Texas Freight Network Technology and Operations Plan

High-Resolution Freight Traveler Information System Concept of Operations
Texas Department of Transportation, Freight Planning Branch

Final: December 2020
Contents

1.0 Introduction .................................................................................................................. 1

1.1 Project Overview ......................................................................................................... 1

1.2 Project Reports ........................................................................................................... 2

1.3 Stakeholder Engagement ............................................................................................ 3

1.4 Texas Multimodal Freight Network ........................................................................... 4

1.5 Summary of Existing Conditions and User Needs ..................................................... 8

1.6 Summary of Strategies and Conceptual Framework Report ........................................ 9

1.7 Purpose of the Concept of Operations Document ...................................................... 12

1.8 High-Resolution Freight Traveler Information System Overview .............................. 14

1.9 Organization of the Report .......................................................................................... 16

2.0 The Current Situation in Texas .................................................................................... 17

2.1 Description of the Current Situation ........................................................................... 17

2.1.1 Mobility and Reliability ......................................................................................... 18

2.1.2 Economic Competitiveness .................................................................................. 23

2.1.3 Asset Preservation and Utilization ........................................................................ 25

2.1.4 Safety ................................................................................................................... 26

2.2 Existing Systems ......................................................................................................... 28

2.2.1 ITS Field Devices ................................................................................................ 28

2.2.2 Third-Party Traffic Data Services ......................................................................... 34

2.2.3 Advanced Traffic Management System ................................................................ 34

2.2.4 Local Road Management ..................................................................................... 37

2.2.5 Weigh-In-Motion / Permanent Count Stations ...................................................... 37

2.2.6 Artificial Intelligence (AI) Systems in Transportation Operations ......................... 39

2.2.7 Electronic Toll Collection Systems ...................................................................... 39

2.2.8 Border Travel Time System .................................................................................. 39

2.2.9 Blocked Rail Warning System ............................................................................. 41

2.2.10 Flood Detection/Warning Systems ..................................................................... 42

2.2.11 I-10 Corridor Coalition Truck Parking Availability System (TPAS) ....................... 42

2.2.12 I-35 Corridor Freight Advanced Traveler Information System (FRATIS) and Dallas-Fort Worth FRATIS Deployments ........................................................................... 43

2.2.13 Smart Work Zones .............................................................................................. 44

2.2.14 Connected and Automated Vehicle Data ............................................................. 44

2.2.15 DriveTexas .......................................................................................................... 45

2.2.16 Highway Condition Reporting System ................................................................ 46

2.2.17 Statewide Traffic Analysis and Reporting System (STARS II) ......................... 46

2.3 Deficiencies of the Current Situation ........................................................................... 47

2.3.1 Mobility and Reliability ......................................................................................... 47

2.3.2 Economic Competitiveness .................................................................................. 48

2.3.3 Asset Preservation and Utilization ........................................................................ 48

2.3.4 Safety ................................................................................................................... 49

2.4 Profiles of User Classes ............................................................................................... 49

2.4.1 TxDOT Divisions .................................................................................................. 49

2.4.2 TxDOT Districts .................................................................................................... 50

2.4.3 Traffic Management Centers ............................................................................... 50

2.4.4 Metropolitan Planning Organizations ................................................................. 51

2.4.5 Trucking Industry Groups .................................................................................... 51
2.4.6 Transportation Data Providers .................................................. 51
2.4.7 Truckers .................................................................................. 51
2.4.8 Trucking Companies/Dispatchers ............................................ 51
2.4.9 Other Road Users .................................................................... 52

2.5 User Needs .................................................................................. 52

2.6 Assumptions and Challenges ..................................................... 57
2.6.1 Assumptions ............................................................................ 57
2.6.2 Challenges .............................................................................. 59

3.0 Concept for the Proposed High-Resolution Freight Traveler Information System .............................................. 62

3.1 Objectives .................................................................................. 62

3.2 Description of ConOps Essential Features, Capabilities, and Functions ................................................................. 63
3.2.1 Data Collection ....................................................................... 66
3.2.2 Data Processing ...................................................................... 67
3.2.3 Information Distribution ......................................................... 69

3.3 Conceptual High-Level System Architecture .................................. 70

3.4 Support Environment .................................................................. 76

3.4.1 Supporting Subsystems ............................................................ 76
3.4.2 Supporting Personnel ............................................................... 77
3.4.3 Supporting Processes ............................................................... 77

4.0 Benefits, Impacts, and Alternatives of the High-Resolution Freight Traveler Information System ......................................................... 78

4.1 Benefits ...................................................................................... 78
4.2 Impacts ....................................................................................... 80
4.2.1 Policies .................................................................................. 80
4.2.2 Constraints ............................................................................ 81
4.2.3 Operational Impacts ............................................................... 81
4.2.4 Organizational Impacts ........................................................ 82
4.2.5 Impacts During Development ................................................ 83
4.2.6 Impacts to Stakeholders ....................................................... 84

4.3 Alternatives To This Strategy ...................................................... 86
4.3.1 Disadvantages and Limitations ............................................. 87
4.3.2 Alternatives and Tradeoffs Considered ................................. 87

5.0 Operational Scenarios .................................................................. 90

5.1 Pre-Trip Traveler Information Using Expanded Traffic Data Services and Travel Forecasts .................................................. 90

5.2 En-Route Traveler Information Using Expanded Traffic Data Services and Travel Forecasts ........................................... 91

5.3 Incident-Related Traveler Information Using Artificial Intelligence ................................................................. 92

5.4 Weekly Fleet Planning Using Forecasted Data ............................ 93

5.5 TxDOT Freight Planning ............................................................. 94

6.0 Next Steps .................................................................................. 96

7.0 References ................................................................................ 97
Exhibit 1: Distribution of Stakeholder Types for Public/Private Sector Outreach ................. 4
Exhibit 2: Overview of Texas Multimodal Freight Network Assets ........................................... 6
Exhibit 3: The Texas Multimodal Freight Network ................................................................. 7
Exhibit 4: 2018 TFMP Goals ................................................................................................... 8
Exhibit 5: Summary of Proposed FNTOP Strategies ............................................................... 10
Exhibit 6: Potential Integrated Services and Strategies ............................................................ 11
Exhibit 7: Formulation of Strategies from Proposal to Final Texas Freight
Network Technology and Operations Plan .............................................................................. 12
Exhibit 8: Systems Engineering V-Model ............................................................................... 13
Exhibit 9: Illustrative Example of High-Resolution Freight Traveler Information
System Strategy ...................................................................................................................... 15
Exhibit 10: Texas’ Freight Mobility Plan Goals and Objectives Related to the
Highway Mode ..................................................................................................................... 17
Exhibit 11: Level-of-Service (LOS) Descriptions ................................................................. 19
Exhibit 12: Daily Level-of-Service on the THFN, 2016 ......................................................... 21
Exhibit 13: Truck Buffer Time Index on the THFN 2016 ....................................................... 22
Exhibit 14: Annual Hours of Truck Delay (Millions) – Interstates .............................................. 23
Exhibit 15: Forecasted Total Freight Tons by Mode, 2016 and 2045 ........................................... 24
Exhibit 16: Bridge Issues and Poor Pavement Conditions on the Texas
Highway Freight Network ......................................................................................................... 26
Exhibit 17: Commercial Motor Vehicle-Related Crashes on Texas Roads (2013
to 2017) ..................................................................................................................................... 27
Exhibit 18: TxDOT ITS Inventory - CCTV Camera ...................................................................... 29
Exhibit 19: TxDOT ITS Inventory - Dynamic Message Sign .................................................... 31
Exhibit 20: TxDOT ITS Inventory - Vehicle Detection Stations .................................................. 33
Exhibit 21: TxDOT TMCs and ATMS Platforms ........................................................................ 34
Exhibit 22: LoneStar ATMS Information Availability ............................................................. 35
Exhibit 23: TxDOT Traffic Management Centers – ITS Coverage ........................................... 36
Exhibit 24: TxDOT ITS Inventory – Weigh-In-Motion and Permanent Count
Stations ..................................................................................................................................... 38
Exhibit 25: Commercial Ports of Entry with Border Wait Time Information .............................. 40
Exhibit 26: Border Crossing Information System Website ......................................................... 41
Exhibit 27: City of Sugar Land ITS Website (with Rail Crossing Status Layer Shown) ................ 42
Exhibit 28: I-10 TPAS High-Level Concept .............................................................................. 43
Exhibit 29: DriveTexas Website (Statewide) ........................................................................... 46
Exhibit 30: TxDOT STARS II Website ..................................................................................... 47
Exhibit 31: Affiliated User Needs for the High-Resolution Freight Traveler
Information System Strategy ...................................................................................................... 53
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>AASHTO</td>
<td>American Association of State Highway and Transportation Officials</td>
</tr>
<tr>
<td>AI</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>AIAA</td>
<td>American Institute of Aeronautics and Astronautics</td>
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<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
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<tr>
<td>API</td>
<td>Application Programming Interfaces</td>
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<tr>
<td>ATCMTD</td>
<td>Advanced Transportation and Congestion Management Technologies Deployment</td>
</tr>
<tr>
<td>ATIS</td>
<td>Advanced Traveler Information System</td>
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<tr>
<td>ATMS</td>
<td>Advanced Traffic Management System</td>
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<tr>
<td>ATRI</td>
<td>American Transportation Research Institute</td>
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<tr>
<td>BCO</td>
<td>Beneficial Cargo Owners</td>
</tr>
<tr>
<td>BTI</td>
<td>Buffer Time Index</td>
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<tr>
<td>CAT</td>
<td>Cooperative Automated Transportation</td>
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<tr>
<td>CAV</td>
<td>Connected and Automated Vehicle</td>
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<tr>
<td>CCTV</td>
<td>Closed-Circuit Television</td>
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<tr>
<td>CMV</td>
<td>Commercial Motor Vehicle</td>
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<tr>
<td>ConOps</td>
<td>Concept of Operations</td>
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<tr>
<td>CRFC</td>
<td>Critical Rural Freight Corridor</td>
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<tr>
<td>CRIS</td>
<td>Crash Records Information System</td>
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<tr>
<td>CTECC</td>
<td>Combined Transportation, Emergency &amp; Communications Center</td>
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<tr>
<td>CTR</td>
<td>University of Texas at Austin Center for Transportation Research</td>
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<tr>
<td>CV</td>
<td>Connected Vehicle</td>
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<tr>
<td>DMS</td>
<td>Dynamic Message Sign</td>
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<tr>
<td>DSRC</td>
<td>Dedicated Short Range Communications</td>
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<td>ELD</td>
<td>Electronic Logging Device</td>
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<td>ETC</td>
<td>Electronic Toll Collection</td>
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<td>FHWA</td>
<td>Federal Highway Administration</td>
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<td>FNTOP</td>
<td>Freight Network Technology and Operations Plan</td>
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<td>FRATIS</td>
<td>Freight Advanced Traveler Information System</td>
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<tr>
<td>FTE</td>
<td>Full Time Equivalents</td>
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<tr>
<td>GHG</td>
<td>Greenhouse Gases</td>
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<td>GIWW</td>
<td>Gulf Intracoastal Waterway</td>
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<tr>
<td>HCRS</td>
<td>Highway Condition Reporting System</td>
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<tr>
<td>HOT</td>
<td>High Occupancy Toll</td>
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<tr>
<td>HWDS</td>
<td>High Water Detection Systems</td>
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<tr>
<td>IEC</td>
<td>International Electrotechnical Commission</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
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<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
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<tr>
<td>IT</td>
<td>Information Technology</td>
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<td>Acronym</td>
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<tr>
<td>ITS</td>
<td>Intelligent Transportation System</td>
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<tr>
<td>LOS</td>
<td>Level-of-Service</td>
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<tr>
<td>MPO</td>
<td>Metropolitan Planning Organization</td>
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<tr>
<td>O&amp;M</td>
<td>Operations and Maintenance</td>
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<tr>
<td>OBU</td>
<td>On-Board Unit</td>
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<tr>
<td>O-D</td>
<td>Origin and Destination</td>
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<td>OEM</td>
<td>Original Equipment Manufacturers</td>
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<tr>
<td>OS/OW</td>
<td>Oversize/Overweight</td>
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<td>PAAC</td>
<td>Port Authority Advisory Committee</td>
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<tr>
<td>PII</td>
<td>Personally Identifiable Information</td>
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<tr>
<td>RFID</td>
<td>Radio Frequency Identification</td>
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<tr>
<td>RIMS</td>
<td>Regional Incident Management System</td>
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<tr>
<td>RSU</td>
<td>Roadside Unit</td>
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<tr>
<td>RWIS</td>
<td>Road Weather Information System</td>
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<tr>
<td>STARS II</td>
<td>Statewide Traffic Analysis and Reporting System</td>
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<td>STRATIS</td>
<td>South Texas Regional Advanced Transportation Information System</td>
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<tr>
<td>SWRI</td>
<td>Southwest Research Institute</td>
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<tr>
<td>SWZ</td>
<td>Smart Work Zones</td>
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<tr>
<td>TCDS</td>
<td>Traffic Count Database System</td>
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<tr>
<td>TCFC</td>
<td>Texas Connected Freight Corridors Project</td>
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<td>TFMP</td>
<td>Texas Freight Mobility Plan</td>
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<tr>
<td>THFN</td>
<td>Texas Highway Freight Network</td>
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<tr>
<td>TIDC</td>
<td>Traveler Information During Construction</td>
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<tr>
<td>TMC</td>
<td>Traffic Management Center</td>
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<tr>
<td>TMFN</td>
<td>Texas Multimodal Freight Network</td>
</tr>
<tr>
<td>TMS</td>
<td>Truck Management System</td>
</tr>
<tr>
<td>TPAS</td>
<td>Truck Parking Availability System</td>
</tr>
<tr>
<td>TPP</td>
<td>Transportation Planning and Programming</td>
</tr>
<tr>
<td>TTI</td>
<td>Texas 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>
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<tr>
<td>TxDPS</td>
<td>Department of Public Safety</td>
</tr>
<tr>
<td>USDOT</td>
<td>United States Department of Transportation</td>
</tr>
<tr>
<td>V2I</td>
<td>Vehicle-to-Infrastructure</td>
</tr>
<tr>
<td>VC</td>
<td>Vehicle Classification</td>
</tr>
<tr>
<td>WIM</td>
<td>Weigh-in-Motion</td>
</tr>
<tr>
<td>XML</td>
<td>Extensible Markup Language</td>
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1.0 Introduction
The Freight Network Technology and Operations Plan (FNTOP) is anticipated to be the most comprehensive freight technology planning effort among state Departments of Transportation (DOTs) in the U.S. The FNTOP intends to outline potential strategies to guide technology- and operations-related investments on the Texas Multimodal Freight Network (TMFN). The FNTOP includes a review of current and future transportation challenges, opportunities, and the development of user needs informed by 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 across all modes of freight transportation.

This document—titled Concept of Operations—discusses key information for the High-Resolution Freight Traveler Information System strategy, which was one of the strategies identified in the FNTOP and recommended by stakeholders for advancement to the ConOps phase. The objective of a ConOps is to describe the operation of the proposed system in a non-technical and easy-to-understand manner. How the system is to be used and its anticipated benefits is described from multiple stakeholder viewpoints as a way to provide a bridge between the needs that motivated the project and the specific technical requirements.

1.1 Project Overview
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 the Texas Department of Transportation’s (TxDOT) needs, challenges, and opportunities in terms of physical Intelligent Transportation System (ITS) and related infrastructure, digital framework and related infrastructure, operations, staffing and expertise, and state-wide, 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 will guide Texas’s strategic development and deployment of innovative multimodal freight transportation technologies, techniques, research, and methods.

1.2 Project Reports
The FNTOP is based on a detailed assessment of current and future needs, challenges, gaps, and opportunities that inform strategies and a stand-alone Implementation Plan. These assessments are compiled in the following technical reports:

- **Goals and Objectives Report.** Developed goals and objectives for the FNTOP in alignment with existing and ongoing planning efforts and stakeholder input.

- **State of the Practice Assessment Report.** Assessed the state of the practice regarding freight-related groups, policies, and initiatives in Texas, in addition to existing and emerging domestic and international freight technological and operational developments.

- **Inventory of Existing Conditions Report.** Identified ITS assets, applications, and programs that exist on the TMFN, as well as summarized operational and management processes related to TxDOT and partner use of technology infrastructure.

- **Stakeholder Outreach Summary Report.** Summarized discussions and feedback collected at Texas public agency meetings, deeper-dive discussions with various TxDOT Divisions, Cooperative Automated Transportation (CAT) meeting, Port Authority Advisory Committee (PAAC) meeting, FNTOP regional stakeholder meetings, TxDOT stakeholder webinar workshop, FNTOP briefing with private and public sector stakeholders, as well as the set of one-on-one stakeholder interviews conducted.

- **User Needs Assessment Report.** Identified and assessed the technological and operational needs of the TMFN based on public and private sector stakeholder feedback, which were combined with initial research efforts to establish a set of FNTOP User Needs.

- **Strategies and Conceptual Framework Report.** Documented FNTOP identified strategies that are relevant to the goals and objectives of the FNTOP and based on documented FNTOP User Needs. Identified details of the FNTOP identified strategies, including how they are prioritized and how they could fit together as part of a larger conceptual framework that builds upon the existing Texas ITS program.

- **Concepts of Operations.** Developed in-depth concepts of desired operations and maintenance requirements for the six FNTOP recommended strategies selected for Concept of Operations (ConOps) development.

- **Implementation Plan.** Identified near-term, medium-term, and long-term actions, in addition to considerations necessary for the rollout of each of the 10 FNTOP recommended strategies as they are transitioned from planning to design.
• **Freight Network Technology and Operations Plan.** Will summarize the entire plan development tasks, as well as incorporate the technical and stakeholder engagement tasks completed throughout this project in a final plan.

In an effort to keep up with technology trends, TxDOT is separately developing its CAT Strategic Plan. This statewide plan looks at strategies and opportunities for advancing emerging technologies, such as Connected Vehicles (CVs), Automated Vehicles (AVs), and electric vehicles (EVs). With a number of goals that relate to the TMFN, the plan aims to put Texas at the forefront of innovation. Although the CAT Strategic Plan is separate from the FNTOP, it has overlapping goals and objectives that have been used to help inform the FNTOP’s efforts and identified strategies.

1.3 **Stakeholder Engagement**
The FNTOP began with research on existing freight initiatives at TxDOT to gain a better understanding of the current challenges faced by the Texas freight community. TxDOT then reached out to a diverse group of stakeholders with a goal 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. The stakeholder interviews verified and supported many of the issues identified by the FNTOP, while also informing the prioritization of potential strategies to address deficiencies in the system.

