Texas Freight Network Technology and Operations Plan

Implementation Plan
Texas Department of Transportation, Freight Planning Branch

Final: December 2020
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<th>Full Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>API</td>
<td>Application Programming Interface</td>
</tr>
<tr>
<td>ATIS</td>
<td>Advanced Traveler Information System</td>
</tr>
<tr>
<td>ATMS</td>
<td>Advanced Traffic Management System</td>
</tr>
<tr>
<td>AV</td>
<td>Automated Vehicle</td>
</tr>
<tr>
<td>BTMP</td>
<td>Texas-Mexico Border Transportation Master Plan</td>
</tr>
<tr>
<td>CAT</td>
<td>Cooperative Automated Transportation</td>
</tr>
<tr>
<td>CAV</td>
<td>Connected and Automated Vehicle</td>
</tr>
<tr>
<td>CBP</td>
<td>Customs and Border Protection</td>
</tr>
<tr>
<td>ConOps</td>
<td>Concept of Operations</td>
</tr>
<tr>
<td>CV</td>
<td>Connected Vehicle</td>
</tr>
<tr>
<td>C-V2X</td>
<td>Cellular Vehicle-to-Everything</td>
</tr>
<tr>
<td>DMS</td>
<td>Dynamic Message Sign</td>
</tr>
<tr>
<td>DOT</td>
<td>Department of Transportation</td>
</tr>
<tr>
<td>DSRC</td>
<td>Dedicated Short Range Communication</td>
</tr>
<tr>
<td>ELD</td>
<td>Electronic Logging Device</td>
</tr>
<tr>
<td>FNTOP</td>
<td>Freight Network Technology and Operations Plan</td>
</tr>
<tr>
<td>FRATIS</td>
<td>Freight Advanced Traveler Information Systems</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographic Information System</td>
</tr>
<tr>
<td>HOS</td>
<td>Hours-of-Service</td>
</tr>
<tr>
<td>ICM</td>
<td>Integrated Corridor Management</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
</tr>
<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>ITD</td>
<td>Information Technology Division</td>
</tr>
<tr>
<td>ITS</td>
<td>Intelligent Transportation Systems</td>
</tr>
<tr>
<td>IVMS</td>
<td>In-Vehicle Monitoring System</td>
</tr>
<tr>
<td>LiDAR</td>
<td>Light Detection and Ranging</td>
</tr>
<tr>
<td>MOU</td>
<td>Memorandum of Understanding</td>
</tr>
<tr>
<td>OBU</td>
<td>Onboard Unit</td>
</tr>
<tr>
<td>OEM</td>
<td>Original Equipment Manufacturer</td>
</tr>
<tr>
<td>OS/OW</td>
<td>Oversize/Overweight</td>
</tr>
<tr>
<td>PPP</td>
<td>Public-Private Partnership</td>
</tr>
<tr>
<td>RFI</td>
<td>Request for Information</td>
</tr>
<tr>
<td>RFP</td>
<td>Request for Proposal</td>
</tr>
<tr>
<td>ROW</td>
<td>Right of Way</td>
</tr>
<tr>
<td>RSU</td>
<td>Roadside Unit</td>
</tr>
<tr>
<td>SAT</td>
<td>Servicio de Administración Tributaria</td>
</tr>
<tr>
<td>SCT</td>
<td>Secretaría de Comunicaciones y Transportes</td>
</tr>
<tr>
<td>SOP</td>
<td>Standard Operating Procedure</td>
</tr>
<tr>
<td>SRA</td>
<td>Safety Rest Area</td>
</tr>
<tr>
<td>STARS II</td>
<td>Statewide Traffic Analysis and Reporting System</td>
</tr>
<tr>
<td>STOC</td>
<td>Statewide Traffic Operations Center</td>
</tr>
<tr>
<td>TFMP</td>
<td>Texas Freight Mobility Plan</td>
</tr>
<tr>
<td>TMC</td>
<td>Traffic Management Center</td>
</tr>
<tr>
<td>Acronym</td>
<td>Full Form</td>
</tr>
<tr>
<td>---------</td>
<td>-----------</td>
</tr>
<tr>
<td>TMFN</td>
<td>Texas Multimodal Freight Network</td>
</tr>
<tr>
<td>TMUTCD</td>
<td>Texas Manual on Uniform Traffic Control Devices</td>
</tr>
<tr>
<td>TOC</td>
<td>Traffic Operations Center</td>
</tr>
<tr>
<td>TPAS</td>
<td>Truck Parking Availability System</td>
</tr>
<tr>
<td>TRB</td>
<td>Transportation Research Board</td>
</tr>
<tr>
<td>TxDOT</td>
<td>Texas Department of Transportation</td>
</tr>
<tr>
<td>TxDMV</td>
<td>Texas Department of Motor Vehicles</td>
</tr>
<tr>
<td>TxDPS</td>
<td>Texas 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>V2V</td>
<td>Vehicle-to-Vehicle</td>
</tr>
<tr>
<td>V2X</td>
<td>Vehicle-to-Everything</td>
</tr>
<tr>
<td>VC</td>
<td>Vehicle Classification</td>
</tr>
<tr>
<td>WIM</td>
<td>Weigh-in-Motion</td>
</tr>
</tbody>
</table>
1.0 Introduction

1.1 Project Background

The Texas Department of Transportation's (TxDOT) comprehensive freight technology planning effort – the Texas Freight Network Technology and Operations Plan (FNTOP) - outlines potential strategies to guide technology- and operations-related investments on the Texas Multimodal Freight Network (TMFN). This effort includes a detailed assessment of current and future transportation technology needs, challenges, gaps, and opportunities gathered through focused public and private sector engagement that inform the development of the FNTOP. The FNTOP is a 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.

