs on the topic of Connected and Automated Freight Vehicles.
• **Section 9 – Intermodal Terminal Operations.** This section evaluates potential gaps and discusses stakeholder needs on the topic of Intermodal Terminal Operations.

• **Section 10 – Next Steps.** This section outlines the next steps of the Texas FNTOP following the User Needs Assessment.

• **Section 11 – References.** This section lists all references used in the creation of this report.

• **Appendix A – User Needs Assessment.** This section includes a comprehensive list of proposed user needs that have been developed within this User Needs Assessment.
3.0 Traffic Management

Traffic management is a freight technology area that includes applications that seek to improve mobility and safety for all modes of transportation by managing operations and promptly responding to travel disruptions. Traffic management is generally viewed as improving operations for all users, but certain applications target freight and freight-based activities.

Needs and gaps are discussed in the following section. A User Needs Assessment is discussed thereafter.

3.1 Needs and Gaps

3.1.1 Regional and Statewide Traffic Management

TxDOT operates seven Traffic Management Centers (TMCs) across the state, entirely within major metropolitan areas. These TMCs manage traffic operations for all users, including passenger, freight, and transit vehicle services that use public roads. Most TMCs serve as facilities that house multiple transportation agencies, typically the TxDOT District, major city, and first responders. Supporting TxDOT are a collection of communities and counties that operate their own TMCs for operations on local roads. TxDOT TMCs are operated by an Advanced Traffic Management System (ATMS) called LoneStar, although the Houston TranStar facility uses a separate system called the Regional Incident Management System (RIMS) for certain applications.

The locations of the TxDOT TMCs are shown in Exhibit 5.
TxDOT does not operate a statewide TMC that has overarching authority of traffic operations in real-time. Districts with TMCs and ITS programs may follow directions issued from Central Office, such as for certain public safety or high-level evacuation information, but each District is responsible for managing their ITS assets. Additionally, there is no central transportation manager, like the Transportation Operations Coordinating Committee (TRANSCOM) in New York/New Jersey that manages operations over state boundaries, although that may also be due to most major Texas cities with TMCs being inland from other state boundaries or along the Mexican border. TxDOT TMCs do house multiple agencies in their facilities, which is better than a number of other states which are limited to Department of Transportation (DOT) operations.

Within LoneStar, traffic condition data is made available to operators for viewing, but no advanced automation tools for incident detection are utilized. As noted in the state of the practice, the Freeway and Arterial System of Transportation (FAST) Transportation Center in Southern Nevada utilizes Waycare to analyze data and advise users of conditions that are indicative of an incident, such as hard-braking events reported by connected vehicles. Similarly, Delaware utilizes the Artificial Intelligence Integrated Transportation Management System (AIITMS) program to identify incidents using artificial intelligence (AI). Texas is currently studying use of AI for traffic operations, but it is not at a deployment level as of June 2020. Although LoneStar uses tools for incident detection that are fairly consistent with other state TMCs, there are more advanced capabilities in practice that can help with early detection and faster mitigation of incidents.

### 3.1.2 Border Traffic Management

The Laredo and El Paso TxDOT Districts both operate TMCs that are adjacent to the U.S.-Mexico border. These TMCs operate TxDOT roads within their jurisdiction only, and coordinate information with other transportation services that operate along the border. The bridges between Mexico and the U.S., many of which lie within 20 miles of each other, are operated by their own respective entities and focus on their local operations as a priority.

Across the practice, there are no good examples of a cross-border operation that has successfully implemented a collaborative bi-national TMC. Many reasons make this a challenge, but one common issue is the jurisdictional differences between the two countries. The closest U.S. example is the effort undertaken by the San Diego Association of Governments (SANDAG), the California Department of Transportation (Caltrans), and Mexican authorities to link operations between the San Diego and Tijuana TMCs, but this is still under development. Most efforts have focused on data sharing of travel information in a border region. Data sharing across borders has shown success in certain cases, such as the Washington State Department of Transportation (WSDOT) Cascade Border Gateway Data Warehouse between the U.S. and Canada. In other border cases, such as between Singapore and Malaysia, both countries have TMCs that manage traffic operations within their respective jurisdictions.
3.1.3 ITS Inventory

TxDOT operates a comprehensive ITS program for collecting, processing, and disseminating traffic data in real-time. Most of these devices are operated by one of the TxDOT TMCs, although some parts of the state have devices that are managed on as-needed basis by a remote terminal at the TxDOT District. These devices serve all users of the highway system and include:

- **CCTV Cameras**: TxDOT deploys CCTV cameras on urban freeways and on major corridors to help monitor conditions, evaluate incidents, and visually observe other important traffic-related conditions. According to the FNTOP Inventory of Existing Conditions Report, CCTV cameras are deployed across the State, but are concentrated primarily around urban metropolitan regions and along key high-volume corridors, including Interstate 35 (I-35) and parts of I-20 and I-10. TxDOT CCTV Cameras are shown statewide in Exhibit 6.

- **DMSs**: TxDOT deploys DMSs on urban freeways and on major corridors to help provide information (travel times, safety advisories, incident information, etc.) to motorists to help them make informed route decisions. According to work completed as part of the FNTOP Inventory of Existing Conditions Report, DMSs are deployed in comparable regions as the CCTV cameras. This is consistent with ITS programs in other states, as CCTV cameras are used by TxDOT to help support and verify the information provided on the DMSs. TxDOT DMSs are shown statewide in Exhibit 7.

- **Detectors**: TxDOT deploys detectors on urban freeways and on major corridors to help detect traffic volumes, occupancies, and speeds. This data is used to establish a performance profile of the road in question, typically using multiple detectors to determine true performance along the corridor that can be used to generate travel time data and detect the presence of an incident. According to the FNTOP Inventory of Existing Conditions Report, most detectors are located on either roads around major metropolitan areas (i.e. El Paso, Houston, Dallas-Fort Worth, Austin, and San Antonio) or along the I-35 corridor. TxDOT Traffic Detectors are shown statewide in Exhibit 8.
Exhibit 6: TxDOT CCTV Cameras - Statewide

TxDOT ITS Inventory - CCTV Camera

CCTV Camera
Texas Highway Freight Network
Exhibit 8: TxDOT Traffic Detectors - Statewide

TxDOT ITS Inventory - Vehicle Detection Station

- Vehicle Detection Station
- Texas Highway Freight Network

Prepared by Cambridge Systematics.
Data for planning purposes only.
May 29, 2020
TxDOT’s ITS deployment is consistent with other states that operate comparable programs. Concentration of assets in urban areas is standard practice because that is where most of the operational benefits exist. In addition, TMCs, which work with and manage the assets are also primarily located in urban areas. In rural areas, ITS assets are usually deployed more scarcely, focused at areas of high strategic value. Benefits are less prominent at most rural locations except along highly-traveled corridors. TxDOT supplements some of the limited rural coverage by subscribing to alternative data sources, namely third-party traffic data, to capture some of the operational road performance in areas where detectors are not present. Note the third-party data does not capture all the traffic data that a detector would.

The need for ITS in rural applications is usually dependent on:

1) Does a safety, mobility, or environmental problem exist that could be mitigated (e.g. non-recurrent congestion)?
2) Is a traffic management strategy along that rural corridor planned for implementation that could mitigate that problem (e.g. coordinated signal timings that could be modified based on new ITS data)?
3) Would the ITS be supported by other necessary assets to form a useful system (e.g. can traffic signals be connected to the ITS)?

Other states have expanded their ITS program into rural areas by conducting extensive “gap assessments” and evaluations of potential rural strategies. For example, some states have decided to deploy CCTV cameras to all rural interchanges along a corridor to help support evacuation and incident response measures, with operational protocols established for which agency manages the incident and operates the cameras.

In Texas, there are many high-traffic corridors, such as I-10 and I-20, that have a more limited ITS deployment than other facilities. Determining whether a gap is present is difficult to do on this fact alone. However, there are some instances that can help identify where a gap exists that needs to be filled including:

- Conduct a statewide ITS gap analysis and prioritize new ITS assets at locations where benefit-cost ratios support implementation.
- Deploy new ITS at locations that support larger traffic management strategies, such as potential freight technology and operational strategies identified as part of specialized initiatives such as the FNTOP.

3.1.4 Evacuation Traffic Operations

TxDOT has a published strategy for all contraflow and emergency shoulder use scenarios on major routes leaving major coastal cities. This strategy is used during evacuations of Houston, Corpus Christi, or Brownsville (Pharr District), with a primary focus on hurricane evacuations. During a voluntary evacuation notice, the emergency shoulders—designated as Evaculane—may be used by motorists if noted by TxDOT. When the evacuation becomes a
mandatory notice, TxDOT may modify the traffic flow to close the inbound travel lanes and reverse all flow to the outbound direction. The contraflow and/or Evaculane strategy may be used on I-10, I-45, US 290, US 59, I-37, and I-2/US 83/I-69C/US 281. During such events, TxDOT’s ITS assets help support monitoring of traffic flow, responding to incidents, and providing real-time notifications to motorists.

The TxDOT contraflow strategy is consistent with or better than other efforts in the current state of the practice. Although technology is used to help collect and disseminate information, one area that falls short is the use of technology to help manage the traffic. For example, some other states utilize gate systems to assist in closing entrance ramps during evacuations or large weather events on the interstate. Technology options exist to install a gate that can be remotely lowered—while this lowered gate may still require personnel on site to redirect motorists when the contraflow plan is active, an automatically controlled gate can be lowered initially to help clear out the roads in preparation of the contraflow plan activation.

3.1.5 Integrated Corridor Management
Integrated Corridor Management (ICM) aims to improve mobility from an origin to a destination by managing and balancing traffic across several parallel routes. TxDOT was a participant in one of the U.S.’s first Integrated Corridor Management programs along US-75 in Dallas. This ICM, led by the Dallas Area Rapid Transit (DART), included a Decision Support System that TxDOT and other stakeholders helped develop. This system operates separate from TxDOT’s LoneStar ATMS platform and manages its operations separate from ongoing TxDOT TMC operations. Although this is consistent with other ICM programs, there are opportunities to formally integrate ICM into the full traffic management system. Additionally, ICM may be applicable for freight corridors beyond just US-75.

3.1.6 Truck Priority Signals
Truck priority signal systems monitor truck volumes along a signalized corridor and prioritize signal green time for trucks to reduce stops and delays. TxDOT has several initiatives planned that are exploring the use of truck priority signal systems along key freight corridors. Between TxDOT’s Texas Connected Freight Corridor project and the efforts being undertaken by the Texas A&M Transportation Institute (TTI), these truck priority systems use a range of technology from CV to traditional detection.

A few other states are exploring concepts for truck priority signals, sometimes called freight priority signal, but the level of real-world deployment is fairly limited. TxDOT is consistent with the state of the practice in terms of planning for truck signal priority. As the benefits of this technology become more studied, TxDOT may benefit from continued implementation.
3.1.7 Stakeholder Feedback

Exhibit 9 lists the feedback received from stakeholders on the topic of Traffic Management. Among the stakeholder group distribution shown in Exhibit 4, trucking companies provided much of the feedback on Traffic Management, although other public and private sector stakeholders found it to be a topic of interest as well. Exhibit 9 represents feedback received as part of this stakeholder outreach.