This outreach included public sector stakeholders (internal and external to TxDOT; federal, state, and local) and private sector stakeholders. A brief overview of the full FNTOP outreach effort is provided below:

- **TxDOT Stakeholder Groups (Division Offices)** – This effort included key personnel from many TxDOT Divisions, including the 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 TxDOT CAT Meeting, PAAC Meeting, Houston (TranStar) Stakeholder Meeting, Dallas/Fort Worth Stakeholder Meeting, a dedicated breakout session at the 2019 Texas Mobility Summit in San Antonio, a stakeholder webinar workshop, and a FNTOP briefing with private and public sector stakeholders. At each meeting or session, moderators collected feedback regarding challenges and opportunities associated with technology-based operational strategies to improve freight transportation safety and mobility in Texas.

- **Public/Private Sector Stakeholder Outreach** – This effort consisted of one-on-one phone and in-person interviews (total of 58) with stakeholder representatives in multiple freight modes, freight companies, railroads, original equipment manufacturers (OEMs), startups, industry groups, telecommunications companies, research institutes, MPOs,
cities, federal government, and others. A breakdown by type of stakeholder, based on the 58 interviews, is shown in Exhibit 1.

**Exhibit 1: Distribution of Stakeholder Types for Public/Private Sector Outreach**

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### 1.4 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\(^1\), 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. 21,861 miles are on the 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 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

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\(^1\) Texas Department of Transportation, *Texas Freight Mobility Plan 2018*, March 7, 2018.
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 Railway Company, and Union Pacific Railroad), 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 are 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 (M-69), is also a part of the TMFN. M-69 handles two-thirds of the waterway’s traffic, moving 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 are 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, 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 identifies the key corridors that facilitate the efficient and safe movement of goods in Texas and are the most critical for focused investment.
**Exhibit 2: Overview of Texas Multimodal Freight Network Assets**

- **313,000** roadway centerline miles
  - 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

- **10,539** miles of railroads on the TMFN
  - 8 Class I railroads
  - 49 Class III or shortline railroads
  - Transporting **441 million** tons

- **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 GIWW, all on TMFN
  - Transporting **598 million** tons

- **24** commercial airports
  - 7 air cargo airports on TMFN
  - Transporting **1.8 million** tons

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

- **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.*
The 2018 TFMP identified eight goals and associated objectives that help inform and articulate TxDOT’s freight investment priorities, help define freight system investment needs,
and identify the desired future performance of the TMFN. Exhibit 4 summarizes these goals, some of which will be utilized later in this document to identify deficiencies in the existing system and justify deployment of the identified strategy.

**Exhibit 4: 2018 TFMP Goals**

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<thead>
<tr>
<th>2018 TFMP Goals</th>
<th>Description</th>
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<tbody>
<tr>
<td>Safety</td>
<td>Improve multimodal transportation safety</td>
</tr>
<tr>
<td>Economic Competitiveness</td>
<td>Improve the contribution of the Texas freight transportation system to economic competitiveness, productivity and development</td>
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<tr>
<td>Asset Preservation and Utilization</td>
<td>Maintain and preserve infrastructure assets using cost-beneficial treatments</td>
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<tr>
<td>Mobility &amp; Reliability</td>
<td>Reduce congestion and improve system efficiency and performance</td>
</tr>
<tr>
<td>Multimodal Connectivity</td>
<td>Provide transportation choices and improve system connectivity for all freight modes</td>
</tr>
<tr>
<td>Stewardship</td>
<td>Manage environmental and TxDOT resources responsibly and be accountable in decision-making</td>
</tr>
<tr>
<td>Customer Service</td>
<td>Understand and incorporate citizen feedback in decision-making processes and be transparent in all TxDOT communications</td>
</tr>
<tr>
<td>Sustainable Funding</td>
<td>Identify sustainable funding sources for all freight transportation modes</td>
</tr>
</tbody>
</table>

Source: Texas Department of Transportation, Texas Freight Mobility Plan 2018

1.5 **Summary of Existing Conditions and User Needs**

The FNTOP reviewed the existing ITS program in Texas, which represents the vast majority of TxDOT’s real-time traffic management applications that serve roadway user needs, including freight. TxDOT utilizes Traffic Management Centers (TMC) as one of the key tools to operate and manage its road network and DriveTexas as an Advanced Traveler Information System (ATIS) for distributing information to the public. TxDOT is a participant in several advanced mobility initiatives, including an Integrated Corridor Management (ICM) program, a freight signal priority project, and several Connected Vehicle initiatives; still, the vast majority of the ITS and traffic management program resides in major metropolitan areas, with limited coverage or response capabilities in rural areas. Relevant ITS programs in the context of this strategy are discussed later in Section 2.2. Further details on these programs and others can be found in the FNTOP State of the Practice Assessment Report and FNTOP Inventory of Existing Conditions Report.
User Needs for the FNTOP were informed by the FNTOP Goals and Objectives, the FNTOP State of the Practice Assessment Report, the FNTOP Inventory of Existing Conditions Report, and input from stakeholders. Relevant user needs that apply to this ConOps are presented in Section 2.5 to aid with traceability of features described later in the document. A full list of FNTOP User Needs can be found as part of the FNTOP User Needs Assessment Report.

1.6 Summary of Strategies and Conceptual Framework Report

The FNTOP developed a series of technological strategies for improving freight operations in Texas. The strategies developed as part of the FNTOP consider the range of existing and emerging solutions available, based on traceability of the solutions to identified user needs prepared as part of the FNTOP User Needs Assessment. Exhibit 5 summarizes the potential strategies proposed to guide technology- and operations-related investments on the TMFN. Based on internal discussion and coordination with TxDOT, 10 of the 12 FNTOP strategies were advanced based on favorable feedback regarding direct relevance/importance to freight needs, uniqueness as a standalone strategy, and value as an application. The two strategies not advanced represented an infrastructure solution (Fiber Optic Expansion) and a strategy deemed to be too similar to another strategy (Freight Integrated Corridor Management).

Key public and private stakeholders were engaged to obtain feedback on the 10 strategies, including suggested refinements, and priorities. Through outreach efforts, stakeholders were asked to rank the identified strategies based on the following questions:

- Does the strategy add value to the Texas Multimodal Freight Network?
- Is the strategy likely to succeed in Texas?

A total of six strategies were recommended to advance to Concept of Operations development. There was consistent agreement among TxDOT and its stakeholders that these strategies had high scores for adding value to the TMFN and were likely to succeed in Texas. The other strategies developed as part of this effort were either underway as part of a separate effort or deferred due to another TxDOT initiative. Exhibit 5 reflects the final recommendations for each strategy.
Exhibit 5: Summary of Proposed FNTOP Strategies

<table>
<thead>
<tr>
<th>Identified Strategy</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck Parking Availability System</td>
<td>Underway(^1)</td>
</tr>
<tr>
<td>High-Resolution Freight Traveler Information System</td>
<td>Advanced to Concept of Operations</td>
</tr>
<tr>
<td>Centralized Data Repository for Freight Applications</td>
<td>Deferred(^2)</td>
</tr>
<tr>
<td>AV Infrastructure, Connected Signing, and Data Safety Warning Detection System</td>
<td>Advanced to Concept of Operations</td>
</tr>
<tr>
<td>Smart Freight Connector</td>
<td>Advanced to Concept of Operations</td>
</tr>
<tr>
<td>Blocked Rail Crossing Traffic Management System</td>
<td>Advanced to Concept of Operations</td>
</tr>
<tr>
<td>Smart Work Zone Information System</td>
<td>Underway(^1)</td>
</tr>
<tr>
<td>Statewide Traffic Operations Center</td>
<td>Advanced to Concept of Operations</td>
</tr>
<tr>
<td>Binational Traffic Operations Center</td>
<td>Deferred(^2)</td>
</tr>
<tr>
<td>Freight Integrated Corridor Management</td>
<td>Not Advanced(^3)</td>
</tr>
<tr>
<td>Fiber Optic Cable Expansion</td>
<td>Not Advanced(^4)</td>
</tr>
</tbody>
</table>

\(^1\) Included in other TxDOT ongoing initiatives  
\(^2\) Better fulfills goals and objectives of other TxDOT initiatives  
\(^3\) Not advanced due to similarities with Smart Freight Connector strategy  
\(^4\) Not advanced due to being an infrastructure-focused commodity instead of a technological or operational application.

An overall technology framework was developed to demonstrate how the proposed FNTOP strategies could work together as an integrated statewide system. The framework helps illustrate the relationships between the FNTOP strategies and any overlapping opportunities that might allow for easier deployment. All strategies have the potential to be implemented together in functional groups or as stand-alone systems.

Exhibit 6 shows the relationship among integrated services and strategies.
Exhibit 6: Potential Integrated Services and Strategies
1.7 Purpose of the Concept of Operations Document

The development of a ConOps document is the next critical step necessary for each of the six strategies selected for advancement to create implementable solutions as part of the FNTOP. The objective of a ConOps is to describe the operation of the proposed system in a non-technical and easy-to-understand manner. How the system is to be used and its anticipated benefits is described from multiple stakeholder viewpoints as a way to provide a bridge between the needs that motivated the project and the specific technical requirements. Each required functionality must be traceable back to documented user needs prepared as part of the FNTOP User Needs Assessment to ensure that the ITS project addresses real-world issues. The ConOps document is used to collect feedback from the system users and other stakeholders and to validate key assumptions built into the system concept (e.g., who is responsible for what). By building support, gathering feedback, and refining the proposed concept, the ConOps document serves as a high-level guide for subsequent design efforts (e.g., System Requirements, High-Level Design, Detailed Design). It helps advance the strategy into these subsequent phases by reducing the risk of the strategy failing or being delayed due to a lack of agreement or understanding of the proposed concept.

The establishment of TxDOT and stakeholder priorities informed the selection of the six strategies that advanced to a ConOps. The development of FNTOP strategies, from proposal to ConOps, is outlined in Exhibit 7.

Exhibit 7: Formulation of Strategies from Proposal to Final Texas Freight Network Technology and Operations Plan

Projects that engineer systems—whether the project is a simple ITS deployment or a complex commercial airliner—follow what is called the Systems Engineering Process. This process identifies and outlines procedural steps of how the system is incrementally developed, how the system is incrementally validated by stakeholders, and how the system is to be
measured and accepted. The “V” Development Model, shown in Exhibit 8, is a visualization of one such process. This model was developed based on Systems Engineering industry standards and is part of U.S. Department of Transportation’s (USDOT) best practices for ITS projects. The development processes outlined in the model help transportation agencies use common, consistent, and well-established systems engineering tools and processes to:

- Improve the quality of Intelligent Transportation Systems;
- Reduce the risk of cost and schedule overruns;
- Gain wide stakeholder participation;
- Maintain, operate, and evolve the Intelligent Transportation System;
- Maintain consistency with the regional and state ITS architectures;
- Provide flexibility in procurement options for the agencies; and
- Keep current with the rapid evolution of technology.

Exhibit 8: Systems Engineering V-Model

Development of the ConOps document is the first major step of the Decomposition and Definition phase of the V-Model, where ITS project concepts become more defined. It helps establish the simple expectations of the system so that stakeholders can understand what the project intends to do and understand how it will be later validated when complete.

Source: Federal Highway Administration California Division and Caltrans, Systems Engineering Guidebook for ITS Version 3.0 Website

Website
1.8 High-Resolution Freight Traveler Information System Overview

This ConOps is focused on the High-Resolution Freight Traveler Information System strategy, which was one of the priority strategies identified in the FNTOP and recommended by stakeholders for advancement to the ConOps phase. At a high level, the strategy aims to expand the capabilities of DriveTexas to provide a high-quality freight traveler information service, focused on urban, suburban, and rural truck routes in Texas. This strategy will implement TxDOT-owned sensor infrastructure on key limited-access and arterial truck routes and explore options to fuse TxDOT sensor data with other third-party probe-based data services to create a more robust scan of travel conditions along a route. The purpose of this robust data collection effort is to create a traffic data environment within Texas that 1) provides clear real-time conditions for freight mobility, 2) allows for advanced analysis and early detection of network disruptions, such as due to incidents, and 3) facilitates the use of advanced algorithms to predict travel conditions into the future to help with time-dependent route planning (i.e. route planning that factors in predicted future conditions).

This strategy aims to build upon other ongoing work in Texas. The University of Texas at Austin Center for Transportation Research (UT CTR) is currently leading a research project titled, “Exploring the Use of Artificial Intelligence to Leverage TxDOT Data for Enhanced Corridor Management and Operations.” This work is discussed later in this ConOps.

Exhibit 9 provides an illustrative example of the High-Resolution Freight Traveler Information System strategy that was previously discussed in the FNTOP Strategies and Conceptual Framework Report.
Key objectives—collected through stakeholder outreach and other FNTOP efforts—identified to frame what this system shall ultimately do include:

- Improve the entire transportation system by assisting the freight industry in moving efficiently from a starting location to their desired destination;
- Expand the coverage and granularity of traveler information to include urban arterials and rural truck routes;
- Increase opportunities for truckers to make informed route planning and real-time execution decisions;
- Reduce environmental impacts due to delays;
- Improve freight planning data used internally by TxDOT;
- Facilitate early detection of network disruptions, such as due to incidents;
- Predict travel conditions into the future to help with time-dependent route planning (i.e. route planning that factors in predicted future conditions); and
- Securely collect and distribute data at a clearly-defined virtual location for public use.
1.9 Organization of the Report

This document is one of the deliverables as defined under Task 2.6: Develop Concept of Operations from the scope of work for Cambridge Systematics, Inc.’s project number 160058.006 named Texas Freight Network Technology and Operations Plan. The scope of work document is TxDOT Work Authorization No. 6, Contract No. 50-6IDP5011. This ConOps covers the topic areas outlined in ANSI/AIAA-G-043 and IEEE Standard 1362\(^3\), as recommended by the FHWA for ConOps development.

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

- **Section 2 – The Current Situation in Texas.** This section describes current systems and technologies utilized by stakeholders and how each is being used, deficiencies of the existing systems, desired changes to the systems and priorities, and assumptions and challenges.

- **Section 3 – Concept for the Proposed High-Resolution Freight Traveler Information System.** This section contains a description of the desired system and high-level requirements, how it will address the concerns outlined in Section 2, how it will operate, and how users will interface with the system.

- **Section 4 – Benefits, Impacts, and Alternatives of the High-Resolution Freight Traveler Information System.** This section describes the expected operational and organizational benefits and impacts of the essential features of the new system, the potential impacts during development, disadvantages and limitations of the proposed system, and alternatives and tradeoffs considered while developing the system concept.

- **Section 5 – Operational Scenarios.** This section identifies potential real-world situations for the system. Each scenario describes how stakeholders respond to and benefit from the implementation and operation of the new system.

- **Section 6 – Next Steps.** This section outlines the next steps of the Texas FNTOP following the development of the Concept of Operations documents, including the near-term development of the Implementation Plan.

- **Section 7 – References.** This section lists all references used in the creation of this document.

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3 ANSI refers to the American National Standards Institute, AIAA refers to the American Institute of Aeronautics and Astronautics, and IEEE refers to the Institute of Electrical and Electronics Engineer. All three are standards-setting organizations.
2.0  The Current Situation in Texas

The purpose of this section is to highlight the current situation in Texas, including the existing systems currently in operation, and the deficiencies that are present. It later discusses the user classes that could apply to this ConOps document and the User Needs that support motivations to pursue an enhanced system.

2.1  Description of the Current Situation

The 2018 TFMP provides a comprehensive multimodal freight transportation plan for Texas, which is based on a decade of multimodal strategic planning and stakeholder collaboration at the statewide, regional, and local levels to facilitate continued economic growth and goods movement throughout the state. The TFMP and its related recommendations supports the USDOT National Multimodal Freight Policy and national freight goals; it also includes state-specific recommendations to explore technology options as part of policy and planning to enhance freight transportation system safety, management, operations, and asset preservation. In the context of implementing solutions that would offer freight-specific traveler information along the THFN, there are several TFMP goals as shown in Exhibit 10 that support this strategy. Key existing conditions associated with the impacts of freight on highway safety, mobility, and system asset conditions and the role of freight in supporting the state economy are discussed in the following subsections.

Exhibit 10: Texas’ Freight Mobility Plan Goals and Objectives

<table>
<thead>
<tr>
<th>2018 TFMP Goals</th>
<th>Description</th>
<th>Objectives Related to the Highway Mode</th>
</tr>
</thead>
</table>
| Mobility and Reliability | Reduce congestion and improve system efficiency and performance | • Apply the most cost-effective methods to improve system capacity and reliability (including technology and operations).  
• Leverage technology to improve management and operations of the existing transportation system. |
<table>
<thead>
<tr>
<th>Description</th>
<th>Objectives Related to the Highway Mode</th>
</tr>
</thead>
</table>
| Improve the contribution of the Texas freight transportation system to economic competitiveness, productivity and development | • Strengthen Texas’ position as a global trade and logistics hub by improving and maintaining TMFN’s infrastructure and connectivity.  
• Expand public-private and public-public partnerships to facilitate investments in freight improvements that enhance economic development and global competitiveness.  
• Support strategic transportation investments to address the rapid increase in key industries, such as energy, plastics, agriculture and automotive production. |
| Maintain and preserve infrastructure assets using cost-beneficial treatments | • Leverage and utilize the TMFN.  
• Utilize technology to provide for the resiliency and security of the state’s multimodal freight transportation system in response to multi-hazard threats, including natural disasters and man-made threats. |
| Improve multimodal transportation safety                                      | • Reduce rates of truck-involved crashes, injuries and fatalities on the THFN.  
• Support the deployment of innovative technologies to enhance the safety and efficiency of the TMFN.  
• Increase the resiliency and security of the state’s freight transportation system in response to multi-hazard threats, including natural disasters and man-made threats. |

Source: Texas Department of Transportation, Texas Freight Mobility Plan 2018 – Executive Summary, March 7, 2018

2.1.1 Mobility and Reliability
One of the goals of the 2018 TFMP is to measure the level-of-service (LOS) on the THFN and reduce the number of miles operating at LOS D or worse. Exhibit 11 illustrates the LOS ratings that were used in the 2018 TFMP, with supplemental descriptions provided by the Highway Capacity Manual and the American Association of State Highway and
Transportation Officials (AASHTO) Geometric Design of Highways and Streets ("Green" Book). LOS is a qualitative measure for describing traffic operational conditions. LOS is a standard index of the service provided by a transportation facility and can range from LOS A (free-flow conditions) through LOS F (severely congested conditions).