A total of 12 technology-based strategies were identified as part of the FNTOP to help improve freight operations in Texas, based on the goals outlined in the Texas Freight Mobility Plan (TFMP). These strategies 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, which 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. The FNTOP identified strategies, which are well-aligned with the TFMP goals and the Texas Cooperative Automated Transportation (CAT) Plan focus areas, include the following:

1. Truck Parking Availability System (TPAS);
2. High-Resolution Freight Traveler Information System;
3. Centralized Data Repository for Freight Applications;
4. Automated Vehicle (AV) Infrastructure, Connected Signing, and Data;
5. Safety Warning Detection System;
6. Smart Freight Connector;
7. Blocked Rail Crossing Traffic Management System;
8. Smart Work Zone Information System;
9. Statewide Traffic Operations Center (STOC);
10. Binational Traffic Operations Center (TOC);
11. Freight Integrated Corridor Management (ICM); and
12. Fiber Optic Cable System Expansion.
The FNTOP Strategies and Conceptual Framework Report was developed to provide detailed descriptions of each of the FNTOP identified strategies in terms of strategy elements, corresponding user needs, relevant stakeholders, benefits and costs of deployment, and a deployment timeline. Upon initial development of the identified strategies, discussions with TxDOT Central Office led to the decision to not prioritize the following two strategies: Freight ICM and Fiber Optic Cable System Expansion. The Freight ICM strategy was deemed to be very similar in purpose and need to the Smart Freight Connector strategy and, as a result, was coupled with that strategy. The Fiber Optic Cable System Expansion strategy was viewed as being an infrastructure-focused commodity instead of a technological or operational application, and was not prioritized as part of the FNTOP. The Conceptual Framework introduced in the FNTOP Strategies and Conceptual Framework Report focuses on the 10 remaining strategies, referred to as the FNTOP recommended strategies. Additionally, the FNTOP Strategies and Conceptual Framework Report describes the process of selecting and prioritizing the strategies selected for Concept of Operations (ConOps) development. This process was based on extensive stakeholder engagement, which included in-person interviews, meetings, and workshops with TxDOT Division leads, as well as one-on-one interviews and webinars with other public and private sector stakeholders.

A total of six of the FNTOP recommended strategies were selected for ConOps development. These strategies were viewed by TxDOT and stakeholders as having consistently high scores for anticipated value added to the TMFN and ease of implementation. In-depth concepts of desired operations and maintenance requirements for these six FNTOP recommended strategies can be found in the FNTOP ConOps documents. The other four FNTOP recommended strategies are designated as either Underway as part of a separate effort, or Deferred due to another TxDOT initiative. Exhibit 1 summarizes the recommendation for each of the 12 FNTOP identified strategies.
Exhibit 1: Identified FNTOP Strategies and Recommendations

<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>FNTOP ConOps</td>
</tr>
<tr>
<td>Centralized Data Repository for Freight Applications</td>
<td>Deferred(^2)</td>
</tr>
<tr>
<td>AV Infrastructure, Connected Signing, and Data</td>
<td>FNTOP ConOps</td>
</tr>
<tr>
<td>Safety Warning Detection System</td>
<td>FNTOP ConOps</td>
</tr>
<tr>
<td>Smart Freight Connector</td>
<td>FNTOP ConOps</td>
</tr>
<tr>
<td>Blocked Rail Crossing Traffic Management System</td>
<td>FNTOP ConOps</td>
</tr>
<tr>
<td>Smart Work Zone Information System</td>
<td>Underway(^1)</td>
</tr>
<tr>
<td>Statewide Traffic Operations Center</td>
<td>FNTOP ConOps</td>
</tr>
<tr>
<td>Binational Traffic Operations Center</td>
<td>Deferred(^2)</td>
</tr>
<tr>
<td>Freight Integrated Corridor Management</td>
<td>Not Prioritized(^3)</td>
</tr>
<tr>
<td>Fiber Optic Cable System Expansion</td>
<td>Not Prioritized(^4)</td>
</tr>
</tbody>
</table>

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

The Conceptual Framework developed illustrates at a high-level how the 10 FNTOP recommended strategies could potentially function together as an integrated technology- and information sharing-based system, and how these strategies support and expand TxDOT’s existing technology programs. The Conceptual Framework provides the foundational material that informs the FNTOP ConOps documents as well as the FNTOP Implementation Plan. More information on the Conceptual Framework is provided in Section 2.2 of this document.

1.2 Purpose of the Implementation Plan

The next step in the process to developing the Texas FNTOP, as illustrated in Exhibit 2, is the development of an Implementation Plan. The Implementation Plan outlines the recommended activities that will help facilitate the initiation and deployment of each of the recommended FNTOP strategies. It provides a timeline for deployment and highlights key next steps needed to advance the strategies. The Implementation Plan also describes near-, medium-, and long-term actions that will allow for successful implementation of the strategies.
The goal of the Implementation Plan is to inform the next steps beyond the FNTOP, as these strategies are transitioned from planning to deployment. The remainder of this document is organized into the following sections:

- **Section 2 – Implementation Framework.** This section outlines the structure and basis for the Implementation Plan. It illustrates how the FNTOP strategies and existing TxDOT technology programs could function together as a statewide integrated system.

- **Section 3 – Implementation Planning.** This section describes how each of the selected FNTOP strategies could be implemented through a series of considerations and recommended activities that extend beyond development of the FNTOP.

- **Section 4 – Implementation Action Plan.** This section establishes recommended implementation priorities and timelines and provides a summary comprehensive of all 10 strategies. It highlights key opportunities and actions for the near-, medium-, and long-term for successful implementation of the strategies.

- **Section 5 – References.** This section lists all references used in the creation of this document.
2.0 Implementation Framework

2.1 Overview of Framework
This section provides a framework and describes the elements of the Implementation Plan. The Implementation Plan addresses the 10 FNTOP recommended strategies specified in Section 1.1\(^1\). These strategies encompass freight network technologies, operations, policies, programs, and projects that prioritize freight mobility and safety, and have the potential to improve the efficiency of multimodal freight movements. Based on feedback from TxDOT and key public and private sector stakeholders, these strategies have been specifically recommended as they are better positioned for near-term implementation based on anticipated value added to operation of the TMFN, ease of implementation, and their ability to address high-priority FNTOP stakeholder needs. Exhibit 3 describes the components that are discussed for each strategy in Section 3.0.