Exhibit 9: Stakeholder Feedback on Traffic Management

<table>
<thead>
<tr>
<th>Feedback</th>
<th>Public Sector Interest</th>
<th>Private Sector Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curbside planning would improve traffic operations for many road users.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Managing urban arterials would support freight deliveries.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Truck-only lanes would improve freight mobility.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Toll incentives, roadway pricing, and congestion pricing could help motivate freight operations to off-peak/night-time delivery hours.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investing in strategies to manage congestion are valuable to freight.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expanding traffic management systems to sea operations would help mobility on the maritime mode.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installing a binational border TMC would improve freight operations at the border.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Investing in a statewide TMC would improve freight operations across the state, particularly rural areas.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integrating the incident management system onto one statewide platform would help improve freight route planning.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Frequent Feedback
- Some Feedback
- Limited Feedback

3.2 User Needs Assessment

Exhibit 10 illustrates the proposed user needs that have been developed based on the needs and gap analysis for the Traffic Management freight technology area, which are denoted with “T” for (T)raffic Management (e.g. UN-T1). Each proposed user need has been given a priority level, based on initial feedback received from stakeholders and TxDOT, as well as based on an initial assessment of value. The user needs are prioritized as follows:

- High – The need is a “must-have” and should be considered essential to the development of the FNTOP.
• **Medium** – The need is a “should-have” or desirable capability for which there is considerable interest, but it is not necessarily critical to TxDOT.

• **Low** – The need is a “nice-to-have” or not viable in the near-term.

### Exhibit 10: User Needs Assessment for Traffic Management

<table>
<thead>
<tr>
<th>ID</th>
<th>Preliminary User Needs</th>
<th>2018 TFMP Goals</th>
<th>Priority</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>UN-T1</td>
<td>Need for a Statewide TMC or Traffic Operations Center (TOC) to provide more efficient traffic operations.</td>
<td>Safety, Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>Stakeholder Interviews, State of the Practice Assessment Report, Inventory of Existing Conditions Report</td>
</tr>
<tr>
<td>UN-T2</td>
<td>Need for toll incentives, congestion pricing, or other incentive programs to incentivize freight to operate on off-peak hours or along less-congested parts of the system.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-T3</td>
<td>Need for more investment in congestion management strategies to address growing traffic.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-T4</td>
<td>Need to develop the Houston-Dallas-San Antonio triangle with new smart technologies to improve operations.</td>
<td>Safety, Economic Competitiveness, Asset Preservation and Utilization, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-T5</td>
<td>Need for more efficient and dynamic curbside management strategies to manage first and last mile issues.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>ID</td>
<td>Preliminary User Needs</td>
<td>2018 TFMP Goals</td>
<td>Priority</td>
<td>Source</td>
</tr>
<tr>
<td>------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>----------</td>
<td>--------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>UN-T6</td>
<td>Need for a bi-national border TMC or TOC to improve freight operations between the U.S. and Mexico.</td>
<td>Safety, Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>State of the Practice Assessment Report, Inventory of Existing Conditions Report</td>
</tr>
<tr>
<td>UN-T7</td>
<td>Need for rural ITS in high-traffic freight areas to help support operations.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Inventory of Existing Conditions Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-T8</td>
<td>Need for corridor traffic management for freight operations, such as ICM.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-T9</td>
<td>Need for advanced processing, such as machine learning or AI, to help with traffic operations and incident detection.</td>
<td>Safety, Mobility and Reliability</td>
<td>Low</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-T10</td>
<td>Need for more TxDOT-operated TMCs throughout the State to improve operations.</td>
<td>Safety, Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>Inventory of Existing Conditions Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-T11</td>
<td>Need for truck only lanes on high-traffic freight routes to handle large freight volumes.</td>
<td>Safety, Economic Competitiveness, Asset Preservation and Utilization, Mobility and Reliability</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>ID</td>
<td>Preliminary User Needs</td>
<td>2018 TFMP Goals</td>
<td>Priority</td>
<td>Source</td>
</tr>
<tr>
<td>------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>------------------------------------------</td>
<td>----------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>UN-T12</td>
<td>Need for a statewide integrated Incident Management System to improve traffic operations.</td>
<td>Safety, Mobility and Reliability,</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-T13</td>
<td>Need for more urban arterial management to manage freight deliveries.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-T14</td>
<td>Need for technology to help support emergency evacuation.</td>
<td>Safety, Mobility and Reliability</td>
<td>Low</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
</tbody>
</table>
4.0 Advanced Traveler Information Systems

An ATIS is any system that acquires, analyzes, and presents information to assist surface transportation travelers in moving efficiently from a starting location (origin) to their desired destination. An ATIS may operate through information supplied entirely within the vehicle (automated system) or it can also use data supplied by TMCs via roadside disseminators, like DMS or CV-enabled communications from smart signs to equipped vehicles. Relevant information may include the location of incidents, weather and road conditions, optimal routes, recommended speeds, and lane restrictions.

TMC-based ATIS is a well-developed concept and widely deployed, especially within more urbanized areas or highway corridors. This type of service supports the general traveling population and is not usually specialized to meet the unique needs of freight movement. A specialized subset of ATIS is Freight Advanced Traveler Information Systems (FRATIS), a bundle of applications that provides freight-specific dynamic travel planning and performance information and optimizes drayage operations so that load movements are coordinated between freight facilities to reduce empty-load trips\(^3\).

The key features of FRATIS include: sharing information between the freight terminal operator, truck dispatcher and public or public traveler information systems (e.g. regional TMC’s, WAZE) that relays both real-time and predicted terminal queue time; real-time routing, navigation, construction, traffic and weather data; and drayage optimization. Freight-specific traveler information systems have been limited in scale of deployment and participation by freight-related and transportation firms, due to the priority given to the general motoring public, managing roadways, limited resources, and the often unique informational needs of the freight community. Though ATIS systems do provide information that can be used by trucking firms, often the aftermarket creates specialized applications leveraging use of such information to be even more useful to trucking.

Recognizing the importance of freight, TxDOT is moving towards enhancing its existing ATIS systems and adding capabilities tailored to the freight community. These include:

- **Freight information exchange** – Enabling cooperative platforms for truck dispatchers and other freight operations to share data, or mining data from multiple sources to improve supply chain visibility;
- **Parking information** – Gathering, analyzing, and disseminating information about truck parking availability to drivers;

\(^3\) https://www.its.dot.gov/research_archives/dma/bundle/fratis_plan.htm#:~:text=Freight%20Advanced%20Traveler%20Information%20System%20is%20a%20bundle%20of%20applications,to%20reduce%20empty%20load%20trips.
• **Weather information** – Collecting and disseminating weather/hazard information to truckers and dispatchers;

• **Connected Work Zones** – Information on lane closures due to construction, expected duration, and delays;

• **Rail crossing information** – Delays experienced due to trains at highway-rail at-grade crossings; informing of approaching trains; and

• **Border crossing and maritime port wait times** – Delays experienced crossing international and state borders or wait times at intermodal terminal facilities.

Needs and gaps are discussed in the following section. A User Needs Assessment is discussed thereafter.

### 4.1 Needs and Gaps

#### 4.1.1 DriveTexas

DriveTexas serves as TxDOT’s online, public-facing database that provides real-time highway conditions at a statewide level in addition to other future planned events, like road construction or closures. It provides information at a statewide and district level, with many of the District’s key ITS assets (i.e. CCTV cameras, DMS) available for viewing. Traffic conditions for each District are represented with red-yellow-green indications for many locations. An example of the website is shown in Exhibit 11.

*Exhibit 11: DriveTexas Website - Statewide*

DriveTexas is a fairly robust traveler information portal when compared to services offered by other states, and it provides comparable levels of general traveler information (i.e. camera views, red-yellow-green travel data). Even when compared to trucker-specific traveler information websites—notably the Iowa 511 Trucker website—DriveTexas offers very
similar information, with the exception of direct links on the website to online permits or Commercial Driver License (CDL) information.

Since Texas did not adopt the national 511 service program for traveler information, DriveTexas does not have a formal 511 website or “known space” that drivers from out of state would immediately know to access. That said, the lack of the “511” designation is simply by title only, as the services are very comparable. TxDOT provides a different phone number—(800) 452-9292—for traveler information services that a 511 number would normally provide.

On the public-facing side, DriveTexas does not provide its traveler information through an OpenAPI4 (Application Programming Interface) format for use outside of the DriveTexas website. TxDOT has noted that, on occasion, an OpenAPI has been provided to other service groups, typically during times of major disruption like a hurricane evacuation, but it currently is not doing so. Other states have opened their traveler information data services to the public for private application developers to access and add the public information to their services. This increases the value of the ITS data by sharing it among a larger audience.

### 4.1.2 Smart Work Zone

TxDOT operates a Smart Work Zone (SWZ) program, which applies ITS as a tool to be utilized in highway work zones to help improve public safety and mobility. The general SWZ program is fairly consistent with efforts undertaken by other states, but it goes a step further by utilizing a published Go/No-Go Decision Tool to indicate whether a SWZ system is needed at a particular site, based on a relative scoring assessed during the project development phase. Additionally, TxDOT’s and TTI’s efforts to lead a national test for a connected work zone—which built upon the original I-35 FRATIS program—further puts the SWZ program ahead of other states. Continued investment in this program will keep TxDOT as a leader in this strategy.

### 4.1.3 Truck Parking Availability Systems

TxDOT is currently in the planning stages for a Truck Parking Availability System (TPAS) program along I-10 as part of the I-10 Corridor Coalition, which will deploy real-time parking availability signing along that corridor for truck parking options. Additionally, TxDOT is exploring an expansion of its statewide truck parking sites beyond the I-10 corridor, which will include comparable TPAS equipment. When both efforts are complete, this will likely be one of the largest TPAS deployments in a single state.

---

4 A publicly available application programming interface that provides developers with programmatic access to a proprietary software application or web service. APIs are sets of requirements that govern how one application can communicate and interact with another.
Some states have already implemented TPAS on their major freight interstate corridors, with the eight-state Mid America Association of State Transportation Officials (MAASTO) program being the most recognized. Most states have limited implementation of TPAS to their public rest areas or truck parking area facilities. Michigan and Iowa are exceptions to this, where some private truck stops along the corridor have received TPAS equipment. Other agencies, including the Nevada DOT and the Pennsylvania Turnpike Commission, have plans to implement similar TPAS systems. TxDOT’s investment in TPAS will bridge the gap of truck parking availability data at public rest areas and traveler information centers; additional gaps may be filled by exploring instrumentation of TPAS at private truck stops.

**4.1.4 Border Wait Time System**

TTI developed a system that monitors Radio Frequency Identification (RFID) technology present in trucks at various detection stations to measure wait times at the U.S.-Mexican border. This system is currently present at seven commercial ports of entry along the Texas-Mexico border, which include Veteran’s Memorial Bridge (Brownsville, Texas), Pharr-Reynosa International Bridge (Pharr, Texas), World Trade Bridge and Columbia Bridge (Laredo, Texas), Camino Real International Bridge (Eagle Pass, Texas), and the Ysleta Bridge and Bridge of the Americas (El Paso, Texas). These locations are shown in Exhibit 12. Exhibit 12 also shows the Santa Theresa Port of Entry in Santa Theresa, New Mexico, due to proximity to El Paso. This program is being reviewed for technology upgrades and potential expansion to all other border crossings.
The current system only measures wait times on the Mexican side and provides that information accordingly, as the U.S. side (Mexico-bound) is not reported to experience large delays. That said, border crossings along the U.S-Canada border have benefited by installing border wait time systems on both sides of the border to help load balance the movement of passenger cars and freight traffic between the various crossing locations. This may be a challenge for freight at some locations, as the freight operation permit in Mexico is limited to a certain number of states, which can prevent options to use alternative crossing locations. Still, depending on the permitted vehicles at a crossing location, providing a comprehensive border wait time system may better help with load balancing to reduce wait times.