### Exhibit 11: Level-of-Service (LOS) Descriptions

<table>
<thead>
<tr>
<th>Rating</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOS A</td>
<td>Free flow. Traffic flows at or above the posted speed limit and motorists have complete mobility between lanes. Motorists have a high level of physical and psychological comfort. The effects of incidents or point breakdowns are easily absorbed.</td>
</tr>
<tr>
<td>LOS B</td>
<td>Reasonably free flow. LOS A speeds are maintained, maneuverability within the traffic stream is slightly restricted. Motorists still have a high level of physical and psychological comfort.</td>
</tr>
<tr>
<td>LOS C</td>
<td>Stable flow, at or near free flow. Ability to maneuver through lanes is noticeably restricted and lane changes require more driver awareness. Most experienced drivers are comfortable, roads remain safely below but efficiently close to capacity, and posted speed is maintained. Minor incidents may still have no effect, but localized service will have noticeable effects and traffic delays will form behind the incident.</td>
</tr>
<tr>
<td>LOS D</td>
<td>Approaching unstable flow. Speeds slightly decrease as traffic volumes slightly increase. Freedom to maneuver within the traffic stream is much more limited and driver comfort levels decrease. Minor incidents are expected to create delays.</td>
</tr>
<tr>
<td>LOS E</td>
<td>Unstable flow, operating at capacity. Flow becomes irregular and speed varies rapidly because there are virtually no usable gaps to maneuver in the traffic stream and speeds rarely reach the posted limit. Any disruption to traffic flow, such as merging ramp traffic or lane changes, will create a shock wave affecting traffic upstream. Any incident will create serious delays. Driver level of comfort becomes poor.</td>
</tr>
<tr>
<td>LOS F</td>
<td>Forced or breakdown flow. Every vehicle moves in lockstep with the vehicle in front of it, with frequent slowing required. Travel time cannot be predicted, with generally more demand than capacity. A road in a constant traffic jam is at this LOS, because LOS is an average or typical service rather than a constant state.</td>
</tr>
</tbody>
</table>

Source: Texas Department of Transportation, Texas Freight Mobility Plan 2018 – March 7, 2018

The 2018 TFMP found that 72 percent of Texas’ interstate highway mainlines operated at or better than LOS D during the peak period. Similarly, 90 percent of Texas state highways operated at or better than LOS D during the peak period, with 76 percent operating at or
better than LOS B. The large urban areas of Dallas-Fort Worth, Houston, San Antonio, and Austin had the most significant congestion and the largest share of THFN facilities operating at LOS E or worse. As identified in 2017 by the American Transportation Research Institute (ATRI) for the Federal Highway Administration (FHWA), nine of the top 50 freight bottlenecks in the U.S. were reported to be clustered in Texas’ metropolitan regions (i.e. Austin, Dallas-Fort Worth, and Houston), and the top 10 of Texas Transportation Institute’s (TTI) congested truck locations in 2016 within Texas were reported to be in these metropolitan areas as well. Exhibit 12 shows the 2016 daily LOS for the THFN.

Congestion on the THFN can contribute to additional delays and degradation to travel time reliability. As congestion increases, travel times are increasingly impacted by fluctuations to normal travel from events, such as traffic incidents, work zones, and weather. The 2018 TFMP looked at the truck Buffer Time Index (BTI) on the THFN as a measure of travel time reliability. Buffer Time is the amount of extra time a traveler needs to account for above average travel time to ensure being on time 95 percent of the time. The BTI normalizes that buffer time against the average travel time controlling for distance and typical daily congestion. For example, 15 minutes of buffer time relative to an average commute time of 30 minutes equates to a BTI of 0.50. Exhibit 13 shows the 2016 BTI on the THFN.
Exhibit 12: Daily Level-of-Service on the THFN, 2016

Source: Texas Department of Transportation, Texas Freight Mobility Plan 2018 – March 7, 2018
The 2018 TFMP also included performance targets for projected annual hours of delay for the interstate portion of the Texas highway system. Exhibit 14 shows the actual results and targets for FY 2014 and the targets for FY 2018 and FY 2025. The actual result in FY 2014 for rural areas exceeded its target by one million hours of truck delay, which contributed to the state exceeding its overall target of 12.5 million hours of delay by 300,000 hours. The
targets for FY 2025 compared to the results in FY 2014 indicate a projected increase of over 50 percent in hours of truck delay in urban areas and a greater increase of 110 percent in rural areas; the overall statewide target shows an expected increase of 60 percent resulting in 7.7 million additional hours of truck delay from FY 2014 actual to FY 2025.

Exhibit 14: Annual Hours of Truck Delay (Millions) – Interstates

2.1.2 Economic Competitiveness
The 2018 TFMP has the stated goal of increasing economic competitiveness with the objectives of maintaining Texas’ leading position as a global trade and logistics hub and investing in freight infrastructure that addresses the growth of key industries and consumer needs. Texas is the second largest economy in the U.S. with a gross state product (GSP) of $1.6 trillion in 2016 and is a key logistics hub and gateway for international trade. The state’s freight industry is critical to the competitiveness of the Texas economy, which benefits from an extensive multimodal transportation system that transports billions of tons of goods each year. According to the 2018 TFMP, the freight industry is an important direct contributor to the state economy. The industry employed nearly 2.2 million Texans, paid nearly $145 billion in wages, and contributed $215 billion to the GSP. The economic activity of the freight industry also contributed $16 billion in state and local tax revenues.

The freight industry will be a key driver for economic growth in Texas, as freight volumes are expected to continue increasing in concert with the upward trends in the state’s population and economy, and growth in cross-border trade with Mexico. According to the 2018 TFMP,
highway tonnage is expected to more than double from 1.2 billion tons in 2016 to 2.5 billion tons in 2045. In the same time period, freight value is also expected to grow from $1.7 trillion to $5.2 trillion. Mexico is the state’s largest trading partner. Between 2009 and 2016, the value of exports to Mexico grew by 65 percent while imports increased by 43 percent.

Exhibit 15 provides more detail on the forecasted growth in freight tonnage. It also illustrates that trucks account for a large amount of total freight activity in the state. In 2016, trucks accounted for 54 percent of total tonnage movement in Texas. That tonnage is expected to grow significantly by 2045, underscoring the importance of technological advancements that can improve efficiency in the trucking industry.

Exhibit 15: Forecasted Total Freight Tons by Mode, 2016 and 2045

![Bar chart showing forecasted total freight tons by mode in 2016 and 2045.]

Source: Texas Department of Transportation, Texas Freight Mobility Plan 2018 – March 7, 2018.

TxDOT's focus on making continual infrastructure investments to facilitate freight movement is key to sustaining the state’s economic competitiveness. The statewide population is expected to increase by nearly 70 percent from 28 million in 2016 to 47 million in 2050, according to projections by the Texas Demographic Center. The 2018 TFMP expects population growth to concentrate mostly in the major metropolitan areas of San Antonio, Austin, Dallas-Fort Worth, and Houston. Major freight transfer facilities, such as ports, airports, and distribution centers, are located in urban areas as well. The congestion in those areas can impact freight operations, especially during the peak periods. Urban areas

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4 Source: Texas Populations Projections Program, Sex and Race/Ethnicity Total Population for 2010-2050
with a large number of e-commerce users are shaping new freight delivery models using self-driving or self-piloting technologies, such as drones and automated vans and shuttles.

The expanded use of ITS infrastructure, along with future developments in self-driving or self-piloting technologies, has the potential to increase the efficiency of freight operations by allowing more vehicles to use the existing highway capacity more effectively. The increasing demand for freight from households and businesses will likely outpace the rate at which physical capacity is added to the system. Investments in ITS infrastructure and the proliferation of Connected and Automated Vehicles (CAVs) on Texas roads will result in both greater demand for and availability of traveler information.

2.1.3 Asset Preservation and Utilization
The 2018 TFMP took a comprehensive look at asset preservation needs, including bridges with low vertical clearances, poor condition, or load restrictions, and pavement rated as being in poor condition. Exhibit 16 shows bridge issues and poor pavement conditions on the THFN. The TFMP reported that 85 percent of total lane miles on the THFN in 2016 were deemed “fair” or better. Of the 20,778 bridges on the THFN, 76 bridges were rated in poor condition; 13 bridges were restricted to loads of 80,000 pounds or less; and 291 bridges had a vertical clearance of less than 15 feet (as of 2017).

Bridges with a vertical clearance of less than 15 feet can be especially problematic, resulting in dangerous and costly bridge strikes by oversized vehicles. In 2017, TxDOT implemented a new vertical clearance standard that calls for a minimum clearance height of 18 feet and 6 inches (18’-6”) for all bridges and other overhead structures located on the THFN. The updated standard applies to new bridge construction or reconstruction projects that are let after September 2020. According to the Crash Records Information System (CRIS data), there were a total of 178 Commercial Motor Vehicle (CMV)-related crashes from 2013 to 2017 that involved freight vehicles striking the top of an underpass or tunnel.

The impacts trucks have on bridge and pavement conditions highlight the need for better routing information for trucks. With better information for pre-planned routes, trucks could avoid low clearance or load restricted bridges and areas of the network where overweight trucks are prohibited from operating.
Exhibit 16: Bridge Issues and Poor Pavement Conditions on the Texas Highway Freight Network

2.1.4 Safety
Improving safety on the THFN is a stated goal of the 2018 TFMP, with the specific objective of reducing rates of CMV-related crashes, injuries, and fatalities. Between 2013 and 2017,
there were almost three million crashes on Texas roadways, with approximately 190,000 crashes involving CMVs, as documented in TxDOT’s CRIS. The data revealed that CMV-related crashes have a greater impact on safety, resulting in a greater probability of serious injuries. During the reporting period, non-CMV-related crashes reported an average of 0.03 serious injuries per incident, while CMV-related crashes reported an average of 0.04 serious injuries per incident.

Exhibit 17 shows the number of CMV-related crashes each year and the number of CMV-related crashes that reported serious injuries or fatalities. During the five-year period, total CMV-related crashes grew at an average rate of five percent per year. Crashes involving serious injuries and fatalities combined represent five percent of the total CMV-related crashes. The number of serious injury and fatality-involved crashes combined grew at an average rate of three percent per year, which is lower than the growth rate observed for non-serious CMV-related crashes.

**Exhibit 17: Commercial Motor Vehicle-Related Crashes on Texas Roads (2013 to 2017)**

When crashes occur, they can have disruptive impacts on transportation system operations. State transportation agencies utilize incident management to respond promptly to these crashes, guide traffic around the crash safely, and clear the incident as quickly as possible to restore the transportation system to full operations. Aside from reducing traveler delay caused by these crashes, a faster incident clearance time often reduces the chance of secondary crashes, which are crashes caused by the disruption of traffic from the first crash (e.g., vehicles crashing into other vehicles at the back of a stopped queue). It is generally understood that detecting an incident as quickly as possible can dramatically reduce the
negative externalities. Unfortunately, most incident detection programs rely on responsive measures, such as 911 phone calls, rather than utilize data to predict the presence of an incident (e.g., a sudden slowdown could be indicative of a crash) due to limited available staff resources to monitor all real-time changes in traffic operations for the whole network.

2.2 Existing Systems

This section discusses the existing traffic operations and management systems in Texas, highlighting systems on the highway network. It is important to understand what systems and functionalities have already been deployed, so that the concept for the proposed system described in Section 3.0 can utilize relevant existing systems to support implementation activities. Refer to the FNTOP Inventory of Existing Conditions Report for additional information on the majority of the existing systems included in this section.

2.2.1 ITS Field Devices

TxDOT operates an extensive network of ITS field devices as part of its traffic management program. Most ITS deployments are located near or within major urban areas or along highly traveled routes, as the largest benefit to road users (passenger cars, freight, etc.) is often captured by focusing investments in these areas. Some of the ITS equipment provides real-time monitoring and managing capabilities on Texas highways today, including:

- Closed-Circuit Television (CCTV) Cameras;
- Dynamic Message Signs (DMS); and
- Traffic Detectors.

Exhibit 18 shows the deployment of cameras at a statewide level. Further details on the CCTV camera program in Texas can be found in the FNTOP Inventory of Existing Conditions Report. In the context of this strategy, CCTV cameras could serve as a potential data provider.
Exhibit 18: TxDOT ITS Inventory - CCTV Camera

DMS are electronic roadside signs that can broadcast changeable messages to road users, which may include public safety announcements, traveler information, incident information,
or other key information. In comparison to static signs, DMSs can be changed in response to real-time events, which allows road users to make informed travel decisions to help improve their safety or mobility. Most DMS are located near major urban areas or along highly traveled routes where benefits to road users are often the greatest due to higher congestion rates and potential for incidents. Exhibit 19 shows the deployment of DMS at a statewide level. Further details on the DMS program in Texas can be found in the FNTOP Inventory of Existing Conditions Report. In the context of this strategy, DMS could serve as a potential data distribution tool for communicating advanced information.
Exhibit 19: TxDOT ITS Inventory - Dynamic Message Sign

Source: Texas Department of Transportation, Traffic Safety Division
Traffic detectors, or sensors, are devices that detect vehicles passing or arriving at a certain point. These detectors are used for real-time operations management, as opposed to other data collection devices like Weigh-in-Motion (WIM) or Vehicle Classification (VC) (discussed in the following sections) that generally provide annualized data to support trend analyses and planning work. Exhibit 20 shows the deployment of vehicle detection stations at a statewide level. Further details on the traffic detector program in Texas can be found in the FNTOP Inventory of Existing Conditions Report. In the context of this strategy, traffic detectors could serve as a potential data provider.
Exhibit 20: TxDOT ITS Inventory - Vehicle Detection Stations

Source: Texas Department of Transportation, Traffic Safety Division
2.2.2 Third-Party Traffic Data Services
Several third-party vendors offer traffic data services that provide real-time, extensive coverage of the road network. These services are commonly used to monitor the movement of certain probe and location-based data in order to synthesize and estimate travel conditions along particular road segments. This third-party data provides a high-level assessment of travel performance and is considered acceptable for use by many transportation agencies to report key information like travel times and truck parking demand, as well as many other uses that inform transportation planning and investment decisions. TxDOT selectively subscribes to third-party traffic data as part of its larger data collection effort. This provides high-level coverage (e.g., “red-yellow-green” travel conditions) for the vast majority of TxDOT routes throughout the state.

Further details on the third-party traffic data in Texas can be found in the FNTOP Inventory of Existing Conditions Report. In the context of this strategy, this type of data service could serve as a potential data provider, especially in unmonitored areas of TxDOT’s transportation system.

2.2.3 Advanced Traffic Management System
All TxDOT TMCs operate their ITS programs using Advanced Traffic Management System (ATMS) software. The ATMS collects and processes raw traffic data in real-time, allowing TMC operators to monitor, detect, and respond to planned and unplanned events. The ATMS software brings multiple ITS devices into one single platform for easy operator use and management within each TMC. ATMS platforms allow for several systems to work collaboratively at the single press of a button or entry of a specific event type.

ATMS platforms for each TxDOT TMC are listed in Exhibit 21. Further details on the TxDOT TMCs and ATMS can be found in the FNTOP Inventory of Existing Conditions Report. In the context of this strategy, the ATMS could serve as a potential source of processed ITS data for this strategy’s advanced processing features.

Exhibit 21: TxDOT TMCs and ATMS Platforms

<table>
<thead>
<tr>
<th>TxDOT TMC</th>
<th>ATMS Platform</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austin Combined Transportation, Emergency &amp; Communications Center (CTECC)</td>
<td>LoneStar</td>
</tr>
<tr>
<td>Dallas DalTrans</td>
<td>LoneStar</td>
</tr>
<tr>
<td>El Paso TransVista</td>
<td>LoneStar</td>
</tr>
<tr>
<td>Fort Worth TransVision</td>
<td>LoneStar</td>
</tr>
<tr>
<td>Houston TranStar</td>
<td>RIMS, LoneStar</td>
</tr>
</tbody>
</table>
The ATMS software contains a wealth of information that is not fed into the DriveTexas traveler information system for dissemination to traffic information users. Types of information available through the ATMS are listed in Exhibit 22.

**Exhibit 22: LoneStar ATMS Information Availability**

<table>
<thead>
<tr>
<th>ATMS Component</th>
<th>Information Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Event Management</td>
<td>Traffic conditions and delays, traffic events (planned and unplanned), blocked roads/lanes</td>
</tr>
<tr>
<td>Travel Times Application</td>
<td>Travel times</td>
</tr>
<tr>
<td>Incident Detection</td>
<td>Number of incidents reported, incident location, incident response time, incident clearance time, crash hot spot analysis</td>
</tr>
<tr>
<td>ITS Devices</td>
<td>Video feeds, travel speeds</td>
</tr>
<tr>
<td>Environmental Sensor Stations</td>
<td>Weather conditions</td>
</tr>
<tr>
<td>Railroad sensors</td>
<td>Railroad signal preemption</td>
</tr>
<tr>
<td>Commercial Vehicle Management/Vehicle Compliance Screening</td>
<td>Commercial vehicle weight, height</td>
</tr>
</tbody>
</table>


Exhibit 23 illustrates the approximate coverage areas for each of TxDOT’s TMCs, based on information gathered through LoneStar as part of the FNTOP. These TMCs are located in the major metropolitan areas to provide coverage where recurrent and non-recurrent congestion most commonly occur. It is likely that each TMC may cover a larger area as part of its operations (e.g., through Waze crowd-sourced incident services or third-party traffic data providers). Note that coverage is estimated based on the availability of real-time applications (i.e. CCTV cameras, DMS, traffic detectors).
Exhibit 23: TxDOT Traffic Management Centers – ITS Coverage

TxDOT Traffic Management Centers - ITS Coverage

Source: Texas Department of Transportation, Traffic Safety Division
2.2.4 Local Road Management
For TxDOT arterial routes that travel through local/regional jurisdictions, agreements are often in place regarding how the roads will be operated. The vast majority of TxDOT’s ITS program exists on major travel corridors. On local arterial routes (owned and operating by a local government entity) and some rural TxDOT routes that are not actively managed by a TMC, communities with a TMC may have deployed a few ITS assets to help serve a local need. A handful of local communities operate their own version of a TMC that is separate from—but often working in collaboration with—the TxDOT TMC.

Many law enforcement departments utilize public safety software solutions as part of their day-to-day operations for managing incidents and other traffic-related issues. These solutions can also support Computer Aided Dispatch (CAD), automated vehicle locations services, record management services, and others. Many police departments utilize CAD and it is common for certain TMCs to have access to the CAD feed.

In the context of this strategy, this type of system could serve as a potential data provider for active law enforcement incident monitoring.

2.2.5 Weigh-In-Motion / Permanent Count Stations
TxDOT owns and operates dedicated WIM and permanent count stations around the state that are used to collect data on vehicle count, classification, and weights (trucks) for planning purposes. WIM is a technology that estimates vehicle weights of at-speed trucks to:

- Inventory the percentage of overweight vehicles at a given location;
- Collect and classify traffic volume data for planning activities; and
- Provide notification of a potentially overweight vehicle for law enforcement to investigate.

Many WIM or permanent count stations are permanent in-field devices to collect annual data, although TxDOT often supplements these stations with temporary device stations to collect partial-year data at specific locations that are then annualized.