**Exhibit 3: Implementation Framework Components**

<table>
<thead>
<tr>
<th>Component</th>
<th>Description and Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategy Overview</td>
<td>• Provides a high-level overview of the strategy.</td>
</tr>
<tr>
<td>Roles and Responsibilities</td>
<td>• Identifies strategy owners and key stakeholders who will lead/contribute to the implementation of the strategy.</td>
</tr>
<tr>
<td></td>
<td>• Identifies roles and responsibilities necessary to take the strategy from planning to implementation.</td>
</tr>
<tr>
<td>Organizational and Policy</td>
<td>• Identifies and describes any organizational and policy changes required to support the implementation of the strategy.</td>
</tr>
<tr>
<td>Considerations</td>
<td></td>
</tr>
<tr>
<td>Advancing the Strategy</td>
<td>• Describes the readiness of the strategy for deployment and its scalability. Identifies to what extent, if at all, the strategy has already been deployed in Texas.</td>
</tr>
<tr>
<td></td>
<td>• Defines a timeline associated with the implementation of the strategy.</td>
</tr>
<tr>
<td></td>
<td>• Defines a timeline associated with the implementation of the strategy.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) Excludes Freight ICM and Fiber Optic Cable System Expansion, which were designated as Not Prioritized.
2.2 Strategies as an Integrated System

The Implementation Plan describes each of the 10 FNTOP recommended strategies independently, demonstrating that the strategies could be implemented as standalone systems. However, the strategies also have the potential to be implemented together or in functional groups as part of an integrated system. Exhibit 4 illustrates the Conceptual Framework, which highlights areas of complementary technology use and integration across the strategies and existing TxDOT systems. Integration into TxDOT's comprehensive system would follow existing policies regarding network security and liability, and adjustments to these policies would need to be determined as part of subsequent design efforts.

As shown in the diagram, five of the strategies—namely TPAS, Safety Warning Detection System, Smart Freight Connector, Blocked Rail Crossing Traffic Management System, and the Smart Work Zone Information System—have the potential to enhance existing freight operations at a regional level, enabled through the integration of these systems into the Advanced Traffic Management Systems (ATMSs) operated by each of the seven regional Traffic Management Centers (TMCs). The remaining five strategies—including STOC, Centralized Data Repository, Binational TOC, High-Resolution Freight Traveler Information System, and AV Infrastructure, Connected Signing, and Data—have the potential to improve the operation of regional and the statewide freight networks. This would require integration into TxDOT's centralized ITS network architecture and the enhancement of existing information sharing channels.

There are common elements between the strategies, whether it be the types of Intelligent Transportation System (ITS) equipment (e.g., servers, sensors, digital communications) or the required information or data (e.g., travel time, delay, incidents). The Implementation Plan considers and leverages the complementary technology use between the strategies, as well as with existing TxDOT systems, to help reduce project costs and enhance the overall functionality of the systems.

More detailed information on the Conceptual Framework can be found in the FNTOP Strategies and Conceptual Framework Report. Use case scenarios that describe real-life situations to help readers better understand how implementing the strategies could help improve the mobility and safety of trucking companies and drivers in Texas are also included in the FNTOP Strategies and Conceptual Framework Report. The use cases consider various environments, including urban, rural, port, and statewide settings, where the identified strategies could bring about significant benefits.
Exhibit 4: Conceptual Framework for Integrated Strategies

- Regional TMC(s)
  - ATMS
  - Other ITS Field Equipment

- Centralized Operations
  - Statewide Traffic Operations Center
  - Centralized Data Repository for Freight Applications

- AV, Signing & Data
  - AV Infrastructure
    - Safety
    - Road User Information
    - Autonomous Vehicles
    - Notifications (conditions, incidents, closures)

- High-Resolution Freight Traveler Information System
  - Partner Agencies
  - NavMap/Traffic Services
  - Other Stakeholders
  - Media Outlets
  - Data Subscribers
  - DriveTexas ATIS
3.0 Implementation Planning

This section describes the actions needed to help facilitate the initiation and scalability of the 10 FNTOP recommended strategies, as well as the steps necessary to transition them from planning to deployment. Each strategy-specific subsection provides an overview of the strategy; identifies roles and responsibilities of key stakeholders that will advance the strategy; outlines organizational and policy considerations for TxDOT; and provides a series of recommended next steps for implementation. Recommended next steps are divided into Near-Term Actions, Medium-Term Actions, and Long-Term Actions. While many actions will be similar between strategies, these recommendations highlight a checklist for TxDOT to consider when envisioning what needs to occur to advance these strategies into implementation.

As identified in Section 1.1, the 10 FNTOP recommended strategies are listed below and covered in the following subsections.

1. TPAS;
2. High-Resolution Freight Traveler Information System;
3. Centralized Data Repository for Freight Applications;
4. AV Infrastructure, Connected Signing, and Data;
5. Safety Warning Detection System;
6. Smart Freight Connector;
7. Blocked Rail Crossing Traffic Management System;
8. Smart Work Zone Information System;
9. STOC; and
10. Binational TOC.

3.1 Truck Parking Availability System

3.1.1 Strategy Overview

TPAS helps truck drivers locate available parking spaces in real-time so they can make informed decisions about their parking needs. The TPAS program will implement a platform from which truck parking space availability data will be collected and processed in real-time from all equipped parking facilities. The processed data will be distributed to a variety of sources, notably roadside signage as well as through web and mobile sources. Collectively, this program will aid in the reduction of unauthorized or unsafe parking, driving beyond legal HOS, and wasted time searching for parking by providing useful, real-time information to truckers.
Unlike other strategies, TxDOT has a TPAS effort underway, consisting of the I-10 Corridor Coalition’s TPAS project (I-10 TPAS), a federal grant-funded project that will install TPAS at select locations along I-10 from California to Texas. In addition, TxDOT is actively working to implement the Texas Statewide Truck Parking Implementation Plan, which is anticipated to include a statewide TPAS implementation effort. The focus of the FNTOP implementation activities aligns closely with work that has already been undertaken or initiated as part of these efforts. Details on these current efforts are discussed later in this section.

Exhibit 5 provides an illustrative example of this strategy. TPAS can be designed in several different ways, depending on the local needs of the benefiting users, but most systems implemented to date follow this concept.

Exhibit 5: Illustrative Example of Truck Parking Availability System

3.1.2 Roles and Responsibilities

Relevant stakeholders for implementing TPAS are listed in Exhibit 6. At the Division level, TxDOT would have the administrative responsibility of providing project planning and implementation support in coordination with the TxDOT Districts. The TxDOT Districts would be responsible for operating and maintaining the systems installed on state-owned routes. Many of these responsibilities would be worked out through the I-10 TPAS effort currently under development.