Additionally, the border wait time system does not report into LoneStar, and the data is not utilized by any of the adjacent TMCs (where present) for real-time operations. Depending on how the border wait time program is expanded, as well as possible future responsibilities of the TMCs, there may be an opportunity to fill a gap by utilizing this border wait time information as part of regional transportation operations.
4.1.5 Stakeholder Feedback

Exhibit 13 lists the feedback received from stakeholders on the topic of ATIS. Among the stakeholder group distribution shown in Exhibit 4, stakeholders who offered feedback on ATIS were evenly distributed among all public and private sector groups.

Exhibit 13: Stakeholder Feedback on Advanced Traveler Information Systems

<table>
<thead>
<tr>
<th>Feedback</th>
<th>Public Sector Interest</th>
<th>Private Sector Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Providing commodity flow/trip data would be good information for freight operators.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improving the My35 database would enhance operations.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collecting cell phone data would generate useful traveller information.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Establishing message prioritization would be good to reduce an overload of information.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collecting cargo weights and types would help for planning and operations purposes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply chain performance information (reliability, resiliency) would be good for planning purposes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Issuing terrorism alerts more promptly would allow freight operations to respond.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Publishing safety danger spots (high crashes, severe curves, steep grades, high speeds) would help improve awareness and potentially reduce crashes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Providing queue warnings and length information would help freight operators better understand the degree of delays.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Providing accurate travel times would help freight operators better gauge their trip.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Providing accurate weather reports for conditions that impact freight (e.g. high winds) would help freight operators make informed safety decisions.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Providing information relevant to hazardous material carriers would help with their operations.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Providing ferry wait times would be useful.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Providing delay information would help freight operators make informed route decisions.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feedback</td>
<td>Public Sector Interest</td>
<td>Private Sector Interest</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>------------------------</td>
<td>-------------------------</td>
</tr>
<tr>
<td>Providing advanced noticed of construction and closure information would help freight operators with planning their routes.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Providing alternative freight-specific routes would help during disruptions on the primary route.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Providing roadway grade information would help freight operators with their route planning.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Providing border wait times and processing time would help with freight operations along the border.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronic logging device (ELD) and other in-vehicle monitoring devices would be an option for collecting and disseminating data.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collecting truck origin and destination information would help with freight traffic operations.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collecting weigh-in-motion data would help assess current freight operations and assist with future planning efforts.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distributing accurate real-time traffic alerts would help freight operations respond to disruptions.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distributing information on special events would help freight operations respond to route disruptions.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Providing real-time truck parking availability and rest area information (distance between facilities) would help with freight route planning.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Providing better information on oversize/overweight (OS/OW) routes and permit information would be useful.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deploying overheight clearance detection and other height/weight restriction solutions would be valuable to infrastructure preservation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Providing accurate statewide data on speed and congestion would be beneficial to freight operations and route planning.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Providing mobile app notifications of geofenced alerts would help provide timely information that is not excessive.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collecting real-time freight traffic volumes would be useful for traffic operations.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Disseminating real-time traffic and road conditions would be useful for freight operations.

Creating a mobile application of DriveTexas with real-time information would be helpful for truckers.

Deploying more DMS to primary freight corridors would help provide information for freight operators to make informed route decisions.

Providing statewide smart workzone information as a website or mobile application would help truckers more safely navigate work zone environments.

<table>
<thead>
<tr>
<th>Feedback</th>
<th>Public Sector Interest</th>
<th>Private Sector Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequent Feedback</td>
<td>⬤ ⬤ ⬤</td>
<td>⬤</td>
</tr>
<tr>
<td>Some Feedback</td>
<td>⬤ ⬤</td>
<td>⬤</td>
</tr>
<tr>
<td>Limited Feedback</td>
<td>⬤</td>
<td>⬤</td>
</tr>
</tbody>
</table>

4.2 User Needs Assessment

Exhibit 14 illustrates the proposed user needs that have been developed based on the needs and gap analysis for the ATIS freight technology area, which are denoted with “A” for (A)dvanced Traveler Information Systems (e.g. UN-A1). Each proposed user need has been given a priority level, based on initial feedback received from stakeholders and TxDOT, as well as based on the initial assessment of value. The user needs are prioritized as follows:

- **High** – The need is a “must-have” and should be considered essential to the development of the FNTOP.
- **Medium** – The need is a “should-have” or desirable capability for which there is considerable interest, but it is not necessarily critical to TxDOT.
- **Low** – The need is a “nice-to-have” or not viable in the near-term.
### Exhibit 14: User Needs Assessment for Advanced Traveler Information Systems

<table>
<thead>
<tr>
<th>ID</th>
<th>Preliminary User Needs</th>
<th>2018 TFMP Goals</th>
<th>Priority</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>UN-A1</td>
<td>Need for more advanced notice of waiting times at international border crossings and ports to provide awareness to drivers.</td>
<td>Economic Competitiveness, Mobility and Reliability, Multimodal Connectivity</td>
<td>High</td>
<td>State of the Practice Assessment Report, Inventory of Existing Conditions Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A2</td>
<td>Need for more TPAS deployments to provide information to truckers.</td>
<td>Safety, Economic Competitiveness, Mobility and Reliability, Customer Service</td>
<td>High</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A3</td>
<td>Need for more DMSs on primary freight corridors to relay traffic information.</td>
<td>Safety, Asset Preservation and Utilization, Mobility and Reliability</td>
<td>High</td>
<td>Inventory of Existing Conditions Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A4</td>
<td>Need for more advanced notice of real-time traffic conditions (delays, incidents, construction, weather conditions) to improve routing decisions.</td>
<td>Safety, Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A5</td>
<td>Need to collect high-resolution truck data using cell phones or ELDs to generate advanced performance information and distribute it to drivers.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>ID</td>
<td>Preliminary User Needs</td>
<td>2018 TFMP Goals</td>
<td>Priority</td>
<td>Source</td>
</tr>
<tr>
<td>-------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------</td>
<td>----------</td>
<td>----------------------</td>
</tr>
<tr>
<td>UN-A6</td>
<td>Need for high-resolution delay and traffic information to help with freight operations and planning.</td>
<td>Economic Competitiveness, Mobility and Reliability, Multimodal Connectivity</td>
<td>High</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A7</td>
<td>Need for more accurate data on real-time freight traffic volumes, speed and congestion to improve freight planning.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A8</td>
<td>Need for advanced notice of permitted hazardous materials routes to provide routing options to truckers.</td>
<td>Safety, Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A9</td>
<td>Need for collection of more accurate data on freight trip origins and destinations to improve traffic operations.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A10</td>
<td>Need for better advanced notice of height and weight restrictions on roads to improve safety.</td>
<td>Safety, Asset Preservation and Utilization, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A11</td>
<td>Need for more advanced notice of safety danger spots with high crashes, severe curves, or steep grades to warn drivers.</td>
<td>Safety, Asset Preservation and Utilization, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A12</td>
<td>Need to issue accurate weather reports to help freight operations.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>ID</td>
<td>Preliminary User Needs</td>
<td>2018 TFMP Goals</td>
<td>Priority</td>
<td>Source</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------</td>
<td>----------</td>
<td>-------------------------------------------------------------</td>
</tr>
<tr>
<td>UN-A13</td>
<td>Need for mobile app notifications through DriveTexas to disseminate traveler information and route options.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A14</td>
<td>Need for more advance notice of special events disrupting freight routes for more efficient operations.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A15</td>
<td>Need for an improved My35 database to provide better traffic information in central Texas.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A16</td>
<td>Need to develop message prioritization and distribute it to certain geo-fenced areas to provide location-specific alerts.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A17</td>
<td>Need to provide roadway grade information to assist with freight route selection.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A18</td>
<td>Need for statewide smart work zone information.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A19</td>
<td>Need to collect weigh-in-motion data in real-time for regional and statewide operations.</td>
<td>Safety, Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
</tbody>
</table>
5.0 Dynamic Route Guidance

Dynamic Route Guidance includes technologies that incorporate real-time traffic and roadway conditions to help drivers make re-routing decisions to a more optimal route. It is called ‘dynamic’ because it uses real-time traveler information to continuously evaluate which route is optimal. Real-time traveler information that influences re-routing decisions includes congestion levels, incidents, weather conditions, road closures, and work zones.

For freight transportation, traveler information would be obtained by truck drivers through radio, DMSs, smart phone applications, or in-vehicle Global Positioning System (GPS), or it could be conveyed through a dispatcher/operator. The challenge for freight is having all the necessary information required to make an informed re-routing choice. Besides information on traffic and incidents, truck drivers and dispatchers need to have additional information on route restrictions, low height bridges, hazardous materials (HAZMAT) or OS/OW limits, and availability of truck parking or rest areas. The accuracy of this information is also critical for efficient freight planning and movement.

Needs and gaps are discussed in the following section. A User Needs Assessment is discussed thereafter.

5.1 Needs and Gaps

5.1.1 State of the Practice

TxDOT—like most DOTs—provides traveler information to the public through a variety of means, but historically has not provided route guidance as part of its standard operating procedure. Instead, at strategic locations where multiple route options exist to a single destination, TxDOT provides comparative travel information to help motorists make informed route decisions on their own. Providing information in lieu of route directives—outside of signed detours—leaves the decision-making with the motorists, who can elect to take unfamiliar, alternative routes based on their own comfort level. This is especially true for freight operators, who must know in advance whether an alternative route is approved for their vehicle’s cargo type (e.g. HAZMAT), weight, height, and length.

Dynamic route guidance for freight has typically remained as a private-sector service. Several service providers, including PC*Miler, TomTom, and Trimble Maps, provide real-time routing information to freight operators based on travel conditions that are reported for the route in question. Given the strong presence of private-sector based routing services, TxDOT may help close the gap by continuing to provide reliable, high-resolution traveler information that these services can use. This should be through an OpenAPI to allow developers to have easy access to this public data, similar to what was discussed in Section 4.0.
5.1.2 Stakeholder Feedback

Exhibit 15 lists the feedback received from stakeholders on the topic of Dynamic Route Guidance. Among the stakeholder group distribution shown in Exhibit 4, stakeholders who offered feedback on Dynamic Route Guidance were evenly distributed among public and private sector groups.

Exhibit 15: Stakeholder Feedback on Dynamic Route Guidance

<table>
<thead>
<tr>
<th>Feedback</th>
<th>Public Sector Interest</th>
<th>Private Sector Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>A mobile navigation application that keeps trucks on authorized freight routes will help mitigate many issues, both for truckers and local communities.</td>
<td>● ● ●</td>
<td>● ● ●</td>
</tr>
<tr>
<td>Providing travel time information on alternative freight routes will help truckers make informed route decisions.</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Establishing good OS/OW routes with the right geometric and construction information will help truckers not have their trip disrupted.</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

5.2 User Needs Assessment

Exhibit 16 illustrates the proposed user needs that have been developed based on the needs gap analysis for the Dynamic Route Guidance freight technology area, which are denoted with “D” for (D)ynamic Route Guidance (e.g. UN-D1). Each proposed user need has been given a priority level, based on initial feedback received from stakeholders and TxDOT, as well as based on the initial assessment of value. The user needs are prioritized as follows:

- **High** – The need is a “must-have” and should be considered essential to the development of the FNTOP.
- **Medium** – The need is a “should-have” or desirable capability for which there is considerable interest, but it is not necessarily critical to TxDOT.
- **Low** – The need is a “nice-to-have” or not viable in the near-term.