Exhibit 24 shows the location of WIM and permanent count stations in Texas. Further details on the WIM and permanent count station program in Texas can be found in the FNTOP Inventory of Existing Conditions Report. In the context of this strategy, this type of system—as well as any systems built in this context—could serve as a potential data provider.
Exhibit 24: TxDOT ITS Inventory – Weigh-In-Motion and Permanent Count Stations

Source: Texas Department of Transportation, Transportation Planning and Programming Division
2.2.6 Artificial Intelligence Systems in Transportation Operations
Some transportation agencies are exploring the use of artificial intelligence (AI) to support rapid detection, confirmation, and notification of operational issues. As mentioned earlier, the UT CTR is currently undergoing a research project titled, “Exploring the Use of Artificial Intelligence to Leverage TxDOT Data for Enhanced Corridor Management and Operations”. The project evaluates potential benefits that AI may offer to TxDOT, utilizing data that is currently available to the agency. The final deliverable will seek to provide TxDOT with appropriate use cases for AI. By looking at the current state of the practice of AI and its relevance to TxDOT, the project sets the stage for the agency to explore more advanced applications. This effort may one day inform part or all of this strategy.

Some private-sector vendors that provide traffic data offer AI and machine learning as part of their proprietary traffic data services. Other AI programs in transportation are discussed in the FNTOP State of the Practice Assessment Report. In the context of this strategy, this type of system could serve as a potential data processing tool.

2.2.7 Electronic Toll Collection Systems
An Electronic Toll Collection (ETC) system is a wireless system that reads the unique identifier of a vehicle’s toll tag. With that unique identifier, the system can determine which user account should be assessed the toll, which is done behind the scenes, saving a vehicle from having to stop and manually pay with cash or a credit card. Aside from fare collection, ETC systems can be utilized to estimate travel times, where a vehicle is scanned at various locations along a corridor, regardless of whether a toll is assessed at that scan point or not. Each scanner records the transponder tag and, along with a timestamp, sends the data to a central computer for processing. As the unique transponder is scanned at successive ETC readers, the central computer calculates an average travel time and speed for the roadway segment.

Further details on the ETC program in Texas can be found in the FNTOP Inventory of Existing Conditions Report. In the context of this strategy, this type of system—as well as any systems built in this context—could serve as a potential data provider.

2.2.8 Border Travel Time System
TTI developed a system that monitors Radio Frequency Identification (RFID) technology installed on trucks to measure wait times at border crossings. This system was deployed at seven commercial ports of entry across Texas by fusing Google’s estimated traffic data with the RFID data along with historical performance data to assess true border crossing times. The seven Texas commercial ports of entry with border wait time measurement are shown in Exhibit 25 and include:

- Veteran’s Memorial Bridge (Brownsville, TX)
- Pharr-Reynosa International Bridge (Pharr, TX)
- World Trade Bridge and Columbia Bridge (Laredo, TX)
• Camino Real International Bridge (Eagle Pass, TX)
• Ysleta Bridge and Bridge of the Americas (El Paso, TX)

Exhibit 25 also shows the Santa Theresa Port of Entry in Santa Theresa, NM, due to proximity to El Paso. Border crossing wait times and other information are published on the Border Crossing Information System website, as shown in Exhibit 26.

Further details on the Border Travel Time System can be found in the FNTOP Inventory of Existing Conditions Report. In the context of this strategy, this type of system—as well as any systems built in this context—could serve as a potential data provider.

Exhibit 25: Commercial Ports of Entry with Border Wait Time Information

Source: Texas A&M Transportation Institute, Border Crossing Information System
2.2.9 Blocked Rail Warning System

The City of Sugar Land currently operates a Railroad Monitoring System at nine at-grade highway-rail crossings along the Union Pacific Railroad and US 90A corridor. The system uses doppler readings and guidance on whether the adjacent signal is being actively preempted by the railroad to determine if the rail crossing has been blocked. This information is utilized by first responders when planning their routes to respond to emergency calls. The monitoring information is transmitted via Bluetooth devices through TranStar and published on the city’s ITS website for public viewing, which is shown in Exhibit 27. The railroad monitoring map provides the train’s location, speed, and the railroad crossings that received preemption calls.

Further details on the Sugar Land Rail Monitoring System can be found in the FNTOP Inventory of Existing Conditions Report. In the context of this strategy, this type of system—as well as any systems built in this context—could serve as a potential data provider.
2.2.10 Flood Detection/Warning Systems

High Water Detection Systems (HWDS) are remote monitoring Road Weather Information System (RWIS) stations that evaluate whether water is detected at a specific elevation, usually corresponding to an imminent or near-imminent flooding of a nearby road. These devices are usually installed in remote areas where sudden rising water would not be noticed until roadway flooding has already started.

Further details on the HWDS program in Texas can be found in the FNTOP Inventory of Existing Conditions Report. In the context of this strategy, this type of system could serve as a potential data provider.

2.2.11 I-10 Corridor Coalition Truck Parking Availability System (TPAS)

As part of a separate effort, and on behalf of the four states of the I-10 Corridor Coalition (Arizona, California, New Mexico and Texas), TxDOT submitted and was awarded an Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) grant application by the USDOT in June 2018. The purpose of the grant award is to deploy the I-10 Corridor Coalition TPAS, which will implement a truck parking availability detection and information system at 37 public truck parking locations along the I-10 corridor from California to Texas. The objective of this system is to make real-time truck parking information available to truck drivers and dispatchers to assist them in making informed parking decisions.

The initial deployment of the I-10 Corridor Coalition TPAS will focus on collecting and publishing truck parking information for public facilities. Data will also be made available to third-party application providers and websites to promote widespread use of the truck...
parking availability information. In the future, private-sector operated truck plazas may be incorporated into the system and wider options for truck parking dissemination may be developed. An illustration of the high-level concept is shown in Exhibit 28.

In the context of this strategy, this type of system could be one data source to help inform the overall system.

**Exhibit 28: I-10 TPAS High-Level Concept**

![I-10 TPAS High-Level Concept Diagram](image)

Source: I-10 Corridor Coalition Truck Parking Availability System, ATCMTD Grant, Volume 1 – Technical Approach

### 2.2.12 I-35 Corridor Freight Advanced Traveler Information System (FRATIS) and Dallas-Fort Worth FRATIS Deployments

Texas has been involved in ongoing demonstration projects of FRATIS as a proof of concept deployment, with all material developed available as open source for the industry to use. Texas has been the site of two separate FRATIS deployments: the I-35 Corridor FRATIS demonstration and the Dallas-Fort Worth FRATIS prototype. Each FRATIS deployment occurred in different years with different end goals.

For the I-35 Corridor FRATIS, enhancements were made to the TxDOT I-35 Traveler Information During Construction (TIDC) system, which provides information such as pre-
construction closures, delay predictions, and near real-time construction delay. The system was enhanced with new software and in-vehicle devices to help trucking fleets optimize truck trip dispatch planning. This program led to the I-35 Connected Work Zone.

The FRATIS prototype in Dallas-Fort Worth focused more closely on drayage optimization. This prototype consisted of the following components: optimization algorithms, terminal wait times, route specific navigation/traffic/weather, and advanced notice to terminals. The demonstration projects showed that freight-specific information could be delivered successfully by public agencies and utilized by the freight community for pre-trip and en-route traveler information.

In the context of this strategy, this type of system could inform components of a larger freight traveler information system.

2.2.13 Smart Work Zones

TxDOT uses ITS as a tool in highway work zones to help improve public safety and mobility, as incidents within work zones often have significant impacts. This application is commonly referred to as “Smart Work Zones”. TxDOT has identified the eligible countermeasures for consideration as part of a Smart Work Zone, which include:

- Temporary queue detection systems;
- Speed monitoring systems;
- Construction equipment alert systems (i.e., trucks entering highway alerts);
- Travel time systems;
- Incident detection and surveillance systems; and
- Overheight vehicle warning systems.

LoneStar does not always have an interface with Smart Work Zone deployments, such as in the case of construction projects that are scoped to provide third-party vendor SWZ solutions for a finite period of time. For construction projects like these that are longer in duration, such as multi-year roadway reconstruction projects, some of these vendor-provided SWZ solutions could provide a data feed to the nearest TMC through a separate third-party vendor software. In the context of this strategy, this type of system—even when deployed intermittently—could serve as a potential data provider. Further details on the Smart Work Zone program in Texas can be found in the FNTOP Inventory of Existing Conditions Report.

2.2.14 Connected and Automated Vehicle Data

CV applications have been implemented in isolated cases in Texas and nationally. Through the Texas Connected Freight Corridors Project (TCFC), TxDOT is partnering with a number of public and private sector organizations to deploy CV infrastructure. The project focuses on the 865-mile Texas Triangle of I-35, I-45, and I-10. The TCFC project, along with other
efforts, paves the way for more CV applications in the state, establishing structures for TxDOT to collect freight data from private sector stakeholders. In the context of this strategy, CV and AV data could serve as a potential data provider. Further details on the CV pilots in Texas can be found in the FNTOP Inventory of Existing Conditions Report.

**2.2.15 DriveTexas**

DriveTexas serves as TxDOT’s online, public-facing database that provides real-time highway conditions throughout Texas. This data can include construction projects (ongoing and future), road closures, and other delays, as well as real-time traffic conditions. It is available as a web platform for browser users. DriveTexas receives and publishes data feeds from HCRS (Highway Condition Reporting System), as well as provides links to TxDOT’s ITS pages to show data from LoneStar. At a statewide level, as shown in Exhibit 29, it provides information regarding:

- Road and Lane Closures (current/planned in the near-term, typically out to 6 weeks⁵);
- Construction (current/planned);
- Ice/Snow;
- Traffic Conditions;
- Rest Area Locations;
- Travel Information Centers; and
- Other (conditions not listed, such as parades, special events, low visibility, etc.).

Further details on DriveTexas can be found in the FNTOP Inventory of Existing Conditions Report. In the context of this strategy, DriveTexas could serve as a potential data distribution tool for issuing advanced information.

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⁵ Districts can report planned closures beyond 6 weeks, but it only appears in DriveTexas when within 6 weeks.
2.2.16 Highway Condition Reporting System

Road closure and condition information is collected by local TxDOT Districts and entered into the HCRS as an active or planned condition. This information is then reported as part of the DriveTexas platform, with color differentiation to indicate condition type. Districts may input all planned events, but DriveTexas only displays those events occurring in the next six weeks. DriveTexas reports the description, start/end location, the days and times of the closure, and what facilities are affected (e.g., lane 1, lane 2, etc.), depending on what information is made available. This information is shown as an icon on the DriveTexas map for visual reference. In the context of this strategy, HCRS could serve as a potential data provider.

2.2.17 Statewide Traffic Analysis and Reporting System (STARS II)

TxDOT’s Transportation Planning and Programming (TPP) Division publishes a public-facing data analysis and reporting database called STARS II. The STARS II website includes detailed traffic data and statistics, as well as AADT data and other reported traffic data for transportation planning purposes. The Traffic Count Database System (TCDS), included within STARS II, further details count data that has been collected around the state. An example of STARS II is shown in Exhibit 30. In the context of this strategy, STARS II could serve as a potential data repository of applicable planning information from the data processing tool.
2.3  Deficiencies of the Current Situation

The FNTOP State of the Practice Assessment Report and input from FNTOP stakeholders identified several common deficiencies in the current situation.

2.3.1  Mobility and Reliability

The state’s extensive highway system carried more than half of the total (all modes) freight tonnage transported in Texas in 2016. This tonnage is expected to increase significantly by 2045, adding demands to a system that already experiences significant congestion in the major metropolitan areas where most of the state’s highway freight bottlenecks exist. Outside of the urban areas, freight traffic is expected to increase based on activities associated with the energy, warehousing, logistics, and agricultural sectors that are concentrated in the rural parts of the state. Texas will need additional system capacity to handle the expected increase in freight traffic. Congestion on the THFN can contribute to additional delays and degradation to travel time reliability across the system. As congestion increases, facilities become less capable of accommodating fluctuations to normal travel such as traffic incidents, work zones, special events, and weather.

The effective use of traveler information as a transportation demand management tool is a key benefit of this strategy as it enables users to make informed choices that lead to the optimal selection of routes and departure times. This results in the more efficient use of available system capacity, which reduces delay and increases travel time reliability. For freight users, the enhanced traveler information service would expand the universe of alternative routes based on access to quality data on real-time traffic conditions and operating restrictions for more areas of the highway network. The information is highly valuable for rural truck routes where real-time access to traveler information is more limited.
and delays due to route disruptions are exacerbated by the lack of nearby adequate alternative routes. The strategy would also help reduce CMV-related crashes attributed to the unsafe operations of oversize/overweight (OS/OW) vehicles; the enhanced traveler information service would include freight weight limits for certain roadways, height restrictions, and other parameters to assist with freight routing decisions.

### 2.3.2 Economic Competitiveness

Population growth, economic development, increased energy production, and the integration of global supply chains are among the factors driving demand for freight in Texas. According to the 2018 TFMP, the multimodal freight network is expected to handle an increase in freight volume from 2.2 billion tons in 2016 to over 4.0 billion tons in 2045. Most of the population growth and economic activity in the state is concentrated in the Austin, Dallas-Fort Worth, Houston, and San Antonio regions, which already experience heavy congestion. The rural areas of the state are also anticipated to see a growth in freight activity. Rural freight traffic is expected to increase alongside the growth in energy production and the demand for warehousing and logistics services related to e-commerce and just-in-time manufacturing. Increased delay on the state’s highways increases transport costs and makes businesses and industries less competitive.

With access to high-resolution freight traveler information, CMV operators could make dynamic routing decisions that lead to travel time savings and reduced fuel consumption. The information could be used to make optimal choices regarding route selection and scheduling to avoid congestion bottlenecks, peak demand, and areas impacted by incidents, emergencies, special events, and adverse weather. The information is highly valuable for navigating rural truck routes, which carry a significant share of interstate commerce on the state’s highways. Most rural truck routes are not well instrumented with ITS devices for data collection and monitoring.

### 2.3.3 Asset Preservation and Utilization

Trucks have an increased number of points of conflict with existing roadway infrastructure due to their size, weight, and inherent momentum that makes responding quickly to unexpected events more difficult. These increased points of conflict lead to more severe impacts when incidents occur, either due to a direct vehicle crash or an impact to the existing infrastructure (e.g., bridge damage due to overheight vehicle strikes, pavement degradation due to excessive weight, etc.). The cumulative impacts over time reduce the functional life of infrastructure assets and affects the overall efficiency and safety of all vehicle operations on the highway network. Poor asset condition reduces the resiliency of the network, which can result in declines in mobility and travel reliability. This leads to more travel delays and transport costs which in turn, reduces economic competitiveness for businesses and industries in the state.
This strategy aims to address the need for better awareness of potential hazards such as incidents, low clearance bridges, and the parts of the highway network that are restricted to OS/OW vehicle operations. These static infrastructure elements, including the locations of permitted routes for OS/OW operations and alternative routes (e.g., to allow trucks to exit ahead of low clearance bridge), are valuable information for freight route planning and navigation. This information could be shared through a freight traveler information Application Programming Interface (API) to provide data to trucking companies for route planning that not only optimizes deliveries based on the shortest path or travel time, but factors in operational safety for trucks transporting OS/OW loads.

2.3.4 Safety
There are parts of the Texas highway system—particularly the areas outside of the major metropolitan regions—that have limited deployment of ITS assets such as traffic sensors and CCTV cameras. This highlights a common constraint for many ITS programs that have a fixed amount of resources to deploy, operate, and maintain ITS field devices for traffic data collection and monitoring. Access to real-time information is critical for TMC operators that are scanning wide geographic areas for incidents and other road hazards, particularly along the highway freight corridors that are not well instrumented. The strategy aims to fill in data gaps by increasing the availability of traveler information across the highway system, enabling TxDOT to more efficiently locate, verify, and clear incidents, and remove roadway hazards that could trigger secondary crashes.

Quick incident clearance is critical to saving lives and increasing safety for road users and first responders; according to FHWA, the likelihood of a secondary crash increases by nearly three percent for each minute the primary incident is not cleared. En-route traveler information in the form of DMS messages or broadcasted alerts increases situational awareness so that motorists can anticipate upcoming hazards (e.g., queue backups and sudden changes in speed) while information in the form of navigational guidance allows trucks to avoid the crash scene all together using an alternative freight route. Improvements that reduce the likelihood of secondary crashes provide significant safety benefits to all roadway users.

2.4 Profiles of User Classes
The following contains a profile for users and stakeholders that would be involved with the High-Resolution Freight Traveler Information System strategy.

2.4.1 TxDOT Divisions
TxDOT Divisions handle a wide range of services for the agency. For various TxDOT initiatives, these Divisions coordinate internally to serve as stakeholders and—depending on the topic—lead the initiative. It is anticipated that the Divisions would collaborate closely with

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6 Source: FHWA, Traffic Incident Management (TIM) Performance Measurement: On the Road to Success
involved TxDOT Districts regarding ownership, operation, and maintenance of any new field devices deployed within those Districts.

Several Divisions would be relevant to this strategy, as this strategy builds upon systems that are operated by these Divisions and offers data that these Divisions could use for their initiatives. It is very likely that this strategy would be integrated among these Divisions as opposed to a single lead Division because each has a contributing role. The Travel Information Division produced and manages DriveTexas, the public-facing information channel for conditions on Texas roads; they would be a key stakeholder for operating the public-facing traveler information system, similar to how DriveTexas is operated today. The Traffic Safety Division would also be a key stakeholder; they collect and analyze crash data to improve safety and oversee ITS initiatives across the state. The Traffic Safety Division staff would also develop and maintain statewide specifications and standards for such devices. Using systems engineering best practices, the Traffic Safety Division would ensure that all ITS devices and systems deployed in conjunction with the strategy are interoperable with other ITS deployments in accordance with regional and state ITS architectures. Lastly, TPP would be a key stakeholder for this strategy, utilizing the advanced data to enhance planning and programming efforts for transportation projects and explore opportunities to improve freight operations. TPP owns and manages many data inputs (e.g., WIM and permanent count stations) that could be repurposed to support inputs to this strategy. It is anticipated that the TxDOT Information Technology Division could also be a key stakeholder, as some of the processing requirements to handle this volume of data may require expansion to the existing TxDOT IT architecture. Other Divisions would collaborate on this strategy, based on its relevance to their initiatives.

Details on how the Divisions would lead, operate, and use this strategy would be worked out as part of subsequent implementation planning efforts.

2.4.2 TxDOT Districts
TxDOT operates 25 Districts to manage the state-owned highway system across all geographical areas of Texas. The Districts would be key stakeholders in identifying where data coverage gaps exist, based on their local ITS programs. It is anticipated that the Districts would collaborate closely with involved TxDOT Divisions regarding ownership, operation, and maintenance of any new field devices deployed within the Districts.

2.4.3 Traffic Management Centers
TxDOT’s seven TMCs provide traffic management services for state-owned roads. They would be a stakeholder in identifying specific gaps in data coverage along state highways and off-system roadways, as well as how the existing and new data could better serve their operations. For their real-time traffic management and operations efforts, they would be an end-user for consuming the data, as the enhanced data would offer better insight on what is happening on the road network.
2.4.4 Metropolitan Planning Organizations
Metropolitan Planning Organizations (MPOs) are federally mandated and funded transportation policy-making organizations comprised of local government and transportation officials for areas with populations of at least 50,000. In the context of this strategy, they would be key stakeholders that help identify gaps in data coverage along urban freight routes. MPOs would also be an end-user for utilizing data collected by the system to inform long-range transportation planning decisions.