Exhibit 6: Truck Parking Availability System Stakeholder Roles and Responsibilities

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Strategy Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>TxDOT Division Offices (Owner)</td>
<td>• Will design the sites and the systems.</td>
</tr>
<tr>
<td></td>
<td>• Will own, operate, and maintain certain technological elements associated with truck parking availability systems, such as the central processing component.</td>
</tr>
</tbody>
</table>
### 3.1.3 Organizational and Policy Considerations

Any organizational changes to TxDOT as a result of TPAS would be undertaken as part of the current TPAS project and upcoming statewide TPAS implementation effort. The structure and policies adopted as part of those initial TPAS efforts should be continued. As the system is expanded into new environments (e.g., private truck parking facilities), additional MOUs and data sharing agreements will be needed. Some specific policies to consider include:

- Data sharing agreements and formatting;
- Data security standards;
- Quality Assurance (QA) standards; and
- Rights of access.

### 3.1.4 Advancing the Strategy

TxDOT’s I-10 TPAS deployment along the I-10 is in the initial planning and design phases, and will help set a state-specific architecture for TPAS, in the state of Texas. This effort will produce designs and specifications for TPAS that can serve as a baseline for future endeavors. The I-10 TPAS will go live in the next few years.

TxDOT will determine the feasibility of the statewide scaling of the I-10 TPAS as part of its statewide truck parking implementation efforts. These implementation efforts are anticipated to begin in 2021 and will utilize lessons learned and planning decisions made as part of the I-10 TPAS effort and the Statewide Truck Parking Study (April 2020).

**Near-Term Actions**

Near-Term Actions for this strategy focus on supporting and monitoring the I-10 TPAS deployment, and developing the statewide truck parking implementation effort. As a starting point, it could build off of the ConOps document that was completed as part of the I-10 TPAS effort. The following Near-Term Actions should be considered:

1. **Monitor the I-10 TPAS Implementation:** TxDOT will develop the I-10 TPAS’ organizational structure, design methodology, software development, procurement
approach, accommodation of stakeholder needs, and deployment. The integration of all these elements will be key for the success of the system. Based on the effectiveness of the project, TxDOT should refine the strategy as necessary for statewide implementation.

2. **Look for Partnerships**: Partnerships will be critical to expand and scale the system statewide and beyond. Cooperation among states with deployed TPAS may help accelerate the deployment nationwide and provide opportunities to exchange lessons learned. Public-Private Partnerships (PPPs) should also be considered and explored, especially to promote expansion of the TPAS to off-network and private facilities. Both public agencies and private entities provide parking services, and both can cooperate to deliver a unified system to truckers.

3. **Update ConOps and System Requirements Documents to Accommodate Statewide Goals and Objectives**: The I-10 TPAS effort will generate a ConOps document and a System Requirements document. The statewide TPAS implementation effort should do the same, building off the I-10 effort while expanding the needs criteria to focus on statewide requirements. As TPAS deployments occur, TxDOT should update the ConOps and System Requirements documents based on the lessons learned as needs change.

4. **Update High-Level Design**: The I-10 TPAS effort will generate a design package to support deployments along I-10. The Statewide TPAS Implementation Plan will do the same, but with more design to accommodate the statewide inventory of sites. Given that lessons will be learned from the I-10 TPAS and other early implementations, TxDOT may need to update the Statewide TPAS Implementation Plan to reflect a revised preferred design. This is not uncommon in technology system deployments; the system evolves as new technology is made available and stakeholders witness first-hand the successes and challenges of a particular solution.

5. **Prioritize and Select Sites**: TxDOT should, as part of the I-10 TPAS effort, and the upcoming Statewide TPAS Implementation Plan, identify candidate sites for TPAS. The statewide study in particular, will likely investigate infrastructure needs, site prioritization, and time-phased implementation approaches. Other planning activities regarding TPAS-related elements should occur as part of the statewide study so as to be comprehensive under one project.

6. **Develop Independent Cost Estimate**: For each proposed time-phased implementation of TPAS, TxDOT should prepare an independent implementation cost estimate. This estimate would confirm the necessary expectations on cost as a Request for Proposal (RFP) document is prepared and would allow for proper funding allocations.

7. **Establish Standards and Agreements**: TxDOT should develop the necessary standards and agreements to help guide design.
8. **Select Procurement Approach and Prepare RFP:** The outcome from the I-10 TPAS effort will greatly influence how this strategy is expanded statewide. TxDOT should review its standard procurement methods and identify the preferred procurement strategy for statewide TPAS. If selecting the traditional design-bid-build procurement approach, TxDOT will need to develop an RFP for both the detailed design contract and the construction contract, regardless if TPAS is deployed as one comprehensive project or as several independent projects. The RFP will identify and establish the construction approach. If selecting alternative delivery methods like design-build, TxDOT will only need an RFP to secure the design and construction contracts for the scoped effort.

**Medium-Term Actions**

Medium-Term Actions for this strategy focus on strategy implementation. Similar to the Near-Term Actions, some of these actions may be part of the Statewide TPAS Implementation Plan. Medium-Term Actions should consider the following:

1. **Develop a Detailed Design:** The completed Near-Term Actions will have affirmed the design sites and requirements necessary for this strategy to succeed. With these sites, TxDOT should prepare detailed design plans to address the civil, structural, and electrical designs associated with equipment installation. In addition, the System Design for the I-10 Corridor project will be completed, and may be used as the basis for other TPAS deployments. Depending on the size and scale, this may be through one design contract or several design contracts.

2. **Acquire Access Rights:** TxDOT should obtain the necessary permits and rights of access prior to any field deployments.

3. **Deploy the Strategy:** With a set of design plans, TxDOT should deploy the strategy. This would include both field deployments and updates to backoffice systems or internal processes in place to keep a system running (implemented as part of I-10 TPAS) to make the strategy operate as a complete system. This may be done in one construction contract or several construction contracts.

**Long-Term Actions**

Long-Term Actions for this strategy focus on maintaining and expanding the strategy. Long-Term Actions should consider the following:

1. **Operate and Maintain the System:** TxDOT should operate and maintain all associated hardware and software, as well as integrate applicable future technologies as they become available. TxDOT should maintain funding to support this program and document lessons learned as part of operations and maintenance to inform future efforts.

2. **Expand the Strategy:** TxDOT should leverage existing relationships with vendors and lessons learned from stakeholders on TPAS and similar deployments to build a more
robust program statewide. TxDOT should explore expansion of TPAS into sites that were not high-priority for funding, as well as explore collaborative opportunities to instrument non-public truck parking sites (i.e., private truck stops).