Exhibit 16: User Needs Assessment for Dynamic Route Guidance

<table>
<thead>
<tr>
<th>ID</th>
<th>Preliminary User Needs</th>
<th>2018 TFMP Goals</th>
<th>Priority</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>UN-D1</td>
<td>Need to provide truck drivers with navigation information that guides them through trucking</td>
<td>Safety, Economic Competitiveness, Asset Preservation</td>
<td>High</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-D2</td>
<td>Need for consistent data on OS/OW routes in order to avoid poor rerouting and safety issues.</td>
<td>Safety, Economic Competitiveness, Asset Preservation and Utilization, Mobility and Reliability</td>
<td>High</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-D3</td>
<td>Need for information on alternative freight-specific routes to improve efficiency on Texas roadways.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-D4</td>
<td>Need for more comparative travel time signs (CTT) for freight routes to improve routing decisions.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>Inventory of Existing Conditions Report, Stakeholder Interviews</td>
</tr>
</tbody>
</table>

routes, avoiding local roads that aren't suited for trucks (e.g. Waze/Google Maps for trucks). and Utilization, Mobility and Reliability
6.0 Data Integration and Analytics

Traffic data is generated from different sources, such as from traditional agency-owned road sensors and from private-sector probe-based data aggregators like Google Maps and Waze. The integration of data from multiple sources and the analysis and sharing of large datasets, or “Big Data,” is crucial to understand travel patterns and to help manage traffic and operate transportation systems. Additionally, other data sources impact freight mobility that are not real-time traffic detectors, such as OS/OW route permits, planned construction efforts, and other special event data. Data often is produced by standalone systems as they are deployed. Data sharing or data integration among various systems provides a significant value add to the overall transportation data program.

Needs and gaps are discussed in the following section. A User Needs Assessment is discussed thereafter.

6.1 Needs and Gaps

6.1.1 TxDOT Data and Information Technology Initiatives

TxDOT has many existing processes in place to collect information on traffic and roadway conditions, including the Highway Condition Reporting System (HCRS), LoneStar, and third-party data sources such as INRIX. Additionally, as noted in the FNTOP State of the Practice Assessment Report, TxDOT has data sharing agreements with approximately 70 partners and aims to expand that to additional groups in the public and private sector. TxDOT currently has plans to integrate comprehensive data from the various sources into a single format that feeds into a centralized “Data Lake,” where the information is processed using advanced analytics and shared with the public through platforms like DriveTexas. It also aims to develop an OpenAPI to share the unified data with partners and third-party companies.

The TxDOT Information Technology Division (ITD) Enterprise Information Management Program aims to help implement a centralized data architecture for real-time data ingestion, preparation, storage, mining, and machine learning. Two projects that are proposed as part of the Enterprise Information Management Program include efforts for real-time data integration for traffic management and the streamlining of road condition reporting. Both efforts are expected to provide a consolidation of this data to reduce the need to find information in multiple locations, as well as allow opportunities to fuse the data for predictive applications. As part of a separate effort, TxDOT is also working with the Center for Transportation Research at the University of Texas at Austin (CTR) on a research study to develop an understanding of benefits offered by AI for processing traffic data for operations and planning purposes, for all vehicles, including trucks.

The end-goal for these initiatives is consistent with initiatives that have been undertaken by other states. The vision described for traffic management and road condition reporting is
similar to that of efforts completed as part of 511 San Francisco Bay, Las Vegas FAST’s Performance Monitoring and Measurement System, Denver’s COTrip website, and various others. The vision for AI is similar to other systems described earlier as part of Section 3.0, including Southern Nevada RTC’s FAST Waycare and Delaware’s AIITMS program for incident management. With these other systems in place, TxDOT may be able to build upon the lessons learned from those programs to enhance the new system. The gap that remains in the near-term is the fact that these systems are still in the planning phases, relative to the agencies that have them in operation, but this gap may be closed once these initiatives transition from planning to deployment.

6.1.2 TxDOT Statewide Traffic Analysis and Reporting System
TxDOT aggregates planning-related traffic data in the internal Statewide Traffic Analysis and Reporting System (STARS II) application, which includes vehicle classification and weigh-in-motion (WIM) data. This data is historical and annualized, which means it is not used for real-time operations. This is fairly consistent with the data collection programs in other states for large scale annualized traffic data collection. TxDOT, relative to many states, has a more extensive program in terms of coverage. An example of the STARS II website is shown in Exhibit 17.

**Exhibit 17: TxDOT STARS II Website**

While this historical data is very valuable for planning studies and other traffic-related investigations, the lack of a real-time data feed may be a missed opportunity. It is unclear if other states use their remote traffic counting equipment for providing traffic data in real-time, but conducting such an activity could be an additional data service that supports advanced applications. For example, if field units were reporting a substantial increase in traffic—especially heavy freight traffic—in a certain part of the state, a centralized processing system could evaluate and determine if certain response plans were necessary, such as
increased green time on signalized freight corridors (if deployed). This data could potentially support machine learning algorithms for identifying best routes, congestion, or incidents.

6.1.3 Texas Department of Motor Vehicles Oversize/Overweight Permitting System

The Texas Department of Motor Vehicles (TxDMV) is the agency that manages the road use permitting system of OS/OW vehicles. It operates separately from TxDOT and the TxDOT data systems identified earlier. As a result, the OS/OW permitting system does not have access to real-time or planned disruption information from HCRS, such as road and lane closures. Both the public and private sector have identified a desire for these two systems to work collaboratively to avoid situations where OS/OW permits are issued, but result in an OS/OW vehicle stranded mid-route due to a lane closure that it cannot navigate. Similarly, the OS/OW permit process could benefit from geographical information on road infrastructure that impacts OS/OW movements, such as bridge heights, widths, weight restrictions, and other issues.

In the state of the practice, many states struggle with similar issues with coordinating OS/OW permitting and infrastructure requirements. That said, there is significant interest in unifying these data requirements in Texas because of the geographic coverage that the improvement would help unify, as well as the direct benefit to a large number of OS/OW activities that are occurring within the state due to its growing economy.

6.1.4 Stakeholder Feedback

Exhibit 18 lists the feedback received from stakeholders on the topic of Data Integration and Analytics. Among the stakeholder group distribution shown in Exhibit 4, stakeholders who offered feedback on Data Integration and Analytics were evenly distributed among public and private sector groups.

Exhibit 18: Stakeholder Feedback on Data Integration and Analytics

<table>
<thead>
<tr>
<th>Feedback</th>
<th>Public Sector Interest</th>
<th>Private Sector Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collecting international freight movement patterns and demand would be</td>
<td></td>
<td></td>
</tr>
<tr>
<td>useful in freight operations and planning.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Having access to good road traffic volumes with urban growth projections</td>
<td></td>
<td></td>
</tr>
<tr>
<td>would be helpful for planning applications.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two-way sharing of data (reporting hazards, unsafe rest areas) would</td>
<td></td>
<td></td>
</tr>
<tr>
<td>improve the quality of the system and better inform freight operators.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Establishing a central data lake or open data portal (feeds from DriveTexas)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>would be beneficial to end-users.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## 6.2 User Needs Assessment

Exhibit 19 illustrates the proposed user needs that have been developed based on the needs and gap analysis for the Data Integration and Analytics freight technology area, which are denoted with “DI” for (D)ata (I)ntegration and Analytics (e.g. UN-DI1). Each proposed user need has been given a priority level, based on initial feedback received from stakeholders and TxDOT, as well as based on initial assessment of value. The user needs are prioritized as follows:

- **High** – The need is a “must-have” and should be considered essential to the development of the FNTOP.
- **Medium** – The need is a “should-have” or desirable capability for which there is considerable interest, but it is not necessarily critical to TxDOT.
- **Low** – The need is a “nice-to-have” or not viable in the near-term.

### Feedback Table

<table>
<thead>
<tr>
<th>Feedback</th>
<th>Public Sector Interest</th>
<th>Private Sector Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Getting all TxDOT information into standard sharable formats would improve data use capabilities.</td>
<td>🍊🍊🍊 Frequent Feedback</td>
<td>🍊🍊🍊 Frequent Feedback</td>
</tr>
<tr>
<td>Integrating all data across state and local agencies would provide more seamless information to end-users.</td>
<td>🍊🍊🍊 Frequent Feedback</td>
<td>🍊🍊🍊 Frequent Feedback</td>
</tr>
<tr>
<td>Integration of DriveTexas into a mobile application that has incident and traveller information would help freight routing.</td>
<td>🍊🍊🍊 Frequent Feedback</td>
<td>🍊🍊🍊 Frequent Feedback</td>
</tr>
<tr>
<td>Truck connectivity to receive data, such as availability of overnight parking options, would be useful.</td>
<td>🍊🍊🍊 Frequent Feedback</td>
<td>🍊🍊🍊 Frequent Feedback</td>
</tr>
<tr>
<td>Standardized data sharing with public and private partners would improve the availability of comprehensive data.</td>
<td>🍊🍊🍊 Frequent Feedback</td>
<td>🍊🍊🍊 Frequent Feedback</td>
</tr>
<tr>
<td>Data infrastructure with the ability to integrate data from multiple sources (ports, U.S. Customs and Border Protection [CBP], trucking companies, TMCs, etc.) would help facilitate data sharing between groups.</td>
<td>🍊🍊🍊 Frequent Feedback</td>
<td>🍊🍊🍊 Frequent Feedback</td>
</tr>
</tbody>
</table>
### Exhibit 19: User Needs Assessment for Data Integration and Analytics

<table>
<thead>
<tr>
<th>ID</th>
<th>Preliminary User Needs</th>
<th>2018 TFMP Goals</th>
<th>Priority</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>UN-DI1</td>
<td>Need for more integrated data sharing between public and private partners to provide better freight-specific data.</td>
<td>Economic Competitiveness, Customer Service Mobility and Reliability</td>
<td>High</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-DI2</td>
<td>Need for integrated data infrastructure, or central data lake, with various sources of inputs (truckling companies, TMCs, U.S. Customs, ports) to provide more accurate datasets.</td>
<td>Economic Competitiveness, Mobility and Reliability, Customer Service</td>
<td>High</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-DI3</td>
<td>Need for data integration between TxDOT, TxDMV, and other state agencies to create consistent datasets.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-DI4</td>
<td>Need for integration and analysis of ELD data to improve freight operations on the TMFN.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-DI5</td>
<td>Need for two-way data sharing to improve information flows.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-DI6</td>
<td>Need for more fiber connectivity on key corridors and incentives to install more fiber to support new technologies.</td>
<td>Economic Competitiveness</td>
<td>Medium</td>
<td>Inventory of Existing Conditions Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-DI7</td>
<td>Need for integrated data on freight traffic volumes on Texas</td>
<td>Economic Competitiveness</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>ID</td>
<td>Preliminary User Needs</td>
<td>2018 TFMP Goals</td>
<td>Priority</td>
<td>Source</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------</td>
<td>----------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td>roadways for better freight planning.</td>
<td>Mobility and Reliability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UN-DI8</td>
<td>Need for more ITS in rural areas of Texas that lack connectivity and communication to provide better traffic management.</td>
<td>Safety, Asset Preservation and Utilization, Mobility and Reliability</td>
<td>Medium</td>
<td>Inventory of Existing Conditions Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-DI9</td>
<td>Need for data on freight movements to allow for better planning.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-DI10</td>
<td>Need for certain ITS devices currently used only for TxDOT long-range planning efforts to be upgraded to provide real-time information.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-DI11</td>
<td>Need for an OS/OW permit system that would have access to real-time infrastructure condition data.</td>
<td>Safety, Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
</tbody>
</table>
7.0 Enforcement and Inspection

Commercial vehicle enforcement and inspection activities are conducted by the Texas Department of Public Safety (TxDPS). The basic mission or responsibility of the TxDPS Commercial Vehicle Enforcement Service is to check the size, weight and safety of commercial motor vehicles (CMV) operating in Texas. This ensures compliance with the laws regulating size, weight, safety, registration, and the transportation of persons, HAZMAT, and other property. It has joint responsibility with the Highway Patrol Service to conduct Traffic and Criminal Law Enforcement, primarily on rural highways. It supports the operation on TxDOT freight routes as part of these efforts. TxDOT owns commercial vehicle enforcement and inspection equipment, from which the data collected is used to determine where additional enforcement may be needed.