2.4.5 Trucking Industry Groups
Trucking industry groups are trade organizations that represent the types of motor carriers operating in Texas. They would be a key stakeholder in identifying how improvements in traffic data could best serve the trucking industry and identifying opportunities for private-sector data contributions.

2.4.6 Transportation Data Providers
Transportation data providers offer commercial third-party data used for a variety of applications related to transportation planning, performance reporting, and vehicle navigation and routing. The most well-known data is the red-yellow-green travel conditions for road segments based on speeds of anonymized probe data, but other data includes origin-destination estimation and real-time slowdown alerts that suggest a potential instance of stopped traffic (e.g., back of queue). Many public agencies have licenses with these providers to obtain data as a subscription-based service, particularly in parts of the transportation system not monitored by the existing ITS program. They would be a key stakeholder by offering services to expand the coverage and capabilities of the TxDOT transportation system.

2.4.7 Truckers
Truckers would be the main end-users of this system and would use the freight-specific traveler information to make informed departure and routing decisions. As they navigate the highway network, the system information would offer en-route information on travel conditions, incidents, and weather conditions, typically issued through a mobile phone application or a subscribed in-cab information service. For vehicle navigation, the system would offer data that help identify optimal routes based on information on the roadway environment, such as recommended speeds, weight and height restrictions, and vertical clearances of bridges. Any forecasting components offered would aid in providing quicker alternative route information at an earlier opportunity.

2.4.8 Trucking Companies/Dispatchers
Trucking company dispatchers work with truckers to plan trips and assist with real-time route information. This group would be an end-user in the system and would utilize information on traffic conditions (current and forecasted) and route restrictions to help dispatch their trucks in a manner that minimizes potential delays during the trip. They may
also function as a private-sector data provider by offering anonymized probe data to provide freight specific travel information for this strategy, such as trip origin-destination pairs, trip frequency, and travel speeds.

### 2.4.9 Other Road Users

Other road users experience many of the same challenges as truckers when traveling on parts of the Texas transportation system that lack managed traveler information systems. High-resolution traveler information would benefit CMV and non-CMV users alike where users could use the system to optimize routes and identify route alternatives to avoid non-recurrent congestion caused by crashes, disabled vehicles, construction, inclement weather, and special events. It would support vehicles operated by human drivers as well as the growing AV industry in Texas by offering improved routing capabilities and information to support informed decision-making.

In addition to DriveTexas, improved high-resolution traveler information would benefit road users through other internet-based information dissemination platforms in Texas, such as My35, 511DFW, and general media outlets. Traveler information is a travel demand management strategy that provides the ability to maximize use of system capacity, increasing roadway efficiency for all roadway users.

### 2.5 User Needs

As part of the FNTOP, the User Needs Assessment developed a comprehensive list of User Needs identified through a gap analysis and stakeholder engagement. The specific needs and gaps from the FNTOP User Needs Assessment addressed by this strategy are summarized in Exhibit 31. The assessment prioritized these needs based on relevance, plausibility, and alignment with the 2018 TFMP goals and objectives. The User Needs were divided among seven high-level freight technology areas that were previously established in the FNTOP State of the Practice Assessment Report:

- (T)raffic Management;
- (A)dvanced Traveler Information Systems;
- (D)ynamic Route Guidance;
- (D)a ta (I)ntegration and Analytics;
- (E)nforcement and Inspection;
- (C)on nected and Automated Vehicles; and
- (I)ntermodal Terminal Operations.

The naming convention for the user need ID includes the letter code listed above identifying the freight technology area to which it belongs to. For example, in Exhibit 31, UN-T4
represents the fourth User Need for the (T)raffic Management freight technology area. Each User Need is associated with one or more goals from the TFMP and is 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 is not necessarily critical to TxDOT.
- **Low** – The need is a “nice-to-have” or not viable in the near-term.

More information about the FNTOP User Needs and how this strategy can address them is available in the FNTOP User Needs Assessment Report, as well as the FNTOP Strategies and Conceptual Framework Report.

**Exhibit 31: Affiliated User Needs for the High-Resolution Freight Traveler Information System Strategy**

<table>
<thead>
<tr>
<th>ID</th>
<th>Preliminary User Needs</th>
<th>Texas Freight Mobility Plan 2018 Goals</th>
<th>Priority</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Traffic Management Freight Technology Area</td>
<td></td>
<td></td>
<td></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-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, 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, Stakeholder Interviews</td>
</tr>
<tr>
<td>ID</td>
<td>Preliminary User Needs</td>
<td>Texas Freight Mobility Plan 2018 Goals</td>
<td>Priority</td>
<td>Source</td>
</tr>
<tr>
<td>------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------</td>
<td>----------</td>
<td>-------------------------------------------------------------------------------------------</td>
</tr>
<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, Inventory of Existing Conditions, 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, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A5</td>
<td>Need to collect high-resolution truck data using cell phones or Electronic Logging Devices (ELD) 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>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>ID</td>
<td>Preliminary User Needs</td>
<td>Texas Freight Mobility Plan 2018 Goals</td>
<td>Priority</td>
<td>Source</td>
</tr>
<tr>
<td>------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------</td>
<td>----------</td>
<td>------------------------------</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-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, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A14</td>
<td>Need for more advanced 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, 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, 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>ID</td>
<td>Preliminary User Needs</td>
<td>Texas Freight Mobility Plan 2018 Goals</td>
<td>Priority</td>
<td>Source</td>
</tr>
<tr>
<td>-------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------</td>
<td>----------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td><strong>Dynamic Route Guidance Freight Technology Area</strong></td>
<td></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><strong>Data Integration and Analytics Freight Technology Area</strong></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-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><strong>Enforcement and Inspection Freight Technology Area</strong></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, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-E4</td>
<td>Need for more advanced remote monitoring equipment to detect and uniquely identify</td>
<td>Safety, Economic Competitiveness</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>ID</td>
<td>Preliminary User Needs</td>
<td>Texas Freight Mobility Plan 2018 Goals</td>
<td>Priority</td>
<td>Source</td>
</tr>
<tr>
<td>-----</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td></td>
<td>vehicles over allowable limits on Texas roadways to increase freight compliance to roadway laws by robustly identifying offenders.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UN-I6</td>
<td><strong>Intermodal Terminal Operations Freight Technology Area</strong></td>
<td><strong>Economic Competitiveness, Asset Preservation and Utilization, Multimodal Connectivity</strong></td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-I7</td>
<td>Need for more investment in technology and infrastructure to support ports in Texas and allow for growth in freight.</td>
<td><strong>Economic Competitiveness, Multimodal Connectivity</strong></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><strong>Mobility and Reliability, Multimodal Connectivity</strong></td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
</tbody>
</table>

### 2.6 Assumptions and Challenges

Several key assumptions and challenges would apply to a system that provides high resolution freight traveler information. These assumptions and challenges are identified in the following sections.

#### 2.6.1 Assumptions

- **TxDOT would be receptive to adopting advanced processing to generate travel forecasts as part of the statewide ITS program** – FNTOP stakeholders expressed a need for predictive capabilities that employ cutting edge approaches such as machine learning to analyze large transportation datasets. Many tiers of predictive capabilities are available and, although TxDOT may not necessarily need cutting-edge solutions to roll out this strategy, some of the more advanced solutions like AI may provide better service to end-users. Machine learning would apply advanced data science techniques to efficiently mine datasets accumulated by the traveler information system to detect patterns in travel behavior and gain insights on predictive factors that impact system performance.
The strategy would explore opportunities to deploy AI applications as available that utilize predictive analytics to provide advanced decision support for freight routing and navigation, but the requirements of implementing various degrees may require IT infrastructure and technical expertise that is not currently part of TxDOT’s program. It is assumed that TxDOT would make strategic investments to access needed resources and solutions such as massive parallel computing and storage to handle image processing, data transformation, and the management of unstructured data, by working with its university partners who can help guide needs and requirements.

- **AI would gain proliferation within the transportation industry** – Research and development into AI is expected to continue at a rapid rate and would support a range of transportation applications and tools in the coming years. The industry should expect some applications of AI for automating aspects of traffic and incident management, self-driving, and vehicle routing based on predictive analytics. It is expected that software algorithms and computer processing performance would achieve a level of advancement and commercial availability that will allow TxDOT to employ AI in a turn-key fashion. Having AI present in the transportation industry by other agencies would help with adoption, offering collective experience on troubleshooting issues and ongoing maintenance to help generate a greater “comfort factor.”

- **The enhanced traveler information system would be able to accept and fuse a variety of transportation data formats and types** – The system is expected to interface with a variety of new data sources. The data would be accepted as long as it meets requirements that delineates how the information is structured and formatted. As referenced earlier, data sharing agreements would be in place to coordinate the processes and procedures for acquiring additional data from trucking companies, commercial transportation data providers, and other third parties. The system would have the flexibility to ingest both raw and processed data and handle a variety of data types, including link-based speed and travel times, images and video, vehicle probe data, and static information about the roadway environment (e.g., designated truck routes, location of low clearance bridges, etc.). Existing systems, including LoneStar and HCRS, may need to modify their data outputs to align with the same data structure and formatting, depending on the standards that are adopted by TxDOT.

- **Data storage would accommodate historical traffic data** – All sources of traffic data ingested by the system would be archived in a relational database system for performance reporting purposes. As the data archive grows over time, machine learning algorithms would be used to generate predictive analytics to anticipate when operational bottlenecks or incidents are likely to occur. This provides the foundation for decision support systems with AI capabilities, but may require TxDOT to obtain a substantial amount of data storage capacity to manage the large amounts of data that would feed into the system.
• **The private sector would be receptive to exchanging data with the enhanced traveler information system using a secured API** – Trucking companies may agree to share operational data collected from their fleet vehicles in exchange for traveler information catered to their specific freight needs. Trip O-D, routing, and vehicle tracking data are valuable inputs for TxDOT to support freight planning, performance monitoring, and operational fine-tuning, whereas the private sector would look to receive specialized insight on road operations and which routes are best to send freight. It will take extensive coordination to find the right balance of providing a specialized data service as an incentive to private-sector users who contribute additional data, but not so much that other non-contributing private-sector users feel left out or are disincentivized to use the system. Processes and procedures would be delineated to ensure that the private sector data meets system requirements for traveler information accuracy, granularity, formatting, and frequency of updates. The system would function as a data clearinghouse for traveler information that consolidates multiple data sources into a consistent format to facilitate data standardization and sharing with other stakeholders.

• **Private-sector data sources would be anonymized** – Data captured by roadside ITS devices or shared with the system by third parties would have information removed that could be used to uniquely identify the owner of a vehicle. Similarly, any private-sector data offered (such as In-Vehicle Monitoring System (IVMS) or ELD information from trucks or real-time routing information from trucking companies) would need data use agreements in place to anonymize the data.

• **Traveler information would not be limited to the freight community** – Since roads are utilized by other users, traveler information would not be limited to freight vehicles. ITS assets used by this strategy would monitor travel conditions and provide inputs to generate traveler information for passenger and commercial vehicles alike. Any mobile applications developed to assist with routing information would need to differentiate between freight and passenger car users in order to provide useful information, similar to how existing routing applications in the marketplace can differentiate between car and pedestrian routes.

**2.6.2 Challenges**

• **Advanced processing requires careful planning, design, and testing** – Regardless of the advanced processing that might be selected, it is critical that it be planned, designed, and tested rigorously. Localized tests may be necessary in many geographic locations to ensure that accurate results are being provided to users. This may require extensive collaboration from staff who are familiar with statistical testing and confidence intervals to ensure that accuracy benchmarks are being met. System hardware should be carefully designed, with costs estimated to reflect the necessary ongoing operations and maintenance costs for the selected system, to ensure that it can be funded over the long-term.
• **Data processing to generate predictive analytics for the extensive roadway system** – Over time, the enhanced traveler information system is expected to ingest and archive substantial amounts of real-time traffic data, as well as freight operational data should private sector companies agree to share their fleet data. This will require large amounts of data processing to apply machine learning algorithms to analyze patterns and identify predictive factors across the extensive highway network in Texas. In lieu of making capital investments in high performance computing, TxDOT could procure a subscription based model from cloud service providers such as Microsoft Azure and Amazon Web Services. This model could reduce total life cycle costs and project complexities by leveraging resources and tools available through the cloud. Cloud computing costs, while not nominal, would provide TxDOT with the advantage of only paying for what it uses in terms of the number of virtual machines and data storage capacity. These resources can be scaled dynamically to maintain acceptable service levels and availability for system users.

• **Expanding traffic sensor coverage to off-system roadways** – It is common for ITS programs to focus the deployment of traffic sensors and CCTV cameras along controlled access facilities in urban areas where congestion is most concentrated. One of the aims of this strategy is to address the data gaps for arterial truck routes and routes in rural parts of the state which have limited ITS device coverage for data collection and monitoring. This could require TxDOT to expand its ITS program to some off-system roadways, which would require agreements with local agencies to obtain data from non-TxDOT infrastructure where available. Further coordination is needed to share responsibilities and costs for deploying and maintaining new field sensors implemented as part of this strategy. In lieu of installing field sensors, the traveler information system may fill in data gaps using crowd sourced data. However, data providers such as Google or INRIX, who provide processed travel time and speed data, may not provide the granularity needed for planning and analysis compared to agency-owned sensor data.

• **Data sharing concerns** – Trucking companies may not want to share operational information on their fleets due to security and other concerns. Such information is made available to their customers for shipment tracking purposes, but may not be provided as a service for public transportation agencies. If the trucking companies do agree to provide routing information or real-time truck location data, it will be imperative that TxDOT protect any proprietary data from being shared publicly so as to satisfy trucking companies’ data sharing policies. Additionally, TxDOT may need to develop the necessary APIs to receive individual data feeds from each company, as the trucking companies would not likely have the capability to transform their data for external use as part of their business operations.

• **Funding to support ITS equipment is needed to implement the strategy** – Field equipment can be costly depending on how many sites require devices to close data coverage gaps. Additionally, there would be ongoing operations and maintenance (O&M)
costs associated with each system scaled to the number of sites equipped. An inventory of spare parts would be needed to replace components that break down or reach end of life.

- **Funding to support new staff roles** – The enhanced traveler information system would require additional staffing resources to handle ongoing operations and maintenance tasks, such as content administration, Information Technology (IT) administration, and performance reporting. This would require creation of new job titles and positions, which require funding. These types of roles could be filled through internal or external hires, but would be substantial enough to need a new position (i.e., these responsibilities would represent the vast majority of this position’s day-to-day work, and coupling to an existing position as an added responsibility would not be feasible). Additionally, advanced data processing involving machine learning may require TxDOT to hire staff outside of the transportation domain with expertise in computer and data science. The talent pool to implement AI solutions is very limited and would require TxDOT to compete with other industries for that expertise.

- **Incentivizing use of TxDOT data in existing Truck Management Systems.** Most companies have their own dynamic routing software, purchased through third-party software companies that may utilize only their own means to collect and process data. Many of these providers do not use public sector data as part of their data stream. Encouraging use of the new public sector data may require a demonstration to convince these third-party companies to incorporate this into their software packages.

- **Data services may remain unavailable to smaller trucking companies that do not currently utilize equipment to receive data.** Smaller trucking companies with a few trucks may not have made the investment in in-cab equipment to receive traffic and routing data. If a new system is rolled out, they would not see any benefits if data was only available as part of an in-cab service. This supports the need to make data services available through other means, such as through a smartphone application.
3.0 Concept for the Proposed High-Resolution Freight Traveler Information System

This section describes the proposed system. It provides an overview of the objectives; discusses ConOps essential features, capabilities and functions; and outlines the system-level operational environment, processes, and necessary support. The level of detail presented is intended to explain how the proposed system is envisioned to fulfill the user needs and requirements.

3.1 Objectives

The High-Resolution Freight Traveler Information System is intended to expand the capabilities of TxDOT’s public-facing ATIS (DriveTexas) to provide a high-quality freight traveler information service, focused on the THFN. This information service would offer better routing guidance to help improve mobility and reliability along Texas roadways, as well as accomplish other TFMP goals identified in Section 2.1. At a high level, the High-Resolution Freight Traveler Information System will enhance the granularity of traffic information on Texas roads through a combination of deploying TxDOT-owned sensor infrastructure or advanced third-party probe-based data on key limited-access and arterial truck routes. On critical rural truck routes, a similar deployment of instrumentation will be considered, with options to fuse TxDOT sensor data with other third-party probe-based data services to create a more robust scan of travel conditions along a route. Special focus will be given to certain strategic multimodal facilities, particularly those functioning as high-volume freight activity centers. Data services will not be limited to traffic speed data; the system is likely to also generate—either publicly or internal to TxDOT—data on truck percentages and weights, blocked rail crossings, and other mobility information. Additional elements built into the enhanced traveler information service could include truck parking availability, freight weight limits for certain roadways, height and width restrictions, planned construction or maintenance projects resulting in lane closures, and other parameters that assist with freight routing decisions. This data would be processed through advanced analytics tools—including potentially AI or Machine Learning—to identify incidents and forecast traffic conditions.

This traveler information service will have an API-based architecture that requires external stakeholders to apply with TxDOT for approval to help securely collect and distribute data at a clearly-defined virtual location for public use, with all use restrictions clearly noted. This will allow third-party application service developers to have access to the public data feeds and integrate this into their operations. Certain service providers, such as trucking companies with tracking equipment on their vehicles, could offer their anonymized origin-destination, routing, and real-time location information to the traveler information service in exchange for information specific to their freight needs, such as enhanced route recommendations based on their historical trip performance. For other system users without a third-party service, the traveler information service will create a mobile application (e.g., “DriveTexas Mobile for Freight”) that will provide real-time navigation routing tools.
Exhibit 32 provides an illustrative example of the High-Resolution Freight Traveler Information System strategy that was previously discussed in the FNTOP Strategies and Conceptual Framework Report.

*Exhibit 32: Illustrative Example of High-Resolution Freight Traveler Information System Strategy*

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### 3.2 Description of ConOps Essential Features, Capabilities, and Functions

This section describes the proposed system and improvements, based on the components identified earlier. The descriptions are provided at a high-level, indicating the operational features and functionalities without specifying design details or technology-specific solutions.