3.2 High-Resolution Freight Traveler Information System

3.2.1 Strategy Overview
The High-Resolution Freight Traveler Information System is intended to expand the capabilities of TxDOT's public-facing Advanced Traveler Information System (ATIS), DriveTexas, to provide a high-quality freight traveler information service to the trucking industry on key truck routes in Texas. This strategy will enhance the granularity of traffic information on Texas roads through a combination of deploying TxDOT-owned sensor infrastructure and advanced third-party probe-based data on key limited-access and arterial truck routes. This data would be processed through advanced analytics tools—such as Artificial Intelligence (AI) or Machine Learning—to identify incidents and forecast traffic conditions. Exhibit 7 provides an illustrative example of this strategy.

TxDOT currently operates a traditional traveler information system and has been involved in exploring potential advanced analytics tools, but the full FNTOP strategy has not been implemented to date.
3.2.2 Roles and Responsibilities

Relevant stakeholders for implementing the High-Resolution Freight Traveler Information System strategy are listed in Exhibit 8. TxDOT Divisions would own, operate, and maintain the advanced traffic data processing system, including hardware, software, and data subscription services that are part of the central system. The TxDOT Districts would collaborate with TxDOT Divisions to own, operate, and maintain any additional ITS devices deployed in their jurisdictions as part of this strategy to expand freight-related data. In addition to public sector groups that traditionally share available data with the traveler information system, the private sector could also be a key data contributor to this strategy, which could be considered a method to help share the cost of implementing this strategy.
### Exhibit 8: High-Resolution Freight Traveler Information System Stakeholder Roles and Responsibilities

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Strategy Impact</th>
</tr>
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</table>
| TxDOT Divisions (Owner)         | • Will continue to own, operate, and maintain the DriveTexas website, and its mobile application (if developed).  
• Will coordinate with Traffic Safety Division on integrating the advanced traffic data processing system with the ATIS (i.e., DriveTexas).  
• Will own, operate, and maintain the advanced traffic data processing system, including hardware, software, and data subscription services.  
• Will coordinate with Travel Information and Information Technology Divisions integrating new backoffice systems with the ATIS.  
• Will support project implementation by developing standards and specifications for ITS devices and system components.  
• Will ensure that the placement of ITS devices are safe and consistent with national and Texas standards.  
• Will utilize system outputs concerning high crash risk areas to inform safety initiatives. |
| TxDOT Districts (Owner/ Key Stakeholder) | • Will collaborate with the TxDOT Divisions to establish agreements and MOUs regarding ownership, operation, and maintenance of any additional ITS devices deployed to expand freight-related data collection.  
• Will help identify critical corridors where data coverage gaps exist. |
| Transportation Data Providers (Key Stakeholder) | • Will identify and provide opportunities for data subscription services. |

### 3.2.3 Organizational and Policy Considerations

This strategy will not require organizational changes within TxDOT, but there are some policy updates that are recommended to successfully adopt and operate this strategy. Types of policy changes to implement this type of program include:
• Establish data sharing agreements with private sector freight groups (In-Vehicle Monitoring System [IVMS] or Electronic Logging Device [ELD] data);
• Implement data security and privacy protocols;
• Implement Application Programming Interface (API)-based architecture design;
• Ensure compliance with design standards, such as the Texas Manual on Uniform Traffic Control Devices (TMUTCD), throughout Texas;
• Define applicable standards for data exchange;
• Establish data distribution agreements;
• Obtain permit application criteria for device placement in non-TxDOT right of way (ROW); and
• Establish data QA standards.

3.2.4 Advancing the Strategy
Currently, TxDOT utilizes a network of ITS sensors and devices, mostly deployed in urban areas, as well as private sector probe services, to collect data on highway conditions throughout Texas. This data is processed via TxDOT ATMS and published for the general public on DriveTexas, as well as is disseminated through regional TMCs.

This strategy leverages existing systems, yet aims to expand both the coverage and granularity of traveler information available to motorists. TxDOT needs to make investments to advance and expand the current data collection, data processing, and data dissemination capabilities, as well as invest in additional state-owned sensors and/or private sector probe data services to provide increased coverage of urban, suburban, and rural truck routes. In addition, TxDOT needs to collect and provide truckers with dynamic traveler information (e.g., truck parking availability) and static information (e.g., height/weight road restrictions) in order to provide high-quality freight data. Considering the multiple types and sources of information, implementing this strategy requires TxDOT to invest in data processing tools and AI to convert raw field data into useful current and forecasted traveler information. Finally, TxDOT needs to consider establishing a trusted API to broadcast data to the data users and for distributing the information via other platforms, such as a DriveTexas mobile application.

Near-Term Actions
Near-Term Actions for this strategy focus on efforts that advance towards Detail Design. As a starting point, it would utilize the ConOps document that was completed as part of the FNTOP. These efforts should consider the following:

1. **Identify a TxDOT Division to Lead the Implementation:** TxDOT should identify a TxDOT Division to champion this strategy and undertake project planning, program development, and securing initial funding for this project.
2. **Coordinate with Regional Partners:** TxDOT should create a standard set of resources (e.g., data sharing guidelines and agreements, procurement documents, etc.) that can help ensure structure and coordination of processes and procedures among participating stakeholders. Coordination will also help identify existing Standard Operating Procedures (SOPs) and data use guidelines that may serve as a foundation for the system.

3. **Assess Capabilities of Existing Systems:** TxDOT should assess and understand the capabilities of existing ITS systems (e.g., ATMS, DriveTexas) that may impact the ability to integrate with new systems. Interfacing requirements need to be determined and the need for any upgrades identified.

4. **Determine Infrastructure Needs:** TxDOT should conduct a communication infrastructure assessment to determine the amount of network expansion needed to support the implementation of the strategy, as well as to support future ITS projects. Communication issues must be addressed early in the design process. An inventory of existing ITS infrastructure should be undertaken to identify any application gaps.

5. **Generate System Requirements:** TxDOT should generate a set of system requirements that focus on what type of data will need to be collected and integrated into TxDOT existing ATMS and ATIS, and how the data will need to be managed, aggregated, analyzed, and communicated. Requirements for API-based design, mobile application, data accuracy, timeliness, and reliability should also be identified. TxDOT should consider data processing technologies, such as systems based on AI, even if deployment of such systems is scheduled at a later date.

6. **Develop a High-Level Design:** TxDOT should undertake a High-Level Design, which describes the overall system framework, identifying subsystems and breaking them down into hardware and software components that meet the requirements. The resulting design elements will be used to guide the more Detailed Design (Medium-Term Action). This work is typically issued through an RFP and performed by an implementation expert/system integrator.