In addition to roadside enforcement as needed, TxDPS operates nearly 100 enforcement locations\(^5\) throughout the state. These sites include a range of investments from roadside pull-off areas with limited amenities and technology that are used on an infrequent basis to full-scale enforcement sites with pre-screening technology, weight scales, inspection buildings, and consistent staffing. Locations in Texas of all types of enforcement sites are shown in Exhibit 20.

\(^5\) Also commonly called “weigh stations”.
Exhibit 20: Texas Department of Public Safety Inspection Sites
Needs and gaps are discussed in the following section. A User Needs Assessment is discussed thereafter.

### 7.1 Needs and Gaps

#### 7.1.1 Commercial Vehicle Enforcement

Texas is actively engaged in commercial vehicle enforcement and inspection for compliance with laws regulating size, weight, safety, registration, transportation of person, HAZMAT, and other property. TxDPS, in collaboration with the Highway Patrol Service, participates in the national safety information exchange, electronic credential administration, and electronic screening programs to help facilitate these efforts. The 100 enforcement sites—shown in Exhibit 20—include a range of investments from roadside pull-off areas with limited amenities to full-scale enforcement sites with pre-screening technology, weight scales, inspection buildings, and consistent staffing. Texas utilizes both PrePass and Drivewyze, which are interoperable with enforcement and inspection systems in other states to screen vehicles passing enforcement sites. The transponders, mobile phone applications, and other tools to facilitate these national programs are established at the national level, with Texas procuring the necessary equipment to be compatible.

Florida DOT, through their Motor Carrier Size and Weight office, currently hosts a central data repository called the Freight Operations Exchange. This exchange provides various functions to law enforcement and other groups, which can include reporting, notifications, and analytics of freight compliance through sightings and measurements taken around the state. This exchange aims to allow real-time data sharing between in-state facilities, allowing for automated bypass based on time and factoring in congestion reported by ITS equipment. This system initially will focus on collecting data for Hours-of-Service enforcement, but could look toward an ability to pull in vehicle weights from static weigh scales and other enforcement installations to screen against specific weight criteria.

#### 7.1.2 Weigh-In-Motion and Vehicle Classification Technology

One of the more direct technology tools is WIM. TxDOT operates and provides staff for most of the permanent count stations around the State. Types of permanent count stations include WIM stations, Vehicle Classification (VC) stations, and Permanent Automatic Traffic Readers (ATRs). WIM allows officers to determine if a truck falls below a defined weight threshold and can bypass a static weighing, or exceeds that threshold and should be selected for a static weighing.

While WIM technology can help streamline CMV enforcement and inspection processes, a limited number of inspection sites in Texas are equipped with WIM. TxDPS owns and operates WIM technology at some of the weigh stations, but most WIM and VC equipment are owned by TxDOT and are used mainly to collect data for planning purposes instead of enforcement and inspection. TxDOT uses this data to determine typical weights, vehicle
counts, and vehicle classifications on state roadways. Per the FNTOP Inventory of Existing Conditions Report, over 40 WIM sites exist statewide to support these planning activities; these sites are not uniformly distributed throughout the 25 TxDOT Districts, resulting in some having more sites than others. Six Districts do not contain any WIM sites, most notably Houston District (others include Childress, Lufkin, San Angelo, Tyler, and Yoakum). With more than 80,000 miles of roadway in Texas, that amounts to one (1) WIM site every 1,951 miles. TxDOT has commissioned a separate study to identify and address gaps in WIM and VC coverage to help support future planning and operations activities.

Locations of WIM and other permanent count stations are shown in Exhibit 21.
One state of the practice tool not currently used in Texas is the Virtual Weigh-In-Motion, or VWIM, system. Similar to WIM, VWIM utilizes similar weight-detection systems to measure
approximate weights of trucks for potential screening by law enforcement. The key difference is that VWIM utilizes camera technology to take snapshots of an overweight vehicle that can be sent to law enforcement that may be stationed at a different location. In other states, the strategy with VWIM is to place a law enforcement officer several miles downstream of VWIM sites with access to the real-time snapshots of overweight vehicles from the VWIM station, from which the officer can decide if an enforcement action is necessary when the vehicle passes by (a calibrated static scale weighing is still necessary after a VWIM scan, as VWIM technology has the same margin of error as WIM and is not accepted under statute in support of a citation). VWIM allows construction of weight-measuring equipment in areas with limited right-of-way by placing the necessary enforcement pull-off at a different downstream location. It also provides officers with a more comprehensive ability to screen vehicles at many remote sites. Although a VWIM system would come with some systemwide upgrades—namely a system to get VWIM snapshot photos to the law enforcement officer’s remote vehicle—there are additional opportunities to improve the operation.

TxDOT utilizes other devices for purposes of infrastructure preservation, such as real-time overheight detection systems in advance of low bridges. These devices have been installed at a few select permanent locations around the state, namely in the Houston, Austin, and Fort Worth Districts, and are also used for temporary applications like work zones. TxDOT maintains a specification on overheight detection to ensure that it is consistently and sufficiently deployed around the state.

Relative to the state of the practice, Texas as a whole maintains good involvement in the national programs for enforcement and inspection. Expanding the weight monitoring and enforcement systems, namely WIM, would further help with creating a more robust infrastructure preservation and enforcement program, as would further investment in overheight detection systems at locations with high rates of bridge strikes or other undesirable conflicts.

### 7.1.3 Stakeholder Feedback
Exhibit 22 lists the feedback received from stakeholders on the topic of Enforcement and Inspection. Among the stakeholder group distribution shown in Exhibit 4, stakeholders who offered feedback on Enforcement and Inspection were primarily among federal and law enforcement agencies.
Exhibit 22: Stakeholder Feedback on Enforcement and Inspection

<table>
<thead>
<tr>
<th>Feedback</th>
<th>Public Sector Interest</th>
<th>Private Sector Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automating border safety inspections with WIM and queue detection will help improve traffic operations.</td>
<td>🌅 🌅 🌅</td>
<td>🌅</td>
</tr>
<tr>
<td>Investing in more WIM and VC stations will allow for greater enforcement statewide.</td>
<td>🌅 🌅 🌅</td>
<td>🌅</td>
</tr>
<tr>
<td>Using next-generation security screening systems at seaports/ports of entry will help improve efficiency.</td>
<td>🌅 🌅 🌅</td>
<td>🌅</td>
</tr>
</tbody>
</table>

Frequent Feedback | Some Feedback | Limited Feedback

7.2 User Needs Assessment

Exhibit 23 illustrates the proposed user needs that have been developed based on the needs and gap analysis for the Enforcement and Inspection freight technology area, which are denoted with “E” for (E)nforcement and Inspection (e.g. UN-E1). Each proposed user need has been given a priority level, based on initial feedback received from stakeholders and TxDOT, as well as based on initial assessment of value. The user needs are prioritized as follows:

- **High** – The need is a “must-have” and should be considered essential to the development of the FNTOP.
- **Medium** – The need is a “should-have” or desirable capability for which there is considerable interest, but it is not necessarily critical to TxDOT.
- **Low** – The need is a “nice-to-have” or not viable in the near-term.

Exhibit 23: User Needs Assessment for Enforcement and Inspection

<table>
<thead>
<tr>
<th>ID</th>
<th>Preliminary User Needs</th>
<th>2018 TFMP Goals</th>
<th>Priority</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>UN-E1</td>
<td>Need for automated border inspections using WIMs and queue detection devices to improve efficiency.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>State of the Practice Assessment Report, Inventory of Existing Conditions Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>ID</td>
<td>Preliminary User Needs</td>
<td>2018 TFMP Goals</td>
<td>Priority</td>
<td>Source</td>
</tr>
<tr>
<td>-------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------</td>
<td>----------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>UN-E2</td>
<td>Need to deploy more WIM and automated vehicle classification stations in Texas for increased freight inspection and planning capabilities.</td>
<td>Safety, Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>Inventory of Existing Conditions Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-E3</td>
<td>Need for utilization of advanced onboard freight technology to help identify modal issues and contribute to crowdsourced information that allows for prompt response.</td>
<td>Safety, Economic Competitiveness</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-E4</td>
<td>Need for more advanced remote monitoring equipment to detect and uniquely identify vehicles over allowable limits on Texas roadways to increase freight compliance to roadway laws by robustly identifying offenders.</td>
<td>Safety, Economic Competitiveness</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-E5</td>
<td>Need for improved security screening systems at Texas’ points of entry.</td>
<td>Safety, Multimodal Connectivity</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
</tbody>
</table>
8.0 Connected and Automated Freight Vehicles

The development of Connected and Automated Freight Vehicles for freight continues to advance in the industry. Stakeholders, including members of the Texas Freight Advisory Committee (TxFAC) and participants in the statewide workshops, believe that Connected and Automated Vehicle (CAV) technology will have the greatest impact of all technologies on freight movement in Texas, especially in the near- to medium-term. Vehicles can be categorized into levels of automation from no automation to full automation, and most automated technologies deployed today fall somewhere in the middle. Technologies used to support CAV deployment include a combination of vehicle-to-vehicle (V2V) communication, radar and cameras, in-vehicle sensor and control systems, and vehicle-to-infrastructure (V2I) communications.

CAV applications (V2V and V2I) as applied to freight, include, but are not limited to:

- **V2V and V2I Communications**: these applications allow for advanced safety, mobility, and fuel efficiency opportunities as data is exchanged between vehicles and with the infrastructure. Texas has several CV-related projects occurring that align with and help advance the U.S. DOT (USDOT) CV initiative.

- **Truck Platooning**: the linking of two or more trucks in a convoy via V2V communications. These vehicles closely follow each other at a set, close distance by using CV technology and automated driving support systems.

- **Automated Trucks**: utilizes advanced technological systems such as sensors, cameras, and vehicle control systems which in turn limit or eliminate the requirement of a driver for operating the truck.

- **Automated Trains**: completely automated trains which possess their own intelligence communication system (communication based train control or CBTC) that determines their movement, such as how much distance has been traveled, where to stop, when to stop, etc.

- **Unmanned Aerial Vehicles (UAVs)**: such as automated drones, aircraft, or marine craft may be used to ship items on a more flexible schedule in areas where congestion (urban areas), lack of infrastructure (rural areas), or security-sensitive cargo (military operations) can pose challenges for current trucks.

Needs and gaps are discussed in the following section. A User Needs Assessment is discussed thereafter.

8.1 Needs and Gaps

8.1.1 Connected Vehicles

Through its many programs affiliated with the academic community, TxDOT has a well-established role in the State’s ongoing CV programs. The Connected Freight Corridors
Project will deploy a sustainable CV environment across the Texas Triangle (I-35, I-45, and I-10, linking Austin, Dallas-Fort Worth, Houston, and San Antonio) for a variety of applications. Similarly, the I-35 Connected Work Zone will help test and demonstrate the effectiveness of freight-related CV data in a work zone environment, a study from which TxDOT and other states will be able to expand their SWZ programs. TxDOT’s role has primarily been in providing the infrastructure for these programs to support V2I applications, which is consistent with roles undertaken by other states in CV programs.

Among other states, most CV applications are also in the context of pilot projects. The USDOT’s CV Pilot Projects are some of the more high-profile CV projects, but pilot test projects have been undertaken as well by the University of Michigan, the Michigan Department of Transportation (MDOT), the Southern Nevada Regional Transportation Commission (RTC), and other groups. Until the technology is formally adopted in vehicles, most efforts would be in the context of a pilot project. TxDOT is currently keeping pace with this effort and can help this effort further by continued investment and participation in new CV pilot tests.