The main features and functions of the High-Resolution Freight Traveler Information System strategy are discussed in Exhibit 33.
### Exhibit 33: High-Resolution Freight Traveler Information System
#### Features and Functions

<table>
<thead>
<tr>
<th>Features</th>
<th>Main Functions</th>
<th>User Need(s) Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expanded Traffic Data Coverage</td>
<td>Increase the geographic coverage and granularity of automated traffic data collection in Texas. Deploy additional state-owned traffic sensors to fill in coverage gaps. Utilize high-resolution traffic data services for the THFN, primarily through private sector probe data services where state-owned sensors are not available. Certain ITS devices used only for long-range planning to be upgraded to provide real-time information.</td>
<td>UN-T7, UN-DI10, UN-E2, UN-E4, UN-I7</td>
</tr>
<tr>
<td>Data Ingestion, Consolidation, and Aggregation from Multiple Real-Time Data Sources</td>
<td>Consolidate data from state-owned sensors, public agency data feeds, and/or private sector anonymized probe data services into a consistent format for each data type, such as road closure information, vehicle classification and weights, traffic data, incidents, and recent route performance, and place all information in a single digital space. Establish a trusted API mechanism to accept freight-related anonymized probe data to help refine freight data, with established data use guidelines to encourage the private sector to contribute.</td>
<td>UN-T3, UN-T4, UN-A4, UN-A5, UN-A7, UN-A8, UN-A9, UN-A12, UN-A15, UN-DI5, UN-DI9, UN-I6, UN-I10</td>
</tr>
<tr>
<td>Generate Dynamic Traveler Information</td>
<td>TxDOT sensor data will be fused with other third-party probe-based data services to create a more robust scan of travel conditions along a route. Data services will not be limited to traffic speed data; the system will also generate data on truck parking availability, blocked rail crossings, and other available mobility information, as well as changes to roadway operations like lane closures.</td>
<td>UN-A1, UN-A4, UN-A6, UN-A13, UN-A14, UN-A15, UN-A17</td>
</tr>
</tbody>
</table>
### Features

<table>
<thead>
<tr>
<th>Features</th>
<th>Main Functions</th>
<th>User Need(s) Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Generate Static Traveler Information</td>
<td>Static roadway inventory elements will be built into the enhanced traveler information service and include freight weight limits for certain roadways, height and width restrictions, and other parameters that assist with freight routing decisions. This data will consist of both point and link features.</td>
<td>UN-A8, UN-A10, UN-A11, UN-A13, UN-A17</td>
</tr>
<tr>
<td>Travel Condition Forecasting</td>
<td>Utilize AI-enabled forecasting tools to predict future traffic conditions, as well as incident management tools to screen for events. Advanced analytics, such as through AI, differentiates this strategy from traditional systems by introducing the ability to process large volumes of traffic data and predict outcomes.</td>
<td>UN-A1, UN-T4, UN-T9, UN-A4, UN-A14</td>
</tr>
<tr>
<td>Information Distribution via Web Platform, Mobile Application, and Trusted API Connection</td>
<td>Enhance the DriveTexas platform to provide a mobile application to encourage use among truckers and establish a trusted API to broadcast data to the public and private data users, within parameters established under the data use guidelines.</td>
<td>UN-A13, UN-DI5</td>
</tr>
<tr>
<td>Location-specific Alerts</td>
<td>Distribute location-specific alerts to certain geo-fenced areas based on assigned message priorities.</td>
<td>UN-A16</td>
</tr>
<tr>
<td>Real-Time Freight-Specific Navigation Routing</td>
<td>Provide truck drivers with an appropriate navigation system that guides them through truck routes, avoiding local roads that are not suited for trucks (e.g., Waze / Google Maps for trucks).</td>
<td>UN-D1</td>
</tr>
</tbody>
</table>

Since this system relies on technological processes, the general framework follows the requirements for a successful ITS program. At a high level, a successful ITS program requires 1.) a means to collect data, 2.) a means to process the data, and 3.) a means to distribute that data to the targeted user group. As long as this process is followed, this system will have the necessary building blocks to succeed.
The following sections examine several key components to consider as part of the High-Resolution Freight Traveler Information System strategy. The intent is not to define one strategy as the sole approach for all components, but rather outline the key characteristics so that a given strategy can be correctly applied to a situation. The following processes are discussed in the following sections:

- Data Collection;
- Data Processing; and
- Information Distribution.

### 3.2.1 Data Collection

Data collection methods for this system aim to:

- Collect information from state-owned sensors and/or private sector probe data services regarding key highways, limited-access, and arterial truck routes; and
- Establish a mechanism to accept freight-related anonymized probe data to help refine freight data, with established data use guidelines to encourage the private sector to contribute data.

Various components to support some or all of these information elements are discussed in the following sections. These components are conceptual in order to illustrate certain general ideas, but other options could feasibly serve the same role.

#### 3.2.1.1 ATMS Platform

The ATMS software—discussed earlier in Section 2.2.2—collects and processes raw traffic data through real-time automated processes, allowing either automated responses to be issued to field devices or real-time notifications to be issued to operators for further human-initiated actions. Regardless of method, the ATMS processes raw data (e.g., from traffic detectors, external data feeds, etc.) into actionable traveler information, such as traffic conditions, planned events, incidents, and other messages relevant to road users to help them make informed travel decisions. In the context of this system, the ATMS platform manages these processes and response efforts under a single software platform, which provides a single integration point for the High-Resolution Freight Traveler Information System. If TxDOT decides to expand the coverage of ITS field devices to key limited-access and arterial truck routes, the ATMS platform would need to scale and accommodate the additional devices and functionality, and feed information from the new devices to the High-Resolution Freight Traveler Information System.

#### 3.2.1.2 Standalone Systems

There are a variety of systems that contain useful information for this strategy which are currently not integrated with an ATMS platform. These types of systems may include, but are not limited to, HCRS, WIM and permanent count stations, ETC systems, border travel time
systems, blocked rail warning systems, flood detection/warning systems, and smart work zone systems. In the context of this system, standalone systems deemed necessary for this strategy will require additional integration efforts with the High-Resolution Freight Traveler Information System, if they do not currently feed data into DriveTexas.

3.2.1.3 In-Vehicle Monitoring Systems and Electronic Logging Devices
Companies that are willing to share real-time information from IVMS or truckers' ELDs or smartphones would provide a wealth of high-resolution data that could be used to generate advanced performance information to improve freight operations on the THFN. Useful types of truck-specific information include origin-destination, routing, and real-time location information. In the context of this system, TxDOT would accept anonymized freight data with established data use guidelines designed to encourage the private sector to contribute.

3.2.1.4 Connected Vehicles
It is anticipated that CVs will become more prevalent on Texas roadways over the next decade. Data shared from CVs would be a new channel of crowd-sourced data that can be fed into the High-Resolution Freight Traveler Information System. CVs could transmit important safety and mobility information to TxDOT and each other using CV on-board units (OBUs) or more traditional sources such as Bluetooth or Wi-Fi. The position of individual probe vehicles over space and time will give TxDOT a better idea of traffic conditions such as bottlenecks or incidents. CV projects in development are discussed in Section 2.2.14.

3.2.1.5 Third-Party Traffic Data Services
Commercial sources of traffic data are available that could supplement agency sensor coverage. Vendors such as Google, INRIX, and HERE utilize anonymized location-based data to estimate near real-time travel speed and travel time for segments of the roadway network; Waze uses a community of contributors to crowd source information on travel conditions, incidents, and road hazards. These third party services fuse data from GPS equipped smart phones and in-vehicle navigational units that function as vehicle probes, which can provide valuable insights on route travel times. TxDOT would integrate these data sources into the High-Resolution Freight Traveler Information System using interfaces such as APIs and extensible markup language (XML) feeds available through the data provider.

3.2.2 Data Processing
Data processing methods for this system aim to:

- Fuse TxDOT sensor data with other third-party probe-based data;
- Consolidate multiple data sources into a consistent format for each data type;
- Generate new types of static and dynamic traveler information;
- Utilize incident management tools with advanced processing capabilities to screen for events; and
• Utilize forecasting tools with advanced processing capabilities to predict traffic conditions into the future.

The component to support some or all of these information elements is discussed in the following section. This component is conceptual in order to illustrate certain general ideas, but other options could feasibly serve the same role.

3.2.2.1 Advanced Traffic Data Processing System
This component would serve as the “brain” of the High-Resolution Freight Traveler Information System. In the context of this system, it would be used to aggregate the information from various systems to 1) provide clear real-time conditions for freight mobility, 2) allow for advanced analysis and early detection of network disruptions, such as due to incidents, and 3) facilitate the use of advanced algorithms to predict travel conditions into the future to help with time-dependent route planning (i.e. route planning that factors in predicted future conditions).

A general concept for how this Advanced Traffic Data Processing System would operate is shown later in Exhibit 35. While this ConOps does not aim to prescribe how it will work, as many of these details are highly dependent on what features and functionalities are available and pursued at time of deployment, some basic features are anticipated to be present. Notably, this system would need to transform any data that is received into a standardized format for internal use. The myriad of data structures used by TxDOT and external data providers means this effort could be extensive and require frequent review to confirm ongoing consistency.

Once transformed into a standardized format, this data would go through an advanced processing step to generate the traffic data. Advanced processing can take on several different meanings and they do not necessarily have to be overly advanced. For example, TxDOT currently has advanced processing capabilities as part of the ITS program to translate sensor data into travel times, so the capability already exists. That said, industry has developed other tools and procedures for managing data, utilizing statistical analysis and data processing tools to provide highly accurate forecasts, and there are many advantages in exploring use of these tools and procedures for part or all of this strategy. TxDOT is currently involved in some of these tools; as discussed in Section 2.2.6, TxDOT is researching the application of AI and machine learning to enhance corridor management and is collaborating with UT-CTR in understanding the state of the technology and potential use cases for the large amounts of transportation datasets that the agency generates and maintains. The work with UT-CTR will lead to proof of concepts for utilizing AI-driven corridor management tools for transportation decision support based on predictive analytics that evaluates network conditions and identifies events that precede network disruptions. It is likely that this effort could inform the preferred advanced processing for this strategy.
3.2.3 Information Distribution

Information distribution methods for this system aim to:

• Provide freight-specific traveler information to users (e.g., truckers, TMCs, etc.) on travel conditions, location of incidents, weather and road conditions, truck parking availability, optimal routes, recommended speeds, and lane restrictions;

• Provide information on future planned events, such as road construction or closures;

• Establish APIs to broadcast data to the public and private data users, within parameters established under the data use guidelines; and

• Offer traveler information service via mobile application (e.g., “DriveTexas Mobile for Freight”) that will provide real-time navigation routing for different audiences (e.g., freight vs. passenger car).

Various components to support some or all of these information elements are discussed in the following sections. These components are conceptual in order to illustrate certain general ideas, but other options could feasibly serve the same role.

3.2.3.1 Advanced Traveler Information System

In the context of this system, DriveTexas (discussed earlier in Section 2.2.15) will continue to serve as the web-based, public-facing database that provides real-time highway conditions throughout Texas for the general public. This component currently disseminates construction projects, road closures, and other delays, as well as real-time traffic and future construction projects on a web platform. In the context of this strategy, those features would be expanded to include additional geographic and data granularity coverage on rural routes and forecasted travel conditions for time-dependent route selection. Additionally, this strategy would explore developing a mobile application version of this ATIS to provide freight-specific routing services to truckers.

3.2.3.2 API Connectivity for Exchanging Data with External Parties

This component would provide a clearly-defined, publicly available API that would allow approved third-party application service developers to have access to the public data feeds. These public data feeds would be integrated into private-sector applications that serve a particular need, such as truck routing, trip planning, or other traffic services. Trucking companies and dispatchers may find it beneficial to integrate certain data feeds into their Truck Management Systems (TMS) to help optimize fleet scheduling. Additionally, road users with in-dash navigation units that receive data feeds through cellular connection points (e.g., 4G/LTE) may be able to receive this data if their navigation services subscribe to these data feeds.

3.2.3.3 Roadway ITS Devices

This component would provide traveler information via roadway ITS devices, which is often DMS. This strategy relies on TxDOT’s existing policies of deploying DMS at strategic route
decision points to help motorists make informed decisions. As CVs are rolled out, CV roadside units (RSUs) can provide information broadcasts to vehicle OBU s regarding travel conditions, location of incidents, truck parking availability, weather and road conditions, optimal routes, recommended speeds, lane restrictions, and other relevant travel data using Vehicle-to-Infrastructure (V2I) communications. In the context of this system, DMSs and CV RSUs (based on CV adoption rates) would disseminate en-route traveler information to provide truckers with improved opportunities to make informed route planning and real-time execution decisions.

3.3 Conceptual High-Level System Architecture
As noted earlier, advanced processing is a key component of this strategy. Depending on the degree of processing that is adopted, it differentiates this strategy from traditional systems by introducing the ability to process large volumes of traffic data and predict outcomes. AI is one of the more robust forms of advanced processing currently used in other non-transportation applications to evaluate large data sets and draw conclusions regarding unseen trends in the data, often working behind the scenes and producing simply an answer. Some well-known tools that use AI include surge pricing estimates for rideshare services, spam filters on email servers, and fraud prevention tools at financial institutions. While not the only form of advanced processing available, it is one of the more prominent ones.

Exhibit 34 shows the various branches of AI that are used in the industry. Machine Learning, a branch of AI, is one option to improve the traveler information presented on the DriveTexas platform.

- **Machine Learning** combines statistics and software development to give computers the ability to learn from and make predictions on data without explicitly being programmed to do so. The High-Resolution Freight Traveler Information System is expected to ingest, fuse, and archive multiple sources and types of transportation data. Starting with initial datasets, machine learning algorithms “train” themselves to recognize patterns in the data. Over time as the dataset grows, the algorithms can build increasingly detailed and sophisticated models on travel behavior that can be used in a predictive capacity.

- **Deep Learning** is a subset of Machine Learning that uses neural networks to imitate the workings of the human brain in processing data and creating patterns for use in decision-making. Examples of deep learning include image recognition and speech processing. These capabilities could help the system interpret for example, CCTV camera images to detect incidents; distinguish public service announcements from travel alerts in DMS messages; and extract information from social media postings on critical events such as bridge strikes.

- **Predictive Analytics** is another subset of Machine Learning that applies a variety of statistical techniques to analyze current and historical facts to make predictions about
future events. This provides the inputs for AI driven decision support systems to preemptively implement traffic signal timing plans or provide dynamic route guidance based on predictive analytics that anticipate network disruptions before an event actually occurs.

**Exhibit 34: Branches of Artificial Intelligence**

Exhibit 35 illustrates how machine learning could be incorporated into the advanced traffic data processing system. First, structured (i.e., easily searchable in relational databases, such as Excel files) and unstructured (e.g., social media postings, etc.) data would be collected from a variety of sources, such as ATMSs, standalone systems, CVs, and third-party traffic data services. As is currently done, the data would either go through a batch-processing engine or a real-time processing engine. The batch-processing engine waits for a large volume of data before processing, so the output latency is measured in minutes or more. The real-time processing engine involves continuous input, process, and output of data with a much faster latency, but is more resource intensive. The outputs of either engine are stored as processed data, which can be directly presented on DriveTexas based on queries for various types of traveler information. To incorporate machine learning components into the advanced traffic data processing system, the raw data collected would also be sent to an analytical sandbox, where it will go through additional processes for data discovery, exploratory data analysis, and predictive modeling. Current and historical data from the processed data stores can be used to inform the machine learning processes. Outputs of the analytical sandboxes are also stored as processed data stores and available for presentation through DriveTexas. It is worth reiterating that this is not the only way to do...

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7 Source: Future Architecture, A.I. Architecture Intelligence
advanced processing, but exploring use of AI and machine learning effectively would help build a very comprehensive system.

**Exhibit 35: Advanced Traffic Data Processing System with Machine Learning**

Exhibit 36 illustrates how the various systems involved in the High-Resolution Freight Traveler Information System strategy are interconnected with the systems operated by TxDOT, third-party developers, and the end-users themselves. The advanced traffic data processing system would receive raw data from DriveTexas, various standalone systems, other private sector data contributors (e.g., third-party traffic data services or anonymized freight probe data from ELDs/TMSs), as well as CVs. This system would improve traffic and incident management through advanced analytics and early detection of network disruptions.

DriveTexas is currently only offered as a web-based application, but under this strategy, a mobile application version would be developed. TxDOT Divisions and Districts currently collaborate regarding ownership, operation, and maintenance of regional ATMSs, various standalone systems, and roadway ITS devices. Under this strategy, additional TxDOT-owned sensor infrastructure may be deployed on key limited-access and arterial truck routes to enhance the granularity of traffic information. These new roadway ITS devices would be integrated with the ATMS. The ATMS would continue to issue notifications to the traveling public via roadway ITS devices. Traffic condition and incident predictions from the advanced traffic data processing system would be communicated back to regional ATMSs and DriveTexas, resulting in enhanced traveler information for the public and enabling time-dependent route planning for trucking companies.
The traveling public could access traveler information through the DriveTexas web application, mobile application, or—in the case of truckers—from dispatchers who receive traveler information data feeds into their TMSs. Third-party application service developers (e.g., TMS developers) will be able to apply with TxDOT for access to API data feeds. External stakeholders would be able to integrate the data feeds into their operations for improved operational efficiencies.

Exhibit 37 diagrams the information flows from the identified data sources to the conceptualized strategy. The end-users associated with the strategy are identified in the diagram, as well as the dissemination methods to provide high-resolution traveler information to support informed route planning and real-time execution decisions.
Exhibit 36: Systems Diagram for the High-Resolution Freight Traveler Information System Strategy
Exhibit 37: Data Flow Diagram for the High-Resolution Freight Traveler Information System Strategy

Data Sources
- Advanced Traffic Management System: Road and lane closures, current and planned construction projects, roadway incidents, weather conditions (e.g., snow/ice), traffic conditions and delays, rest area locations, travel information centers, information regarding special events, permitted truck routes (e.g., hazardous material routes), roadway grade information
- Weigh-in-Motion/Vehicle Classification Stations: Percentage of overweight vehicles at a given location, vehicle classification, vehicle weight, notification of overweight vehicles
- Electronic Toll Collection Systems: Fare collection, travel time estimation
- Border Travel Time System: Wait times at border crossings
- Blocked Rail/Warning System: Whether a rail crossing has been blocked, duration of blockage
- Flood Detection/Warning System: Whether water is detected at a specific elevation
- Smart Work Zone Systems: Queue detection, speed monitoring, construction equipment alerts, travel times, incident detection/surveillance, overheight vehicle warnings
- Truck Parking Availability System: Whether parking stalls are available at a truck parking lot

Connected and Autonomous Vehicles
- Vehicle speed, location, and trajectory

Third-Party Traffic Data Services
- Real-time and historical traffic flows, travel speeds, roadway analytics, trip paths

System Concept
- Advanced Traffic Processing System

Dissemination Methods
- Advanced Traveler Information System
- Internet-Based Information Dissemination Services
- Trusted Application Programming Interface Connectivity
- Roadway ITS Devices

Users
- TxDOT
- Traffic Management Center Operators
- Metropolitan Planning Organizations
- Third-Party Developers
- Truckers and Dispatchers
- Traveling Public
3.4 Support Environment
This section discusses the major components of the environment supporting the High-Resolution Freight Traveler Information System including:

- Supporting Subsystems;
- Supporting Personnel; and
- Supporting Processes.

3.4.1 Supporting Subsystems
There are various subsystems that form part of the supporting services for the High-Resolution Freight Traveler Information System. Their design would ultimately affect the design of the center. Key subsystems to consider are identified in Exhibit 38.