7. **Prioritize and Select Sites:** The deployment of this strategy includes field elements and services within TxDOT’s information technology (IT) infrastructure. TxDOT should prioritize the sites and select the preferred sites where the strategy should be deployed. Locations for the additional installation of field devices should be determined based on data coverage gaps on critical freight corridors and underserved routes.

8. **Develop Independent Cost Estimate:** TxDOT should generate cost estimates for system detailed design, deployment, and ongoing operations and maintenance. This estimate would confirm the necessary expectations on cost as an RFP is prepared and would allow for proper funding allocation.
9. **Establish Standards and Agreements**: TxDOT should develop the necessary standards and agreements to help guide design.

10. **Select Procurement Approach and Prepare RFP**: TxDOT should review its standard procurement methods and identify the preferred procurement for this strategy. It is recommended to look at how other ATIS efforts—in Texas or in other states—have been typically procured in the past, as that may be a good example to base this decision. If selecting the traditional design-bid-build procurement approach, TxDOT will need to develop an RFP for both the detailed design contract and the construction contract, regardless if this strategy is deployed as one comprehensive project or as several independent projects. The RFP will identify and establish the construction approach. If selecting alternative delivery methods like design-build, TxDOT will only need an RFP to secure the design and construction contracts for the scoped effort.

*Medium-Term Actions*

Medium-Term Actions for this strategy focus on strategy implementation. These actions should consider the following:

1. **Develop a Detailed Design**: The completed Near-Term Actions will have affirmed the deployment sites and system requirements necessary for this strategy to succeed. For these sites and systems, TxDOT should prepare detailed design plans to address the civil, structural, and electrical designs associated with equipment installation. Depending on the size and scale, this may be through one design contract or several design contracts.

2. **Acquire Access Rights**: TxDOT should obtain the necessary permits and rights of access prior to any field deployments.

3. **Deploy the Strategy**: With a set of design plans, TxDOT should deploy the strategy. This would include both field deployments and backoffice systems or internal processes in place to keep a system running, to ensure the strategy operates as a complete system. This may be done in one construction contract or several construction contracts, but it is advisable to build the core components of the system under the same construction contract to ensure successful integration.

*Long-Term Actions*

Long-Term Actions for this strategy focus on maintaining and expanding the strategy. Long-Term Actions should consider the following:

1. **Operate and Maintain the System**: TxDOT should operate and maintain all associated hardware and software, as well as future technologies as they become available.

2. **Expand the Strategy**: TxDOT should leverage existing relationships with vendors and lessons learned from similar deployments to build a more robust program statewide. This may include expanding the traffic data services that support the system. When
possible, use existing software, protocols, and communication interfaces to create the ability to share data throughout Texas.

3.3 Central Data Repository for Freight Applications

3.3.1 Strategy Overview
This strategy aims to implement a centralized data repository, otherwise called data lake, that can support services and applications that are relevant to TxDOT and its partners. This data lake would gather, store, and process data from a variety of internal and external data systems, allowing an output of services that support TxDOT operations and planning. It would be governed by formulated rules for data sharing and privacy that would be reported publicly for all users to understand. Among the many solutions considered, one vision for this strategy would be to gather high-quality routing data from the private sector freight operators that could be translated into a robust data set for advanced traffic management capabilities and routing information. Exhibit 9 provides an illustrative example of this strategy.

TxDOT has had internal discussions about building and operating a data lake. The focus of implementation aligns closely with this ongoing initiative. Details on this current effort are discussed later in this subsection.
3.3.2 Roles and Responsibilities

Relevant stakeholders for implementing this strategy are listed in Exhibit 10. At the TxDOT Division level, TxDOT would own the administrative responsibility of providing project planning and implementation support in coordination with the TxDOT Districts. There are numerous stakeholders, both on the public and private side, that would both provide and consume data.
Exhibit 10: Central Data Repository for Freight Applications Stakeholders Roles and Responsibilities

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Strategy Impact</th>
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| TxDOT Division Offices (Owner) | • Will own, operate, and maintain the hardware and software associated with the centralized data lake.  
• Will store and maintain data.  
• Will provide data inputs.  
• Will use the data to better inform users of TxDOT services and operations. |
| TxDOT Districts and Other Texas Government Departments (e.g., Texas Department of Motor Vehicles (TxDMV), Texas Department of Public Safety (TxDPS), etc.) (Key Stakeholder) | • Will help inform what data is available and how the data lake should be set up to encourage consistent contributions.  
• Will use the data to better inform their services and operations. |
| Transportation Data Providers (Key Stakeholder) | • Will help inform what data is available and how the data lake should be set up to encourage consistent contributions from their systems.  
• Will use the data to better inform their services. |

3.3.3 Organizational and Policy Considerations

This strategy will not likely require organizational changes, although it may necessitate the creation of new roles within TxDOT to oversee and manage the data lake. Some policies will need to be considered when implementing this type of program in order to facilitate adoption and long-term operation. Some considerations include:

- Define the audience that will be the main system users;
- Define applicable standards for data exchange;
- Establish a system architecture design;
- Define data collection methods;
- Identify data sources available from both private and public sectors;
- Outline information sharing procedures;
- Determine the types of information that can be released to the public;
- Establish MOUs for participating entities;
- Establish data sharing agreements among participating agencies;
- Create agreements regarding responsibilities for operating and maintaining these systems; and
- Identify data QA standards.

### 3.3.4 Advancing the Strategy

The FNTOP proposed the data lake as a potential strategy to improve accessibility to freight-related data. The TxDOT Information Technology Division (ITD) is separately exploring a data lake as part of their long-term plan, with the focus on more data exchange than simply freight applications. Since ITD is a logical TxDOT Division to lead development of data infrastructure and currently has a wider-reaching goal for this data lake, it is more advantageous if the FNTOP data lake strategy be adopted as part of the ITD initiative. As a result, next steps for this strategy should focus in large part on advocating for and supporting the inclusion of freight-specific components in the larger ITD data lake initiative.

**Near-Term Actions**

Near-Term Actions for this strategy focus on efforts that advance towards Detail Design. These efforts would most likely be done as part of ITD’s Data Lake initiative, but could be done separately if that is determined to be a preferred approach. Regardless of the project that leads this effort, it should consider the following:

1. **Support the Data Lake Initiative:** TxDOT should support ITD’s planning and investment in a data lake. Freight-focused stakeholders should be a part of the planning process in order to ensure that freight needs are represented in this strategy.