### 8.1.2 Automated Vehicles

With the passage of Senate Bill 2205, the Texas transportation code was amended to allow automated vehicles (AVs) to operate on public facilities with certain prerequisite requirements to be met prior to operation. This has created an opportunity for several AV freight developers to utilize public roads for developing and testing their equipment. For smaller scale applications, certain jurisdictions within Texas have allowed unmanned delivery vehicles to provide last-mile service, which can include smaller scale vehicles (i.e. robotic vehicles).

Across the rest of the practice, similar AV efforts are being piloted. Truck platooning efforts are a very popular topic, being both developed under a continuing Federal Highway Administration-funded test program and also led by private sector developers who utilize public roads (where allowed) for testing purposes. That said, other public sector agencies have taken an active role to provide funding to support AV efforts. Certain cities, including Las Vegas and Columbus, have explored the rollout of a self-driving AV shuttle for transit applications; in this case, the cities or regional planning groups led the way for placing the equipment on a pre-defined transit route. TxDOT currently is keeping pace with the AV efforts and can help this effort further by exploring opportunities to either further allow or fund AV initiatives as pilot tests on its facilities.

### 8.1.3 Aviation

Advanced applications in aviation are occurring within Texas. Uber Air launched in the Dallas market, with demonstration flights expected to begin in 2020 and the first commercial operations in 2023. This service would use Vertical Take-Off and Landing (VTOL) aircraft technology to provide convenient air travel to relieve congestion in major cities.
In the rest of the practice, the Ohio Department of Transportation (ODOT) helped facilitate the creation of the Ohio Unmanned Aircraft Systems (UAS) Center to test and pilot a UAS drone program. This program researches and integrates unmanned aircraft technologies into statewide operations, as well as manages all unmanned aircraft operations for ODOT. Some potential applications include transport of medical-related materials and surveys of infrastructure. With this being a popular item of conversation in Texas, TxDOT may find similar opportunities by working with local university partners and aviation facilities to help establish comparable testing grounds to explore other UAS applications, particularly those more tied to freight and last-mile delivery. A similar effort to the Ohio UAS Center is the Lone Star UAS Center of Excellence at Texas A&M University—Corpus Christi.

8.1.4 Stakeholder Feedback
Exhibit 24 lists the feedback received from stakeholders on the topic of Connected and Automated Freight Vehicles. Among the stakeholder group distribution shown in Exhibit 4, stakeholders who offered feedback on Connected and Automated Freight Vehicles primarily included private sector trucking companies and industry groups.

Exhibit 24: Stakeholder Feedback on Connected and Automated Freight Vehicles

<table>
<thead>
<tr>
<th>Feedback</th>
<th>Public Sector Interest</th>
<th>Private Sector Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment in automated/semi-automated freight/drayage vehicles will improve freight operations.</td>
<td>⬜️⬜️⬜️</td>
<td>⬜️⬜️⬜️⬜️</td>
</tr>
<tr>
<td>Connected trucks will allow data to be more quickly provided to drivers.</td>
<td>⬜️⬜️⬜️</td>
<td>⬜️⬜️⬜️⬜️</td>
</tr>
<tr>
<td>Truck platooning and truck platooning lanes will improve efficiency.</td>
<td>⬜️⬜️⬜️</td>
<td>⬜️⬜️⬜️⬜️</td>
</tr>
<tr>
<td>Investment in the necessary infrastructure improvements for AV now will help support the future.</td>
<td>⬜️</td>
<td>⬜️</td>
</tr>
<tr>
<td>AV Only lane will allow for better testing and evaluation.</td>
<td>⬜️</td>
<td>⬜️</td>
</tr>
<tr>
<td>Truck priority systems will help get freight to destinations quicker.</td>
<td>⬜️</td>
<td>⬜️</td>
</tr>
<tr>
<td>Dynamic digital mapping to support AVs will provide a common environment in which AVs can operate.</td>
<td>⬜️</td>
<td>⬜️</td>
</tr>
</tbody>
</table>

Frequent Feedback ⬜️⬜️⬜️ | Some Feedback ⬜️⬜️ | Limited Feedback ⬜️
### 8.2 User Needs Assessment

Exhibit 25 illustrates the proposed user needs that have been developed based on the needs and gap analysis for the Connected and Automated Freight Vehicle freight technology area, which are denoted with “C” for (C)onnected and Automated Vehicles (e.g. UN-C1). Each proposed user need has been given a priority level, based on initial feedback received from stakeholders and TxDOT, as well as based on the initial assessment of value. The user needs are prioritized as follows:

- **High** – The need is a “must-have” and should be considered essential to the development of the FNTOP.
- **Medium** – The need is a “should-have” or desirable capability for which there is considerable interest, but it is not necessarily critical to TxDOT.
- **Low** – The need is a “nice-to-have” or not viable in the near-term.

### Exhibit 25: User Needs Assessment for Connected and Automated Freight Vehicles

<table>
<thead>
<tr>
<th>ID</th>
<th>Preliminary User Needs</th>
<th>2018 TFMP Goals</th>
<th>Priority</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>UN-C1</td>
<td>Need for more infrastructure improvements to support AVs (roadway markings, signage).</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-C2</td>
<td>Need to provide a more collaborative environment to support the development/deployment of automated trucks in order to advance emerging transportation technologies.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-C3</td>
<td>Need to provide a more collaborative environment to support more truck platooning deployments in order to improve efficiency.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-C4</td>
<td>Need for connected truck infrastructure in Texas to support connected trucks and improve safety.</td>
<td>Safety, Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>ID</td>
<td>Preliminary User Needs</td>
<td>2018 TFMP Goals</td>
<td>Priority</td>
<td>Source</td>
</tr>
<tr>
<td>------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>----------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>UN-C5</td>
<td>Need for more smart infrastructure to support automated vehicles on the TMFN.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-C6</td>
<td>Need to support AV only lanes to help advance automated freight technologies.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-C7</td>
<td>Need to invest in automated aviation infrastructure to support Unmanned Aerial Devices for improved freight deliveries.</td>
<td>Economic Competitiveness, Mobility and Reliability, Multimodal Connectivity</td>
<td>Low</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-C8</td>
<td>Need for Freight Signal Priority systems to improve freight operations.</td>
<td>Economic Competitiveness, Reliability and Mobility</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-C9</td>
<td>Need for a non-proprietary digitized mapping standard for AV environments to support one common map for AV navigation.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
</tbody>
</table>
9.0 Intermodal Terminal Operations

Texas has an extensive multimodal freight transportation system, and the interchange between modes at rail terminals, airports, pipelines, and maritime ports is crucial for freight mobility. Intermodal Terminal Operations include the connectivity between the freight highway network and interchange points, and it covers the following main topics:

- **Water, Air, Pipeline, Rail Terminal, and Warehouse/Distribution/Industrial Center Access**: The design and operational conditions of local roadways providing first-mile/last-mile connectivity by truck to intermodal terminals affects the efficiency of freight movement and impacts the surrounding communities. Examples of issues that often occur on these roads include insufficient capacity, narrow lanes and shoulders, short or lack of queuing lanes, minimal or lack of truck parking, low vertical clearances, inadequate intersections, modal conflicts, passenger vehicle conflicts, steep grades and sharp corners, lack of wayfinding signage, inadequate pavement design to support OS/OW trucks, and lack of awareness by the non-freight users of the roadways.

- **Truck Queuing**: Long queues of trucks at intermodal terminals is a recurring issue. During peak activity, trucks often must wait on state and local roadways to access the terminal entrances creating safety, traffic, and emissions concerns. There are queue detection systems that are designed to measure truck queue length and wait times. These systems are placed at key points approaching the terminal gates and use sensors and video cameras to provide real-time data of the queuing activity.

- **Truck Staging/Parking**: Providing accommodations, such as truck queuing lanes or designated truck staging and parking areas, could help mitigate long queuing at intermodal terminals. Truck staging and parking can be located in close proximity to terminals and can be designed to facilitate truck movement from/to the freight highway network and terminal.

- **Truck Appointment Systems**: Terminal appointment systems are used to coordinate terminal capacity with truck arrivals. By setting appointments for truck drivers to arrive at the port, the flow of trucks throughout the day is smoothened. This reduces queuing and waiting time and improves the use of the terminal capacity.

- **Drayage Operations**: Drayage is the transportation of freight for short distances by trucks. It may include trucking between terminals, or trucking from terminals to warehouses, distribution centers, or directly to the final destination. There are software solutions developed to provide insight into supply chain analytics and to support and optimize drayage operations through better coordination and monitoring of the process. New data availability from connected and automated vehicles, connected infrastructure, and probe devices opens up opportunities to understand freight movements in more granular detail and determine ways to better optimize drayage operations.
• **Maritime Terminal Operations:** Maritime terminals have the goal of maximizing the number of goods that transit through their facilities and improving the overall efficiency of their operations. To assist with their operations, these maritime terminal operators use a variety of container tracking and matching tools to improve real-time container location visibility and automated freight-matching (i.e., the process of assigning goods to trucks will be automated).

• **Rail Freight Improvements:** Rail freight operators enact technology solutions to better track shipments, mitigate delays and bottlenecks, reduce conflicts at highway-rail at-grade crossings, and get more capacity and reliability from their existing networks. Examples of solutions include positive train control, automatic train operation, and software to coordinate across railroads.

• **International Border Crossings:** CBP manages the security of cross border freight movements at all POEs across multiple modes and utilizes technologies to support credentialing, inspections, and traveler information. These include ATIS and systems for advanced inspection and approval.

Needs and gaps are discussed in the following section. A User Needs Assessment is discussed thereafter.

### 9.1 Needs and Gaps

#### 9.1.1 State of the Practice

Intermodal terminal operations include operational activities of several modes, depending on the facility in question. Although TxDOT is involved in many advisory committees for port authorities, border trade, aviation, and others, most of the opportunities for helping better facilitate operations are tied to the highway mode, given that state ownership is generally over the highways. TxDOT has subsequently studied opportunities to improve freight operations using technology on the highway system. As part of the TxDOT Port Connectivity Study, TxDOT explored opportunities to deal with operational issues such as truck queueing, modal conflicts, and incompatibility with surrounding land uses. As part of a separate Freight Innovative Technology project for TxDOT, TTI identified an opportunity to reduce freight congestion around the Port of Beaumont by installing a train monitoring system at rail crossings and provide advance notification of blockages. Another effort by TTI studied the potential of ITS and CV solutions to manage truck queueing and provide real-time notification of an allowable entry into the Archer-Daniels Midland grain elevators along the Joe Fulton International Trade Corridor (JFITC), a two-way arterial roadway located along the north bank of the Inner Harbor of the Port of Corpus Christi Authority (POCHA). Other applications that involve Port connectivity are discussed in Section 3.0.

In the practice, many state agencies have faced similar limitations toward intermodal terminal operations, some more so due to the complex jurisdictional and institutional
boundaries that exist in certain locales, but some have found opportunities for success. At the Port of Oakland, the Alameda County Transportation Commission (Alameda CTC) is currently fielding a project to implement comprehensive ITS improvements around the facility to improve freight operations and manage truck arrivals. In a slightly different approach, the Port Authority of New York and New Jersey (PANYNJ) implemented a Truck Management System (TMS) at one of their container terminals to allow truckers to make appointments for container pickup or delivery; this system utilizes ITS technologies to work with the TMS and validate the arrivals. In the private sector, several vendors have built product lines around a TMS, allowing the intermodal facilities to use it internally for their own multimodal operations.