Exhibit 38: Supporting Subsystems

<table>
<thead>
<tr>
<th>Supporting Subsystem</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Traveler Information System</td>
<td>This subsystem refers to the existing DriveTexas platform. Regardless of backoffice services, DriveTexas would be a supporting subsystem for publishing data to the public. DriveTexas’s API for data integration would likely form a foundation for data structuring under this strategy.</td>
</tr>
<tr>
<td>ITS Field Devices</td>
<td>This subsystem refers to any existing or newly deployed ITS field devices, primarily sensors but also including DMS.</td>
</tr>
<tr>
<td>Security</td>
<td>This subsystem relates to robust firewalls, intrusion detection systems, and encryption technologies that protect the High-Resolution Freight Traveler Information System from potential risks and exposures from unauthorized access (internal or external). Tools and methods to secure data, such as encryption, would be done so in accordance with enterprise IT policies on information security.</td>
</tr>
<tr>
<td>Communication Subsystem</td>
<td>This subsystem provides network communications between the field elements and the High-Resolution Freight Traveler Information System. Traffic data is provided in real-time. Typically, fiber communications are used in an environment with accessible and reliable communications while wireless communication may be used in remote/rural sites.</td>
</tr>
</tbody>
</table>
3.4.2 Supporting Personnel
TxDOT system administrators and system support staff are the key personnel required to support the High-Resolution Freight Traveler Information System. Primary functions for supporting personnel are outlined in Exhibit 39.

Exhibit 39: Supporting Personnel

<table>
<thead>
<tr>
<th>User Group</th>
<th>Primary Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Administrators</td>
<td>Monitors High-Resolution Freight Traveler Information System performance, configures ITS devices that support the High-Resolution Freight Traveler Information System, oversees ITS asset management, and coordinates response to system issues.</td>
</tr>
<tr>
<td>System Support</td>
<td>Develops new and maintains existing High-Resolution Freight Traveler Information System applications.</td>
</tr>
<tr>
<td>Maintenance Staff</td>
<td>Supports and maintains ITS hardware.</td>
</tr>
</tbody>
</table>

3.4.3 Supporting Processes
The following are processes required to support the High-Resolution Freight Traveler Information System:

- **Software Support and Updates**: Establish processes to ensure that all the required software are available and up-to-date for the High-Resolution Freight Traveler Information System.

- **Automated Performance Reporting**: Establish processes to ensure that forecasts from the High-Resolution Freight Traveler Information System align with actual real-world conditions, within certain predefined allowances. Utilize processes to identify when adjustments to forecasts are necessary.
4.0 Benefits, Impacts, and Alternatives of the High-Resolution Freight Traveler Information System

The purpose of this section is to identify the benefits and impacts created with the deployment of this strategy. This section also identifies alternative options to this strategy and notes their respective drawbacks relative to the strategy proposed in this ConOps.

4.1 Benefits

This subsection summarizes the key benefits that TxDOT should expect from deployment of this strategy. From a benefits perspective, the implementation of this strategy would have the following impacts:

- **Increased Mobility** – The system would provide improved coverage statewide on route information, such as road closures, incidents, and overall route performance. Truck dispatchers and drivers will have more opportunities to make pre-trip and on the road decisions to maximize their overall efficiency.

- **Decreased Vehicle Operating Costs** – A decrease in vehicle operating costs would be a benefit of this strategy. As more robust real-time traveler information is available, roadway users would see increased overall efficiency based on avoiding congestion, in turn reducing their vehicle operating costs.

- **Improved Routing for Truck-Specific Routes** – Routing decisions provided by services such as Waze or Google Maps do not take into consideration truck route limitations and may direct truckers onto routes not meant for heavy vehicles. This strategy would tailor route recommendations for the appropriate audience (e.g., truckers vs. general population), which would prevent routing trucks on unauthorized roadways and provide decision makers with information on average and recent route performance.

- **Increased Safety on Critical Freight Routes** – Improved high-resolution traffic data would provide increased coverage of upcoming queuing, incidents, and traffic volumes. Truckers would have more opportunities to make informed decisions or adjustments ahead of potential hazards, reducing secondary crashes and improving overall safety.

- **Increased Use of Real-time Information** – Increased access to real-time information would be provided by expanding sensor coverage across the state’s roadway network and establishing mechanisms for receiving more freight-related anonymized probe data. Truckers and other road users would have access to improved real-time information.

- **Increased Availability of Freight Data** – The improvements under this strategy would increase the availability of freight-specific data, such as freight traffic volumes, speed, and congestion. This data would be collected by increased sensor coverage and support other freight-focused FNTOP strategies that benefit from enhanced data for real-time traffic operations, such as the Statewide Traffic Operations Center or the Smart Freight Connector strategies. Over time, TxDOT could access historical datasets for system asset planning and monitoring, as well as further support other initiatives like TTI’s Freight
Fluidity approach for measuring performance of the transportation segment of the supply chain.

- **Increased Operational Coverage of Urban Arterial and Rural areas** – Currently, TxDOT has limited real-time operational capabilities on rural parts of the THFN that fall outside the existing jurisdictions of the regional TMCs. This strategy would increase the ITS coverage throughout the state, including key rural freight routes and urban arterials.

- **Increased TMC Operator Efficiency** – The system would expand the number of tools a TMC operator could use. TMC operators would see increased efficiency due to more robust sensor coverage and availability of traffic data. Advanced AI traffic management capabilities would assist TMC operators in detecting incidents.

- **Improvement to Overall Traveler Experience** – The system would improve travel time and minimize delays along key freight corridors throughout the state by reducing the detection time of incidents. The system would also provide truckers and road users with the ability to make more informed travel decisions, which would allow them to be more successful with their day-to-day operations and boost their satisfaction with the system.

- **Helps Fill in Gaps in ITS Coverage** – Since deploying ITS devices at a statewide scale is costly, most ITS deployments are located near major urban areas or along highly traveled routes, as the largest benefit to road users (passenger cars, freight, etc.) is often captured by focusing investments in these congested areas. Aside from expanding sensor coverage, this strategy would permit information on roadway conditions, traffic conditions, incident locations, etc., to be collected through crowd-sourced channels (subject to TxDOT verification). This provides an opportunity to gather information on roadways that may have gaps in ITS coverage (e.g., rural roads and/or arterials).

- **Improved Traffic and Incident Management** – The system would expand the number of tools a TMC operator could use for traffic management and incident detection. The increased availability and use of real-time information that is relevant to the freight community would increase situational awareness of TMCs, allowing them to better coordinate traffic management and incident response. Probe data from trucks on speed, location, and trajectory would help enable better management of incidents and traffic flow.

- **Increased Support for Supply Chain Evaluation Efforts** – A robust data set of transportation system performance would aid many supply chain evaluation efforts that are occurring in Texas. For example, TxDOT and TTI are working together on a “freight fluidity” effort to evaluate supply chain performance in Texas, which utilizes time-dependent trip information to gauge the efficiency of freight routes. Increasing the quality of data to support these efforts would help provide justification for other improvements.
4.2 **Impacts**

This subsection describes the impacts that TxDOT and its stakeholders should expect as a result of the strategy’s deployment. First, impacts to the operational and institutional policies and constraints are highlighted, which TxDOT should review as part of the planning process for this strategy. It then highlights the operational and organizational impacts that TxDOT should expect during deployment, as well as any impacts incurred as a result of development. Lastly, it documents the expected impacts to stakeholders identified earlier.

4.2.1 **Policies**

The following summarizes some of the key impacts to operational and institutional policies associated with system development:

- **Data Sharing** – The system will comply with TxDOT agreements for sharing data with regional TMCs, external agencies, and third parties.

- **Data Security and Privacy** – The system will comply with any legal requirements for the protection, security, and privacy of data provided by and shared with stakeholders during system development, testing, and implementation. The system will not compromise any personally identifiable information (PII).

- **Operational Uptime** – Any system investment should be in operation 24 hours per day, seven days a week, 365 days per year, as time spent offline will decrease a user’s perceived value of the system. The system must utilize equipment that can fail in isolation so as to not take the entire system offline for a minor outage.

- **System Architecture Design** – The system will require flexibility in the system architecture design to respond to additional data feeds, improved data processing technology, and other technological advancements. The design should include the ability to consolidate multiple data sources into a consistent format and implement controlled access for authorized public and private data users.

- **Data Latency and Reliability** – The system shall provide traveler information in a timely and reliable manner that supports real-time decision-making. Any algorithmic tools used for forecasting traffic shall provide reliable forecasts in a timely manner.

- **Data Quality** – TxDOT shall ensure that the data feeds ingested by the system accurately reflect current conditions on Texas roadways. The system shall also implement a series of data checks to validate that the information comes from an authorized source. Forecasted traffic conditions shall be based on an extensive historical record of operational performance, and these forecasts should publish their expected confidence intervals.

- **Driver Distraction Laws** – Any mobile applications will be designed in a manner that prevents potential safety hazards from distracted driving. For instance, the proposed DriveTexas mobile application should default to audible alerts for truckers.
4.2.2 Constraints
The following summarizes some of the key operational constraints impacting system development:

- **Budget Constraints** – Funding is limited, which means a full-measure solution may not be attainable at the initial deployment. Additional funds will likely be necessary to expand the system beyond the initial deployment.

- **Maintenance** – The system will include ITS hardware that will need maintenance and replacement. This will require TxDOT staff or a TxDOT-funded maintenance contractor to dedicate time for system upkeep.

- **Limitations on Alternative Freight Routes** – Traveler information such as traffic congestion, incidents, and lane closures are less useful to truckers if they cannot take action to avoid anticipated delays. In some areas, there may be limited alternative freight routes, which may cause truckers to be forced to wait out delays, or take a break until the congestion clears, which can help them conserve their hours of service. Deployment priorities should consider locations where alternative routes can provide assistance during disruptions.

- **Limited Liability** – TxDOT and any other party using this traveler information service will need to work out a limited liability agreement for the information shared on DriveTexas. Real-time navigation routing needs to be viewed as an assistive service, but truckers will need to be able to navigate their route safely on their own should that service not be available. Traffic forecasts will need to publish the confidence intervals to convey user expectations with the system and indicate that forecasts cannot be fully reliable.

- **Coordination within TxDOT** – Maintenance responsibilities for ITS field devices to support this strategy would need to be coordinated between the TxDOT Divisions and the Districts with assets on their roadways. Coordination across Districts and between Districts and Divisions will be required.

- **Limited ITS Deployment on Urban Arterial and Rural Truck Routes** – Most state ITS assets are deployed on major corridors in urbanized areas. Urban arterial and rural truck routes often experience decreased ITS coverage, and, as a result, less granular traveler information availability. Since full coverage of the roadway system is not financially feasible, TxDOT will need to prioritize which corridors and routes should receive high-granularity data, based on freight volumes, safety issues, or access to freight activity centers, and other considerations. TxDOT may need to utilize third-party traffic data services to fill in gaps in ITS coverage for other lower-priority segments, which provides useful information, but not often at the highest or preferred level of granularity.

4.2.3 Operational Impacts
From an operational perspective, the implementation of the High-Resolution Freight Traveler Information System strategy would have the following impacts:
• **Increased Demand for Real-Time Network Communications** – With increased ITS coverage, efficient and reliable communications would be needed to collect and monitor traffic data, view CCTV video images, provide delay information to drivers while in route, and disseminate this information via traveler information systems.

• **New Training Requirements** – Maintenance personnel would require additional training to support new systems, equipment, and sensors that would be installed. IT staff would need new training on managing and calibrating any advanced processing algorithms that are adopted, including how to successfully troubleshoot issues associated with incorrect forecasts. TMC operators may require additional training to manage new devices or data sources.

### 4.2.4 Organizational Impacts

From an organizational perspective, the implementation of the High-Resolution Freight Traveler Information System strategy would impact both the public and the private sector.

#### 4.2.4.1 Public Sector

• **Improved Asset Utilization** – Enhanced freight routing could help trucks safely navigate around low clearance bridges and avoid areas where OS/OW vehicles are not permitted.

• **Improved Mobility and Reliability** – Without additional system capacity to meet growing demand, increases in freight traffic could lead to more hours of truck delay and less travel time reliability. High-resolution traveler information services would enable highway users to make informed decisions that utilize the existing capacity more efficiently.

• **Increased Utilization of Agency-Owned Traveler Information Services** – The development of a mobile application version of DriveTexas would help drive adoption amongst truckers and the general population.

• **Increased Data for Project Planning and Development** – The deployment of this strategy would expand the availability of high-resolution traffic data across the state. Project planning and design efforts would benefit from having the data to develop inputs needed for roadway maintenance, safety improvements, and accommodations for future freight technologies. This would in turn help improve the overall traveler experience.

• **Requires Collaboration between Public and Private Sectors** – In order for the strategy to be effective, close collaboration, interaction, and system integration between public sector agencies (i.e., TxDOT and regional agencies) and private sector companies (i.e., TxDOT and trucking companies, transportation data providers) would be required. Collaboration should begin prior to the design of the High-Resolution Freight Traveler Information System.

#### 4.2.4.2 Private Sector

• **Access to More Freight-Related Traveler Information** – This strategy includes improvements to both the granularity and coverage of traveler information available
today, which would expand the amount of freight-related traveler information that could be used to optimize freight operations.

- **Access to a Mobile App Version of DriveTexas** – The development of a mobile application version of DriveTexas would help drive adoption amongst truckers. In order to comply with driver distraction laws, notifications would default to audible format and app content would support Spanish in addition to English.

- **Increased Economic Competitiveness** – Advanced notice of delays and availability of alternative routes would support more informed route planning and real-time execution decisions, which would lead to improved operational efficiencies and increased economic competitiveness, compared to trucking companies who do not use the available traveler information services.

- **Decreased Vehicle Operating Costs** – Reducing delays and idling on the roadway can help truckers decrease their fuel usage and other vehicle operating costs.

- **Required Data Sharing Agreements** – Anonymized IVMS and ELD data would provide invaluable insights to TxDOT regarding freight travel patterns, as well as improvements needed to support freight mobility and reliability. Data sharing agreements would need to be set up between TxDOT and trucking companies in order to obtain IVMS and ELD data feeds.

- **Required Software Development Efforts** – Third-party developers, such as TMS companies, would need to set up API connections with TxDOT in order to initiate one- or two-way data sharing channels.

- **Required Collaboration between Public and Private Sectors** – In order for the strategy to be effective, close collaboration, interaction, and system integration between public sector agencies (i.e., TxDOT and regional agencies) and private sector companies (i.e., TxDOT and trucking companies, transportation data providers) would be required. Collaboration should begin prior to the design of the High-Resolution Freight Traveler Information System.

### 4.2.5 Impacts During Development

The development of the High-Resolution Freight Traveler Information System is not expected to disrupt the operations of any ITS device currently operating on the Texas roadway network. This strategy will expand the coverage of state-owned sensors and establish procedures for utilizing private sector probe data. In addition to increased data collection, Advanced Processing will be developed to support functions such as incident management, event screening, and forecasting of traffic conditions. The development of this system is not expected to disrupt current day-to-day TMC operations.

During implementation, TxDOT will need to coordinate with private sector trucking companies and transportation data providers to ensure that probe data is collected and
stored correctly. The data sharing mechanisms between TxDOT and these agencies will be important. Once the High-Resolution Freight Traveler Information System is deployed, this data will be integrated with the state’s ATMS.

4.2.6 Impacts to Stakeholders
Relevant stakeholders for the High-Resolution Freight Traveler Information System strategy are listed in Exhibit 40. Stakeholders are denoted by roles of owner, key stakeholder, and/or end-user. TxDOT Divisions would own, operate, and maintain the advanced traffic data processing system, including hardware, software, and data subscription services. They, along with TxDOT Districts, would also own, operate, and maintain any additional ITS devices deployed as part of this strategy to expand freight-related data. In addition to public sector groups that would share available data with the traveler information system, the private sector could also be key data contributors to this strategy. End-users will include TMCs, MPOs, truckers, trucking company dispatchers, and the general traveling public – all of which would utilize the DriveTexas traveler information to optimize freight operations and general travel.

Exhibit 40: Relevant Stakeholders for the High-Resolution Freight Traveler Information System strategy

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Role</th>
<th>Strategy Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>TxDOT Division(s)</td>
<td>Owner</td>
<td>• Will identify the Division to manage and fund the strategy. Will collaborate with other Divisions who will support or lead this effort.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Will collaborate with affiliated TxDOT Districts regarding ownership, operation, and maintenance of any field assets that are deployed in that District.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Will develop the strategy and identify funding needs for capital and O&amp;M.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Will oversee the development of a mobile application version of the DriveTexas website tailored to freight users.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Will coordinate with applicable stakeholders on integrating the advanced traffic data processing system with the ATIS.</td>
</tr>
<tr>
<td>Stakeholder</td>
<td>Role</td>
<td>Strategy Impact</td>
</tr>
<tr>
<td>------------------</td>
<td>-----------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>TxDOT Districts</td>
<td>Owner/Key Stakeholder</td>
<td>• Will own, operate, and maintain the advanced traffic data processing system, including hardware, software, and data subscription services.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Will coordinate on integrating new backend systems with the ATIS.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Will support project implementation by developing standards and specifications for ITS devices and system components.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Will ensure that the placement of ITS devices are safe and consistent with national and Texas standards.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Will utilize system outputs concerning crash safety to inform safety initiatives.</td>
</tr>
<tr>
<td>TMCs</td>
<td>Key Stakeholder / End-User</td>
<td>• Will collaborate with TxDOT Divisions regarding ownership, operation, and maintenance of any field assets that are deployed in the District.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Will help identify critical corridors where data coverage gaps exist.</td>
</tr>
<tr>
<td>MPOs</td>
<td>Key Stakeholder / End-User</td>
<td>• Will be responsible for operating ITS devices within their respective geographical region or jurisdiction.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Will help identify specific gaps in data coverage and contribute knowledge on how the system could best improve their operations.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Will utilize the system to improve traffic and incident management.</td>
</tr>
<tr>
<td>Stakeholder</td>
<td>Role</td>
<td>Strategy Impact</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>---------------</td>
<td>---------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Trucking Industry Groups</td>
<td>Key Stakeholder</td>
<td>• Will utilize data for planning applications.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transportation Data Providers</td>
<td>Key Stakeholder</td>
<td>• Will identify what freight-related traveler information would best serve their members.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Will identify opportunities for private-sector data contributions.</td>
</tr>
<tr>
<td>Truckers</td>
<td>End-User</td>
<td>• Will use the information supplied by the system to make informed departure time and routing decisions.</td>
</tr>
<tr>
<td>Trucking Companies / Dispatchers</td>
<td>End-User</td>
<td>• Will use the system to help their truckers make informed departure time and routing decisions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Will identify opportunities for private-sector data contributions.</td>
</tr>
<tr>
<td>Other Road Users</td>
<td>End-User</td>
<td>• Will use the system to make more informed travel decisions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Will receive improved traveler information and use system capacity more efficiently.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Texas Department of Motor Vehicles (TxDMV) will use route attribute information for OS/OW routing.</td>
</tr>
</tbody>
</table>

### 4.3 Alternatives To This Strategy

The proposed ConOps for this strategy comes with many benefits and impacts, but it inherently comes with prerequisite requirements in order to be successful in the long-term. While it meets the goals and objectives defined in the FNTOP strategy, it is not the only option available. This subsection identifies the inherent disadvantages and limitations of this strategy, and then contrasts the strategy against candidate alternatives that would also satisfy the intent, but were rejected due to being less advantageous.
4.3.1 Disadvantages and Limitations
The strategy in this ConOps is expected to have several disadvantages and limitations, which form prerequisite requirements that TxDOT will need to satisfy for it to fully succeed. Unlike the policy and constraint considerations identified earlier, these disadvantages and limitations will need to be continuously addressed.