2. **Develop ConOps and System Requirements Documentation:** TxDOT should follow the systems engineering process by preparing ConOps and System Requirements documents. This will ensure that stakeholder user needs are traceable to the proposed system, which will include the needs of freight-focused stakeholders.

3. **Develop High-Level Design:** TxDOT should undertake a design effort to understand the components and specifications of the data lake, as well as its interface needs in the larger TxDOT IT environment. Freight-focused stakeholders will have a minimal role in this technical step, but it will be an opportunity to affirm that the design still aligns with the system requirements.

4. **Develop Independent Cost Estimate:** TxDOT should prepare an independent implementation cost estimate for the data lake. This would confirm the necessary expectations on cost as an RFP is prepared and would allow for proper funding allocations.
5. **Establish Standards and Agreements**: TxDOT should develop the necessary standards and agreements to help guide design.

6. **Select Procurement Approach and Prepare RFP**: TxDOT should review its standard procurement methods and identify the preferred procurement for this strategy. It is advised to review how procurement is generally carried out for other ITD IT initiatives, such as procurement of a server system, network security software, and other similar projects that have a development component. If selecting the traditional design-bid-build procurement approach, TxDOT will need to develop an RFP for both the detailed design contract and the construction contract. The RFP will identify and establish the construction approach. If selecting alternative delivery methods like design-build, TxDOT will only need an RFP to secure the design and construction contracts for the scoped effort.

**Medium-Term Actions**

Medium-Term Actions for this strategy focus on strategy implementation. Similar to the Near-Term Actions, some of these actions may be part of ITD's initiative. Medium-Term Actions should consider the following:

1. **Develop a Detailed Design**: The completed Near-Term Actions will have affirmed the requirements necessary for this strategy to succeed. TxDOT should prepare detailed design plans to address the network communication designs associated with hardware installation. Unlike other strategies that focus detailed design more closely on civil components, this design would focus more closely on the IT network infrastructure affiliated with this strategy. It would likely be designed as part of one design contract.

2. **Deploy the Strategy**: TxDOT should build the data lake based on the design requirements that have been agreed to. This would likely be done through one construction contract, with milestones based on meeting system requirements. TxDOT should document lessons learned to inform future expansions.

**Long-Term Actions**

Long-Term Actions for this strategy focus on maintaining and expanding the strategy. Long-Term Actions should consider the following:

1. **Operate and Maintain the System**: TxDOT should operate and maintain all associated hardware and software. TxDOT should maintain funding to support this program and document lessons learned as part of operations and maintenance to inform future efforts.

2. **Expand the Strategy**: TxDOT should leverage existing working relationships and lessons learned to build out the data lake and support future endeavors. This may include adding new data services to the data lake as they become available, either on the public or private sector side.
3.4 AV Infrastructure, Connected Signing, and Data

3.4.1 Strategy Overview

The AV Infrastructure, Connected Signing, and Data strategy offers information on the roadway environment to improve the efficiency and safety of automated freight vehicles. At a high level, this strategy would help clarify the complex roadway environment for AV trucks, while providing the opportunity for AV trucks to report asset condition information to TxDOT. This strategy aims to enhance the quality of data available to AV trucks to help them operate in complex roadway environments, such as construction zones, areas with roadside signs that are occluded or defaced, or atypical messaging. It would utilize a publicly-available digitized map of the roadway environment, as well as roadside signing with connected vehicle transceivers, to offer a representation of the environment that is easy for an onboard AV computer to better recognize, so that it can reconcile any unclear environments that are detected by its onboard sensing equipment (e.g., Light Detection and Ranging [LiDAR], radar, etc.). The goal of this strategy would be to help improve freight mobility and safety by providing greater clarity on the local roadway environment. Exhibit 11 provides an illustrative example of the strategy.

TxDOT has been part of the conversation with the AV industry regarding AV operations in Texas. However, hardware specific for advancing AV applications, such as roadside units (RSUs), used to broadcast digitized messages to AVs have not been implemented to date. These dynamic connected signs would retrieve the message from the existing ATMS dynamic message sign (DMS) subsystem that TMC operators currently use to input messages to be posted and request the digitized message equivalent from the new advanced data processing system through the new ATMS connected vehicle (CV) module. The ATMS CV module would then broadcast the digitized message from the appropriate RSUs, without requiring involvement from the TMC operator.
3.4.2 Roles and Responsibilities

Relevant stakeholders for implementing the AV Infrastructure, Connected Signing, and Data strategy are listed in Exhibit 12. Stakeholders are denoted by roles of owner and key stakeholder. TxDOT would work with AV stakeholders to establish best practices and standards for pursuing this strategy. Private sector AV companies would be key stakeholders to help inform and test this strategy as it is developed.
## Exhibit 12: AV Infrastructure, Connected Signing, and Data Strategy
### Stakeholder Roles and Responsibilities

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Strategy Impact</th>
</tr>
</thead>
</table>
| **TxDOT Divisions**<br>(Owner, Key Stakeholder) | • Will own, operate, and maintain the non-proprietary digital map database and the advanced data processing system, or will support TxDOT network capabilities for sending data to a third-party service.  
• Will update the non-proprietary digital map database as geometries and work zones change.  
• Will coordinate with TxDOT ROW Division and Aviation Division to use LiDAR survey data collected to contribute to the non-proprietary digital map database.  
• Will support project implementation by developing standards and specifications for foundational capabilities required to support Connected and Automated Vehicle (CAV) deployments.  
• Will conduct outreach activities and collaborate with AV industry stakeholders. |
| **TxDOT Districts**<br>(Owner, Key Stakeholder) | • Will collaborate with the divisions to establish agreements and MOUs regarding ownership, operation, and maintenance of any technological deployments as part of their ITS program, such as connected signing/RSUs.  
• Will help identify potential areas that could serve as corridors for piloting this strategy. |
| **AV Industry**<br>(Key Stakeholder, End-user) | • Will help inform possible needs, gaps, and solutions in this strategy that could help improve the safety, efficiency, mobility, and longevity of their AV operations.  
• Will compare their proprietary digital map database with the non-proprietary digital map database and update their map as necessary. |

### 3.4.3 Organizational and Policy Considerations
The implementation of the AV Infrastructure, Connected Signing, and Data strategy will not likely require organizational changes, although it may necessitate the creation of new roles within TxDOT to oversee and manage the AV program. These roles may be responsible for
defining relationships, roles, and responsibilities; creating scope and operations of deployments; training staff to augment their understanding and knowledge on the topic of AV technology; and managing the technology. It is likely that this role would align with TxDOT’s current ITS program.