With truck queuing being an issue, continued investment in ITS equipment to help manage traffic, provide good advisory information, and disseminate informative route data will help manage the localized congestion events that occur around intermodal facilities. A large-scale congestion mitigation strategy near intermodal terminals would be to expand the existing TMS to jointly operate all traffic management services, including the road advisory information from TxDOT. This type of unified platform could link terminal appointment systems with the traffic management systems to provide a more seamless operating environment for freight near these intermodal facilities.

### 9.1.2 Stakeholder Feedback

Exhibit 26 lists the feedback received from stakeholders on the topic of Intermodal Terminal Operations. Among the stakeholder group distribution shown in Exhibit 4, stakeholders who offered feedback on Intermodal Terminal Operations primarily included maritime ports and railroads.

<table>
<thead>
<tr>
<th>Feedback</th>
<th>Public Sector Interest</th>
<th>Private Sector Interest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automation from yard to highway would improve operations within intermodal storage facilities.</td>
<td><img src="#" alt="Blue" /></td>
<td><img src="#" alt="Yellow" /></td>
</tr>
<tr>
<td>Automation of yard operations would speed up loading and uploading.</td>
<td><img src="#" alt="Blue" /></td>
<td><img src="#" alt="Yellow" /></td>
</tr>
<tr>
<td>Technology improvements at highway-rail grade crossings would improve freight traveller information.</td>
<td><img src="#" alt="Blue" /></td>
<td><img src="#" alt="Yellow" /></td>
</tr>
<tr>
<td>Improving freight transfers between modes would improve efficiency.</td>
<td><img src="#" alt="Blue" /></td>
<td><img src="#" alt="Yellow" /></td>
</tr>
<tr>
<td>Establishing freight pickup/delivery appointments would help manage freight operations around facilities.</td>
<td><img src="#" alt="Blue" /></td>
<td><img src="#" alt="Yellow" /></td>
</tr>
<tr>
<td>Efficient border crossing and expedited customs would improve freight operations at the border.</td>
<td><img src="#" alt="Blue" /></td>
<td><img src="#" alt="Yellow" /></td>
</tr>
</tbody>
</table>
Barge mooring areas would improve certain maritime freight operations.

Improving primary and secondary transport modes would collectively improve freight mobility.

Vessel scheduling and arrival information would benefit freight operations.

Container tracking would help understand operations in real-time.

Blocked rail crossing notifications (e.g. locations, wait times) would help freight operations.

### 9.2 User Needs Assessment

Exhibit 27 illustrates the proposed user needs that have been developed based on the needs and gap analysis for the Intermodal Terminal Operations freight technology area, which are denoted with “I” for (I)ntermodal Terminal Operations (e.g. UN-I1). Each proposed user need has been given a priority level, based on initial feedback received from stakeholders and TxDOT, as well as based on the initial assessment of value. The user needs are prioritized as follows:

- **High** – The need is a “must-have” and should be considered essential to the development of the FNTOP.
- **Medium** – The need is a “should-have” or desirable capability for which there is considerable interest, but it is not necessarily critical to TxDOT.
- **Low** – The need is a “nice-to-have” or not viable in the near-term.

#### Exhibit 27: User Needs Assessment for Intermodal Terminal Operations

<table>
<thead>
<tr>
<th>ID</th>
<th>Preliminary User Needs</th>
<th>2018 TFMP Goals</th>
<th>Priority</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>UN-I1</td>
<td>Need to further develop the Texas rail freight network and other multimodal technologies to decrease reliance on roadways.</td>
<td>Economic Competitiveness, Multimodal Connectivity</td>
<td>High</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-I2</td>
<td>Need for more blocked rail crossing notification systems to improve safety and efficiency.</td>
<td>Safety, Mobility and Reliability, Multimodal Connectivity</td>
<td>High</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>ID</td>
<td>Preliminary User Needs</td>
<td>2018 TFMP Goals</td>
<td>Priority</td>
<td>Source</td>
</tr>
<tr>
<td>-----</td>
<td>----------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>----------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>UN-</td>
<td>Need for efficient international border crossings and expedited customs to improve border</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>I3</td>
<td>freight exchange.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UN-</td>
<td>Need for operational improvements along primary and secondary transport modes to</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>I4</td>
<td>support freight mobility as a whole.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UN-</td>
<td>Need to support the use of more technology for automating intermodal terminal operations</td>
<td>Economic Competitiveness, Mobility and Reliability, Multimodal Connectivity</td>
<td>Medium</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>I5</td>
<td>to increase efficiency at these terminals.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UN-</td>
<td>Need for more investment in technology and infrastructure to support ports in Texas and</td>
<td>Economic Competitiveness, Asset Preservation and Utilization, Multimodal Connectivity</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>I6</td>
<td>allow for growth in freight.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UN-</td>
<td>Need for more data collection around ports and other multimodal facilities to improve</td>
<td>Economic Competitiveness, Multimodal Connectivity</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>I7</td>
<td>planning.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UN-</td>
<td>Need to support the use for more intelligent systems for container tracking and</td>
<td>Economic Competitiveness, Mobility and Reliability, Multimodal Connectivity</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>I8</td>
<td>optimization to improve efficiency at ports.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UN-</td>
<td>Need to support the use for a large-scale freight appointment service at intermodal</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>I9</td>
<td>terminals.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ID</td>
<td>Preliminary User Needs</td>
<td>2018 TFMP Goals</td>
<td>Priority</td>
<td>Source</td>
</tr>
<tr>
<td>-------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------</td>
<td>----------</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td>UN-I10</td>
<td>Need to support the use for more data on vessel schedule and arrivals at ports to improve freight planning.</td>
<td>Mobility and Reliability, Multimodal Connectivity</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-I11</td>
<td>Need for technology improvements at highway-rail grade crossings to improve safety.</td>
<td>Safety, Multimodal Connectivity</td>
<td>Low</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-I12</td>
<td>Need for more technology to improve freight transfer between modes to improve multimodal connectivity.</td>
<td>Mobility and Reliability, Multimodal Connectivity</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
</tbody>
</table>
10.0 Next Steps

This User Needs Assessment is intended to document the denoted user needs that would support the challenges, needs, and gaps that could be improved as part of the FNTOP. These user needs inform and support the strategies that are being developed as part of the next steps. Strategies advanced into a series of Concept of Operations documents, and an Implementation Plan, are expected to be traceable back to the fundamental user needs documented herein.

This User Needs Assessment provides the necessary information to help support strategies that will be determined in the next task by answering the below questions:

- **Do the proposed strategies help fill gaps in the existing TxDOT freight technology program?** Any gap identified between the existing TxDOT program and the options available as part of the state of the practice is documented herein as a potential user need. Contrasting a proposed strategy against the existing ITS program would help gauge whether the investment is necessary, attainable, and cost-effective.

- **Do the proposed strategies support the needs identified by the stakeholders?** Stakeholder needs are a good indicator of where a particular service is absent in the field. Even if not to the degree of technology found in the state of the practice, stakeholder feedback can provide a good assessment of where the freight community collectively feels there are deficiencies that could be improved.

- **Do the proposed strategies align with the prioritization established by TxDOT and its stakeholders?** As part of this plan, the user needs will be aligned with the prioritization established by TxDOT and its stakeholders. This prioritization will help balance the needs and gaps to select strategies that offer near-term implementation options, as well as provide opportunities for TxDOT to advance the state of the practice.
11.0 References

- Texas Senate Bill 2205: https://capitol.texas.gov/tlodocs/85R/billtext/pdf/SB02205F.pdf
- Lone Star UAS Center of Excellence – Texas A&M University – Corpus Christi: https://lsuasc.tamucc.edu/
Appendix A: User Needs Assessment

Appendix A illustrates the comprehensive list of proposed user needs that have been developed within this User Needs Assessment. Each proposed user need has been given a priority level, based on initial feedback received from stakeholders and TxDOT, as well as based on the initial assessment of value. The user needs are prioritized as follows:

- **High** – The need is a “must-have” and should be considered essential to the development of the FNTOP.
- **Medium** – The need is a “should-have” or desirable capability for which there is considerable interest, but it is not necessarily critical to TxDOT.
- **Low** – The need is a “nice-to-have” or not viable in the near-term.

**Exhibit A.1: User Needs Assessment for all Freight Technology Areas**

<table>
<thead>
<tr>
<th>ID</th>
<th>Preliminary User Needs</th>
<th>2018 TFMP Goals</th>
<th>Priority</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>UN-T1</td>
<td>Need for a Statewide Traffic Management Center (TMC) or Traffic Operations Center (TOC) to provide more efficient traffic operations.</td>
<td>Safety, Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>Stakeholder Interviews, State of the Practice Assessment Report, Inventory of Existing Conditions Report</td>
</tr>
<tr>
<td>UN-T2</td>
<td>Need for toll incentives, congestion pricing, or other incentive programs to incentivize freight to operate on off-peak hours or along less-congested parts of the system.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-T3</td>
<td>Need for more investment in congestion management strategies to address growing traffic.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>ID</td>
<td>Preliminary User Needs</td>
<td>2018 TFMP Goals</td>
<td>Priority</td>
<td>Source</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------</td>
<td>----------</td>
<td>--------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>UN-T4</td>
<td>Need to develop the Houston-Dallas-San Antonio triangle with new smart technologies to improve operations.</td>
<td>Safety, Economic Competitiveness, Asset Preservation and Utilization, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-T5</td>
<td>Need for more efficient and dynamic curbside management strategies to manage first and last mile issues.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-T6</td>
<td>Need for a bi-national border TMC or TOC to improve freight operations between the U.S. and Mexico.</td>
<td>Safety, Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>State of the Practice Assessment Report, Inventory of Existing Conditions Report</td>
</tr>
<tr>
<td>UN-T7</td>
<td>Need for rural ITS in high-traffic freight areas to help support operations.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Inventory of Existing Conditions Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-T8</td>
<td>Need for corridor traffic management for freight operations, such as ICM.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-T9</td>
<td>Need for advanced processing, such as machine learning or artificial intelligence, to help with traffic operations and incident detection.</td>
<td>Safety, Mobility and Reliability</td>
<td>Low</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>ID</td>
<td>Preliminary User Needs</td>
<td>2018 TFMP Goals</td>
<td>Priority</td>
<td>Source</td>
</tr>
<tr>
<td>---------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------</td>
<td>----------</td>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>UN-T10</td>
<td>Need for more TxDOT-operated Traffic Management Centers throughout the state to improve operations.</td>
<td>Safety, Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>Inventory of Existing Conditions Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-T11</td>
<td>Need for truck only lanes on high-traffic freight routes to handle large freight volumes.</td>
<td>Safety, Economic Competitiveness, Asset Preservation and Utilization, Mobility and Reliability</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-T12</td>
<td>Need for a statewide integrated Incident Management System to improve traffic operations.</td>
<td>Safety, Mobility and Reliability</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-T13</td>
<td>Need for more urban arterial management to manage freight deliveries.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-T14</td>
<td>Need for technology to help support emergency evacuation.</td>
<td>Safety, Mobility and Reliability</td>
<td>Low</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
</tbody>
</table>