- **System Development, Operations, and Maintenance May be Costly** – New hardware and software would be needed to implement the High-Resolution Freight Traveler Information System, including backoffice processing equipment and potentially customized software for the advanced processing features. Additional ITS field equipment procured by TxDOT to support the strategy in rural areas would need to be maintained regularly, which would increase overall ITS programmatic O&M costs.

- **Advanced Processing Scope** – Various options for advanced processing exist, ranging from existing processing services that TxDOT currently uses to translate sensor data into travel conditions to more sophisticated AI that makes educated forecasts of traffic conditions. While this strategy could be supported by any type of advanced processing, it would be far more advantageous to employ the more robust tools offered by AI and machine learning. As these types of tools grow more advanced, they also become more complicated to operate and maintain.

- **Subscriptions to Traffic Data Services May be Costly** – Under this strategy, one of the sources of traffic data would come from subscription services with private sector transportation data providers. Although TxDOT already purchases traffic data from private sector companies, these agreements can be costly. The expansion of traffic data collection under this strategy may require more services, further increasing costs.

- **Geographic Coverage** – Not every section of the THFN would be instrumented with high-resolution traffic data services. Deployments would be done strategically to focus first on critical freight corridors and underserved routes. Truckers may notice differences in the quality of traveler information throughout the State.

- **Compliance with Traveler Information Provided** – The system would only be effective if truckers and other roadway users receive and react to the traveler information that is provided to them. If drivers do not use the web and mobile applications to make pre-trip and on-the-road routing decision, there may be no improvements in overall traveler experience or safety. In addition, system credibility will be critical (i.e., system notifications must be consistently accurate).

4.3.2 Alternatives and Tradeoffs Considered
Given the above disadvantages and limitations, alternative options and tradeoffs were examined in lieu of the strategy in its proposed form. The alternative options listed below explore different approaches to improving the availability and use of high-resolution freight traveler information. It is important to note that some of these alternatives may seem
intuitively nonsensical, but they are worth noting to confirm that all options have been explored and rejected for the stated reasons.

4.3.2.1 Alternative 1: “Do Nothing” Approach
This alternative would maintain the current situation, which would require no changes to the existing program, no increases in costs, and no additional staff. TxDOT’s existing traffic operations program would continue to provide the same types of service, with no improvements in traveler information. Messages for the traveling public would be shared via DMSs and DriveTexas, as done currently. Traveler information improvements would fall under the responsibility of third-party transportation data providers. If this alternative is pursued, TxDOT would expect to maintain the status quo, capturing none of the benefits outlined in Section 4.1.

4.3.2.2 Alternative 2: Deploy Advanced Processing without Additional Data
This alternative would maintain the network of ITS devices that are currently used for traffic management, but implement an ATIS with advanced analytics capabilities to evaluate the currently available data. This ATIS would include Advanced Processing—such as potentially AI and machine learning capabilities—which would assist in incident management, event screening, and forecasting of future traffic conditions. Although the state’s ITS network would not be expanded and additional probe data would not be collected from private sector partners, the existing devices would be used more efficiently. Therefore, some of the benefits outlined in Section 4.1 would be realized.

4.3.2.3 Alternative 3: Deploy More ITS Devices instead of Advanced Processing
This alternative would focus on deploying more of the ITS devices currently found in the state, but not implement an advanced ATIS that has advanced processing capabilities like the AI or machine learning options. In this alternative, the ATIS would present data similar to DriveTexas in its current form. TxDOT and partner agencies would see an increase in capabilities by having more ITS devices than currently available, with existing traffic management benefits being extended into new coverage areas. Maintenance and TMC personnel would not require any additional training. However, TxDOT would miss out on benefits related to the advanced processing components, which would limit the ability to do traffic forecasting and faster incident detection. Few of the benefits outlined in Section 4.1 would likely be achieved.

4.3.2.4 Alternative 4: Use Crowd-Sourced Data Only
This alternative would reduce the scope of the strategy to strictly the crowd-sourced data aspects. TxDOT would maintain the existing network of ITS devices with the same capabilities, but this alternative would integrate a component of third-party traffic data. Sources for this data could include transportation data provider partnerships with trucking companies that use their fleets to actively collect probe data, or crowd-sourced reports such as Waze. Although the ITS network would still be the same, this third-party data would serve
an important function in helping to fill in ITS coverage gaps. Some of the benefits outlined in Section 4.1 could still be realized under this alternative.
5.0 Operational Scenarios

This section presents five operational scenarios that describe situations in which the High-Resolution Freight Traveler Information System strategy could significantly improve the mobility and reliability, economic competitiveness, preservation and utilization of assets, and safety of users on the THFN. Each operational scenario describes the users involved and the issues that are intended to be addressed, as well as the outcomes or benefits the users are expected to experience through the deployment of this strategy. The following operational scenarios do not address all of the improvements, nor do they represent a comprehensive set of use cases, but rather they demonstrate some of the key situations that this system could help mitigate. Exhibit 41 summarizes the operational scenarios presented in this section.

Exhibit 41: Summary of Operational Scenarios

<table>
<thead>
<tr>
<th>#</th>
<th>Scenario</th>
<th>FNTOP Stakeholders Involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pre-trip traveler information using expanded traffic data services and travel forecasts</td>
<td>Dispatcher, Trucker</td>
</tr>
<tr>
<td>2</td>
<td>En-route traveler information using expanded traffic data services and travel forecasts</td>
<td>Trucker</td>
</tr>
<tr>
<td>3</td>
<td>Incident-related traveler information using artificial intelligence</td>
<td>Trucker</td>
</tr>
<tr>
<td>4</td>
<td>Weekly fleet planning using forecasted data</td>
<td>Dispatcher</td>
</tr>
<tr>
<td>5</td>
<td>TxDOT freight planning</td>
<td>TxDOT</td>
</tr>
</tbody>
</table>

5.1 Pre-Trip Traveler Information Using Expanded Traffic Data Services and Travel Forecasts

Trucking International is a trucking firm operating throughout the U.S. with operations in Texas. To try to improve their fleet’s on-time performance, Trucking International decided to utilize the improved, high-resolution freight traveler information system available through TxDOT’s DriveTexas platform. To efficiently integrate the data available from DriveTexas, they elected to directly link their TMS to DriveTexas using trusted API connections made available by TxDOT. As dispatchers plan daily driver schedules, they can turn on various data layers to see current and future traffic conditions, planned closures, and work zones. The enhanced DriveTexas platform is now integrated with ITS devices, probe data, and historical data, and uses predictive modeling to extrapolate future traffic conditions. The dispatchers find the real-time and future conditions information very useful in planning daily driver schedules.

Nina has been a dispatcher at Trucking International for two years. As a driver arrives to pick up his first delivery, she sees that it involves overweight cargo. She has run into issues with
oversized/overweight cargo in the past. Even though they apply for the appropriate permits through TxDMV ahead of time, sometimes TxDOT road work such as lane closures to repair a guardrail, interferes with the assigned route, which can cause permits to be cancelled at the last minute. This information also does not always get relayed to trucking firms, which leaves her scrambling to find an alternative route that accepts oversized or overweight cargo. She double checks the roadway conditions in the TMS before the driver heads out. From the DriveTexas-provided data, she confirms that there are no current or planned road closures on the assigned route and also sees no major slowdowns that would impact the delivery time. With a sigh of relief, she tells the trucker that he is free to leave.

By integrating DriveTexas data feeds into dispatcher operations, Trucking International began noticing an increase in their fleet’s on-time performance. Drivers could be routed more efficiently and dispatchers were able to provide assignments with a higher degree of confidence that they could be carried out on-time and within a driver’s hours of service. This improves the mobility and economic competitiveness of trucking companies in Texas.

5.2 En-Route Traveler Information Using Expanded Traffic Data Services and Travel Forecasts

ABC Freight International drivers are generally responsible for developing routing plans for their shifts based on the assigned loads. With a mix of company drivers and owner operators, the sophistication of in-vehicle navigation systems varies, with some drivers relying on their smartphones to access real-time traffic information.

ABC Freight International is excited to have their drivers use the new DriveTexas mobile application (app), a free service to improve truck routing decisions. When the origin and destination of a delivery is entered, DriveTexas can provide drivers with an optimized route using freight-permitted roads. The mobile app’s routing engine can also provide dynamic re-routing recommendations mid-trip based on changes in traffic conditions.

Amy has been a driver for ABC Freight International for five years. She spends a lot of time in traffic slowdowns, at times causing her to nearly miss her delivery window. In those situations, she usually uses Waze to try to find a better route, but has gotten ticketed for veering off truck-permitted roads. As she leaves Laredo, Texas, and heads north toward I-35, she receives an audible alert from her DriveTexas mobile app indicating a blocked rail crossing a few miles up ahead. The new DriveTexas platform used its new predictive modeling features to predict this delay. Determining from a CCTV camera that traffic was stalled, DriveTexas reviewed the traffic pattern, as well as historical travel time records, and determined that this pattern is consistent with nearby blocked rail crossings. The mobile app was able to alert Amy to a possible delay of 20 minutes.

She checks the navigation feature in DriveTexas and sees that the only alternative truck route before the blocked rail crossing would take her too far out of the way to her
destination and it would be faster to just wait for the train to pass. Amy takes this opportunity to check DriveTexas for the closest available rest stop. Without having to check multiple websites, she learns that the rest stop off the next exit not only has available truck parking stalls, but also has restrooms and several food options. She takes a relaxing break until she receives notification that the rail crossing is now clear.

Even though Amy was not able to reduce the delay caused by the blocked rail crossing, with DriveTexas, she confirmed that there was no faster truck route to her destination and made better use of her time instead of idling on the roadway. ABC Freight International and owner-operators both realized fuel savings, and correspondingly, this provided public sector benefits in reductions in emissions and greenhouse gases (GHG).

5.3 Incident-Related Traveler Information Using Artificial Intelligence

DriveTexas can play an important role in identifying issues that may negatively impact On-Time Freight Trucking Company’s daily schedule. DriveTexas combines information from real-time traffic sources to note locations where traffic congestion is worse than normal due to incidents, construction activity, special events, or heavier than normal traffic volumes. Normally, dispatchers rely on traffic reports and calls from drivers already on the road to report on major incidents or other unanticipated delays on common freight routes. Then they have to notify other drivers who will be impacted by the delays and recommend alternative routes, as well as issue advance notice to the receiver that the delivery may be late.

Leo is an owner-operator that just relocated from San Antonio to Houston, Texas, with a new contract with On-Time Freight Trucking Company. Even though he has been driving a truck for years, he is not very familiar with the Houston area. His dispatcher recommended that he keep the DriveTexas mobile app on in his truck. He is making his second delivery of the day to the Barbours Cut Terminal at Port Houston. He enters his destination into the DriveTexas navigation feature. As he heads east on I-10, he receives an audible alert of a slowdown on TX-8 due to a temporary lane closure necessary to clear an incident. Before any TMC personnel had to become involved, the enhanced DriveTexas traveler information system detected the upcoming traffic hotspot via a traffic detector. The AI then confirmed the lane closure, determined alternate routes, and disseminated the information to affected drivers. DriveTexas recommends that he exit onto I-610 and take SH 225 instead, having already taken into account truck-permitted routes when providing rerouting instructions. Before he changes routes, he notices a DMS displaying the same incident information that his mobile app alerted him to. With the enhanced DriveTexas traveler information system, incidents detected within a geofenced area are also displayed on key DMSs for travelers who don’t use the mobile app.

Leo continues driving down I-610, enjoying the smooth flow of traffic. He passes several more DMSs with the “#EndTheStreakTX” safety campaign. He notices that his smartphone
doesn’t issue an alert each time and he appreciates not receiving an overwhelming number of alerts, even if they are audible and cause minimal distraction while he is driving. The enhanced DriveTexas traveler information system assigns priorities to notification types, in order to limit the number of in-cab distractions.

By using the DriveTexas navigation feature to help drivers identify unanticipated events in real-time and more intelligently re-route drivers, On-Time Freight Trucking Company, as well as owner-operators responsible for their own rerouting, began noticing small, but measurable improvements in fuel savings for their trucks. Correspondingly, this provided public sector benefits in reductions in emissions, GHG, and contributed to managing congestion on key freight routes throughout the state. The early incident detection allowed TxDOT to promptly respond to and clear the incident, helping reduce the rate of secondary crashes due to disruptions in the transportation system.

5.4 Weekly Fleet Planning Using Forecasted Data

On-The-Move Trucking Company begins planning its container pickup and delivery schedule prior to the day of dispatch to determine driver needs and confirm driver availability. Currently, this process involves On-The-Move Trucking Company’s dispatchers compiling orders from Beneficial Cargo Owners (BCOs), prioritizing them based on several factors and developing driver assignments. Driver assignment procedures vary between company drivers and owner operators. Company drivers can be assigned with greater confidence while more coordination is needed to assign and confirm the availability of an owner-operator. Drivers are contacted and, once all orders are accepted, drivers are assigned. This information along with appointment times are input into On-The-Move Trucking Company’s TMS. The ability to successfully carry out the plan depends on a number of factors, many of which are out of the control of the trucking company and its drivers. These include container availability and turnaround times at marine terminals, traffic and congestion on the roadways, and whether empty containers are being accepted by vessels.

On-The-Move Trucking Company recently integrated the DriveTexas API into its TMS, enabling real-time data feeds from TxDOT’s enhanced traveler information system. In the past, dispatchers would check the DriveTexas website for listings of planned construction events and road/lane closures and see how that would impact container pickup and delivery schedules. Now, On-The-Move Trucking Company dispatchers have the ability to access freight-specific traveler information within their TMS. The DriveTexas data feeds help their planning process in several ways. The data feeds serve as a portal to several sources of information that can help the dispatcher determine whether the proposed schedule is realistic. These include future predicted traffic conditions, planned construction events, and road/lane closures, which help dispatchers approximate the time each delivery will take. With access to this data from a variety of sources, the new DriveTexas platform uses AI to better predict traffic conditions in real-time. In addition, the DriveTexas data feeds provide information on locations of available truck parking, rest stops with Wi-Fi, and charging
stations for electric trucks, which help dispatchers determine if drivers can complete multiple deliveries within their hours of service.

By using DriveTexas to optimize fleet planning as described above, On-The-Move Trucking Company immediately began noticing an increase in their average fleet metric of truck deliveries per day. Additionally, through reductions in vehicle miles travelled, the company realized fuel savings for both company drivers and owner-operators, which has helped their economic competitiveness. Correspondingly, this provided public sector benefits in reductions in emissions, GHG, and contributed to managing congestion on key freight routes throughout the state. The TMFN as a whole is more economically competitive through improvements gained by trucking companies in Texas.

5.5 **TxDOT Freight Planning**

TxDOT freight planners utilize data to identify freight-related trends, isolate gaps in the existing system, and forecast the improvements of potential countermeasures. While more data is preferred, funding the collection of extensive data and aggregating it through a single service is often a challenge. However, with the implementation of the High-Resolution Freight Traveler Information System, TxDOT freight planners realize that new opportunities may be available.

ITS devices and third-party traffic data was expanded to rural routes, providing a good historical record of traffic patterns in these areas where data collection historically was more scarce. Collaboration between TxDOT Divisions, TxDMV, Texas Department of Public Safety (TxDPS), and other private sector partners allowed the data to be processed into a standard format, allowing planners an easier time pulling a single data set as opposed to aggregating each data set on its own. With information being populated regularly into HCRS and the LoneStar ATMS, TxDOT freight planners have a better understanding of cause-and-effect for certain trends (e.g., congestion on one road created freight congestion on another road, an extended road closure reported in HCRS was tied to an increase of safety issues for freight on nearby routes).

Additionally, with private-sector freight operations contributing anonymized ELD data, TxDOT freight planners can analyze origins, destinations, and stops more thoroughly, allowing conclusions to be drawn about truck parking needs, incentivization of use for certain times of day, and travel demand management. TxDOT was able to better understand delivery patterns and build a business case for these applications. The truck origin-destination information also helped TxDOT prioritize where to deploy additional ITS devices, such as traffic detectors, DMSs, and CV RSUs. Anonymized in-vehicle monitoring system data shared with TxDOT (e.g., hard braking locations, travel speeds below posted speed limits, swerving, etc.) was overlaid on top of internal crash data, which helped TxDOT identify high-crash risk locations and design safety countermeasures.
Even though many features of the High-Resolution Freight Traveler Information System are intended for real-time traffic management and incident response, TxDOT freight planners are able to make good use of the data that has been collected to support this strategy. With this data, they are able to offer stronger recommendations for specific solutions, helping foster a more robust freight environment in Texas.
6.0 Next Steps

This High-Resolution Freight Traveler Information System ConOps is one of six ConOps documents being prepared as part of the FNTOP. As noted earlier, these six strategies were chosen through a selection process that vetted a total of 10 identified strategies with key stakeholders. Each ConOps intends to further answer how each specific strategy would operate, which systems it would interface with, and how various user groups would be impacted by the introduction of the strategy. Based on this document, this strategy is ready for TxDOT to advance to implementation planning in the future, which would include the development of system requirements and high-level design (detailed further in the Implementation Plan as shown in Exhibit 42).

In addition to the ConOps development, the FNTOP is also developing an Implementation Plan that explores the near-, medium-, and long-term actions that will drive the successful implementation of the 10 FNTOP strategies. This will include an assessment of the readiness of each strategy. The goal is to inform the next steps beyond the FNTOP as these strategies are transitioned from planning to design. This will include outlining how the High-Resolution Freight Traveler Information System strategy would ultimately come to fruition, utilizing insights provided as part of this ConOps.

Exhibit 42: Next Step in the Texas FNTOP
7.0 References
The following is a list of relevant documents, standards, and references used in preparing this document:

- Texas Department of Transportation, Texas Freight Mobility Plan 2018, March 7, 2018
- Texas Department of Transportation, Texas Freight Mobility Plan 2018 – Executive Summary, March 7, 2018
- Sugar Land Traffic, [http://its.sugarlandtx.gov/traffic](http://its.sugarlandtx.gov/traffic)
- FHWA, Traffic Incident Management (TIM) Performance Measurement: On the Road to Success