**Advanced Traveler Information Systems Freight Technology Area**

<p>| UN-A1   | Need for more advanced notice of waiting times at international border crossings and ports to provide awareness to drivers. | Economic Competitiveness, Mobility and Reliability, Multimodal Connectivity | High     | State of the Practice Assessment Report, Inventory of Existing Conditions Report, Stakeholder Interviews |</p>
<table>
<thead>
<tr>
<th>ID</th>
<th>Preliminary User Needs</th>
<th>2018 TFMP Goals</th>
<th>Priority</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>UN-A2</td>
<td>Need for more Truck Parking Availability Systems (TPAS) deployments to provide information to truckers.</td>
<td>Safety, Economic Competitiveness, Mobility and Reliability, Customer Service</td>
<td>High</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A3</td>
<td>Need for more Dynamic Message Signs (DMS) on primary freight corridors to relay traffic information.</td>
<td>Safety, Asset Preservation and Utilization, Mobility and Reliability</td>
<td>High</td>
<td>Inventory of Existing Conditions Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A4</td>
<td>Need for more advanced notice of real-time traffic conditions (delays, incidents, construction, weather conditions) to improve routing decisions.</td>
<td>Safety, Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A5</td>
<td>Need to collect high-resolution truck data using cell phones or ELDs to generate advanced performance information and distribute it to drivers.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A6</td>
<td>Need for high-resolution delay and traffic information to help with freight operations and planning.</td>
<td>Economic Competitiveness, Mobility and Reliability, Multimodal Connectivity</td>
<td>High</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A7</td>
<td>Need for more accurate data on real-time freight traffic volumes, speed and congestion to improve freight planning.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>ID</td>
<td>Preliminary User Needs</td>
<td>2018 TFMP Goals</td>
<td>Priority</td>
<td>Source</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------</td>
<td>----------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>UN-A8</td>
<td>Need for advanced notice of permitted hazardous materials routes to provide routing options to truckers.</td>
<td>Safety, Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A9</td>
<td>Need for collection of more accurate data on freight trip origins and destinations to improve traffic operations.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A10</td>
<td>Need for better advanced notice of height and weight restrictions on roads to improve safety.</td>
<td>Safety, Asset Preservation and Utilization, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A11</td>
<td>Need for more advanced notice of safety danger spots with high crashes, severe curves, or steep grades to warn drivers.</td>
<td>Safety, Asset Preservation and Utilization, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A12</td>
<td>Need to issue accurate weather reports to help freight operations.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A13</td>
<td>Need for mobile app notifications through DriveTexas to disseminate traveler information and route options.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A14</td>
<td>Need for more advance notice of special events disrupting freight routes for more efficient operations.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>ID</td>
<td>Preliminary User Needs</td>
<td>2018 TFMP Goals</td>
<td>Priority</td>
<td>Source</td>
</tr>
<tr>
<td>-------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------</td>
<td>----------</td>
<td>------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>UN-A15</td>
<td>Need for an improved My35 database to provide better traffic information in central Texas.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A16</td>
<td>Need to develop message prioritization and distribute it to certain geo-fenced areas to provide location-specific alerts.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A17</td>
<td>Need to provide roadway grade information to assist with freight route selection.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A18</td>
<td>Need for statewide smart work zone information.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A19</td>
<td>Need to collect weigh-in-motion data in real-time for regional and statewide operations.</td>
<td>Safety, Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td></td>
<td><strong>Dynamic Route Guidance Freight Technology Area</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UN-D1</td>
<td>Need to provide truck drivers with navigation information that guides them through trucking routes, avoiding local roads that aren't suited for trucks (e.g. Waze/Google Maps for trucks).</td>
<td>Safety, Economic Competitiveness, Asset Preservation and Utilization, Mobility and Reliability</td>
<td>High</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>ID</td>
<td>Preliminary User Needs</td>
<td>2018 TFMP Goals</td>
<td>Priority</td>
<td>Source</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>----------</td>
<td>----------------------------------</td>
</tr>
<tr>
<td>UN-D2</td>
<td>Need for consistent data on OS/OW routes in order to avoid poor rerouting and safety issues.</td>
<td>Safety, Economic Competitiveness, Asset Preservation and Utilization, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-D3</td>
<td>Need for information on alternative freight-specific routes to improve efficiency on Texas roadways.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-D4</td>
<td>Need for more comparative travel time signs (CTT) for freight routes to improve routing decisions.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>Inventory of Existing Conditions Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-DI1</td>
<td>Need for more integrated data sharing between public and private partners to provide better freight-specific data.</td>
<td>Economic Competitiveness, Customer Service Mobility and Reliability</td>
<td>High</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-DI2</td>
<td>Need for integrated data infrastructure, or central data lake, with various sources of inputs (trucking companies, TMCs, U.S. Customs, ports) to provide more accurate datasets.</td>
<td>Economic Competitiveness, Mobility and Reliability, Customer Service</td>
<td>High</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-DI3</td>
<td>Need for data integration between TxDOT, TxDMV, and other state agencies to create consistent datasets.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>ID</td>
<td>Preliminary User Needs</td>
<td>2018 TFMP Goals</td>
<td>Priority</td>
<td>Source</td>
</tr>
<tr>
<td>-------</td>
<td>---------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------</td>
<td>----------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>UN-DI4</td>
<td>Need for integration and analysis of Electronic Logging Device (ELD) data to improve freight operations on the TMFN.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-DI5</td>
<td>Need for two-way data sharing to improve information flows.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-DI6</td>
<td>Need for more fiber connectivity on key corridors and incentives to install more fiber to support new technologies.</td>
<td>Economic Competitiveness</td>
<td>Medium</td>
<td>Inventory of Existing Conditions Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-DI7</td>
<td>Need for integrated data on freight traffic volumes on Texas roadways for better freight planning.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-DI8</td>
<td>Need for more ITS in rural areas of Texas that lack connectivity and communication to provide better traffic management.</td>
<td>Safety, Asset Preservation and Utilization, Mobility and Reliability</td>
<td>Medium</td>
<td>Inventory of Existing Conditions Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-DI9</td>
<td>Need for data on freight movements to allow for better planning.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-DI10</td>
<td>Need for certain ITS devices currently used only for TxDOT long-range planning efforts to be upgraded to provide real-time information.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>ID</td>
<td>Preliminary User Needs</td>
<td>2018 TFMP Goals</td>
<td>Priority</td>
<td>Source</td>
</tr>
<tr>
<td>------</td>
<td>---------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------</td>
<td>----------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>UN-DI11</td>
<td>Need for an OS/OW permit system that would have access to real-time infrastructure condition data.</td>
<td>Safety, Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
</tbody>
</table>

**Enforcement and Inspection Freight Technology Area**

<table>
<thead>
<tr>
<th>UN-E1</th>
<th>Need for automated border inspections using WIMs and queue detection devices to improve efficiency.</th>
<th>Economic Competitiveness, Mobility and Reliability</th>
<th>High</th>
<th>State of the Practice Assessment Report, Inventory of Existing Conditions Report, Stakeholder Interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>UN-E2</td>
<td>Need to deploy more WIM and automated vehicle classification stations in Texas for increased freight inspection and planning capabilities.</td>
<td>Safety, Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>Inventory of Existing Conditions Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-E3</td>
<td>Need for utilization of advanced onboard freight technology to help identify modal issues and contribute to crowdsourced information that allows for prompt response.</td>
<td>Safety, Economic Competitiveness</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>ID</td>
<td>Preliminary User Needs</td>
<td>2018 TFMP Goals</td>
<td>Priority</td>
<td>Source</td>
</tr>
<tr>
<td>------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------</td>
<td>----------</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td>UN-E4</td>
<td>Need for more advanced remote monitoring equipment to detect and uniquely identify vehicles over allowable limits on Texas roadways to increase freight compliance to roadway laws by robustly identifying offenders.</td>
<td>Safety, Economic Competitiveness</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-E5</td>
<td>Need for improved security screening systems at Texas’ points of entry.</td>
<td>Safety, Multimodal Connectivity</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
</tbody>
</table>

**Connected and Automated Freight Vehicles Freight Technology Area**

<table>
<thead>
<tr>
<th>ID</th>
<th>Preliminary User Needs</th>
<th>2018 TFMP Goals</th>
<th>Priority</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>UN-C1</td>
<td>Need for more infrastructure improvements to support automated vehicles (roadway markings, signage).</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-C2</td>
<td>Need to provide a more collaborative environment to support the development/deployment of automated trucks in order to advance emerging transportation technologies.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-C3</td>
<td>Need to provide a more collaborative environment to support more truck platooning deployments in order to improve efficiency.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-C4</td>
<td>Need for connected truck infrastructure in Texas to support connected trucks and improve safety.</td>
<td>Safety, Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>ID</td>
<td>Preliminary User Needs</td>
<td>2018 TFMP Goals</td>
<td>Priority</td>
<td>Source</td>
</tr>
<tr>
<td>-------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------</td>
<td>----------</td>
<td>--------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>UN-C5</td>
<td>Need for more smart infrastructure to support automated vehicles on the TMFN.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-C6</td>
<td>Need to support automated vehicle only lanes to help advance automated freight technologies.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-C7</td>
<td>Need to invest in automated aviation infrastructure to support Unmanned Aerial Devices for improved freight deliveries.</td>
<td>Economic Competitiveness, Mobility and Reliability, Multimodal Connectivity</td>
<td>Low</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-C8</td>
<td>Need for Freight Signal Priority systems to improve freight operations.</td>
<td>Economic Competitiveness, Reliability and Mobility</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-C9</td>
<td>Need for a non-proprietary digitized mapping standard for AV environments to support one common map for AV navigation.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td></td>
<td><strong>Intermodal Terminal Operations Freight Technology Area</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UN-I1</td>
<td>Need to further develop the Texas rail freight network and other multimodal technologies to decrease reliance on roadways.</td>
<td>Economic Competitiveness, Multimodal Connectivity</td>
<td>High</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>ID</td>
<td>Preliminary User Needs</td>
<td>2018 TFMP Goals</td>
<td>Priority</td>
<td>Source</td>
</tr>
<tr>
<td>------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------</td>
<td>----------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>UN-I2</td>
<td>Need for more blocked rail crossing notification systems to improve safety and efficiency.</td>
<td>Safety, Mobility and Reliability, Multimodal Connectivity</td>
<td>High</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-I3</td>
<td>Need for efficient international border crossings and expedited customs to improve border freight exchange.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-I4</td>
<td>Need for operational improvements along primary and secondary transport modes to support freight mobility as a whole.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-I5</td>
<td>Need to support the use of more technology for automating intermodal terminal operations to increase efficiency at these terminals.</td>
<td>Economic Competitiveness, Mobility and Reliability, Multimodal Connectivity</td>
<td>Medium</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-I6</td>
<td>Need for more investment in technology and infrastructure to support ports in Texas and allow for growth in freight.</td>
<td>Economic Competitiveness, Asset Preservation and Utilization, Multimodal Connectivity</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-I7</td>
<td>Need for more data collection around ports and other multimodal facilities to improve planning.</td>
<td>Economic Competitiveness, Multimodal Connectivity</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>ID</td>
<td>Preliminary User Needs</td>
<td>2018 TFMP Goals</td>
<td>Priority</td>
<td>Source</td>
</tr>
<tr>
<td>-------</td>
<td>---------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------</td>
<td>----------</td>
<td>------------------------------------------------</td>
</tr>
<tr>
<td>UN-I8</td>
<td>Need to support the use for more intelligent systems for container tracking and optimization to improve efficiency at ports.</td>
<td>Economic Competitiveness, Mobility and Reliability, Multimodal Connectivity</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-I9</td>
<td>Need to support the use for a large-scale freight appointment service at intermodal terminals.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-I10</td>
<td>Need to support the use for more data on vessel schedule and arrivals at ports to improve freight planning.</td>
<td>Mobility and Reliability, Multimodal Connectivity</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-I11</td>
<td>Need for technology improvements at highway-rail grade crossings to improve safety.</td>
<td>Safety, Multimodal Connectivity</td>
<td>Low</td>
<td>State of the Practice Assessment Report, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-I12</td>
<td>Need for more technology to improve freight transfer between modes to improve multimodal connectivity.</td>
<td>Mobility and Reliability, Multimodal Connectivity</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
</tbody>
</table>