It requires a number of polices and agreements to be in place, including:

- Create and regularly update an AV policy statement and plan;
- Standardize work zone markings, statewide pavement markings, and provide consistent signing for AV operations;
- Standardize non-proprietary mapping data including processes and procedures for updating map data: who is authorized to make an update, update confirmation, and update validation;
- Establish a centralized repository to share public and private sector mapping data of the roadway environment for the entire state;
- Align TxDOT infrastructure projects that require design and engineering with topographic LiDAR surveys used for applications such as highway, architectural, and site development;
- Establish sign messaging that complies with TMUTCD throughout Texas;
- Establish a detailed statewide inventory of TMUTCD signs;
- Follow the United States Department of Transportation’s (USDOT) lead on interoperable standards for Vehicle-to-Infrastructure (V2I) and Vehicle-to-Vehicle (V2V) communications to transmit data between onboard units (OBUs) and with RSUs to support a range of CV safety and mobility applications;
- Standardize communication protocols for roadside devices, such as Dedicated Short Range Communications (DSRC) or Cellular Vehicle-to-Everything (C-V2X);
- Establish data sharing agreements with private sector groups for planned/unplanned road closures and work zones, roadway environment data (location of potholes, damaged signs, other assets), and digital map base;
- Create MOUs to delineate roles and responsibilities between TxDOT and the AV industry in terms of data sharing, private sector reporting (i.e., in context of the AVs observing infrastructure issues, such as a pothole, and reporting to TxDOT), and the removal of reporting liability from AV operators;
- Establish agreements regarding responsibilities for operating and maintaining these systems, in addition to new functionality introduced in regional TMC ATMSs to manage connected infrastructure; and
- Identify data QA requirements.
3.4.4 Advancing the Strategy
This strategy aims to be forward thinking in leveraging PPPs to bring innovation to the transportation industry. The strategy would address the need of the AV trucking industry to have better information on the roadway environment. Several Original Equipment Manufacturers (OEMs) and startups have completed test pilots or are currently road testing AV trucks under restricted conditions and with the assistance of human safety drivers. When asked how the public sector could benefit the industry as it advances towards fully automated vehicles, representatives suggested anything TxDOT could do to help facilitate the electronic sharing of infrastructure conditions and parameters, specifically related to atypical or variable conditions, would help AV trucks safely navigate the roadway environment.

The AV trucking industry is already building proprietary digitized maps of the roadway environment to assist with vehicle navigation. The detailed digitized maps are constructed primarily from LiDAR sensors that capture 360-degree views of the environment enveloping the vehicle. These maps are vendor-specific and not shared in an open source format or with public sector agencies. Mapping data that is currently held in proprietary formats specific to the vendor would need to be standardized, and a data exchange location would be necessary to facilitate data sharing of standardized data between parties. While there are numerous examples of Geographic Information System (GIS) applications that allow users to submit updates and obtain refreshed information from the field, these data collection efforts are focused on conducting a periodic inventory of specific assets, such as manholes, overhead utilities, signs, etc. The development of new mapping and data processing systems to handle large, detailed, and frequently updated LiDAR datasets may be needed and would rely on early adopters for initial deployments where the technology can evolve and improve over time.

The other primary component of the strategy is the CV-enabled signs that would complement the AV digital map and broadcast inputs for the onboard algorithms to interpret roadside messages. Implementing this component of the strategy would require CV infrastructure to scale to cover the vast number of signs throughout Texas. Deployment of CV-enabled signs will benefit from the adoption of vehicle-to-everything (V2X) standards, which will ensure that communication of broadcast messages will work seamlessly with different OBU types.

The effectiveness of a particular technology solution should be analyzed and tested via a pilot project before the strategy would be ready for widespread deployment. TxDOT should consider opening the pilot project for collaboration with other DOTs and university research centers to pool knowledge and resources. This provides a framework to test, validate, and improve the technologies or applications before pursuing widespread implementation of the strategy.
Near-Term Actions
Near-Term Actions for this strategy focus on efforts that advance towards Detail Design. As a starting point, it would utilize the ConOps document that was completed as part of the FNTOP. This effort should consider the following:

1. **Identify a Project Champion to Lead the AV implementation**: TxDOT should identify a Division to advocate for and lead the planning of AV pilot projects. The TxDOT Division would lead project planning, program development, and would secure initial funding for pilot projects. Longer term, TxDOT will need to clearly define a Division or unit responsible for the deployment and management of the AV program. This may require organizational change within TxDOT.

2. **Identify the Strategy’s Vision**: TxDOT should determine what the vision is for this AV strategy, relative to its readiness to support implementation. By working with its partners and the private sector, this exercise will clarify the gaps and challenges associated with this pursuit, and establish expectations for what the system will do.

3. **Support AV Standards**: TxDOT should help promote the development of standards that support the advancement of the AV industry. This will likely require collaboration with standards organizations (e.g., International Organization for Standardization [ISO]), transportation groups (e.g., Transportation Research Board [TRB]), and AV partners.

4. **Determine Scope of Pilot**: TxDOT should determine the scope of the pilot that is to be undertaken, including the site where the pilot will take place. By establishing core goals, subsequent design efforts can focus on developing only the solutions that are relevant to the pilot. This scope will involve extensive stakeholder participation leading to a better design, as well as more buy-in from all participating entities. Requests for Information (RFIs) should be issued to the private sector to gain a better understanding of what technology is available.

5. **Establish Digital Mapping Standards**: TxDOT should collaborate in the standardization of non-proprietary digital mapping data including processes and procedures for updating map data. Standards will be set forth by an approved standards commission, such as ISO, with the help of DOTs and AV stakeholders.

6. **Assess Capabilities of Existing Systems**: TxDOT should assess and understand the capabilities of their existing ITS systems (e.g., data storage and management) that may impact the strategy’s deployment.

7. **Generate System Requirements**: Once the pilot scope has been finalized, TxDOT should develop a system requirements document. System requirements define how the system aligns with documented stakeholder needs and ensures the system is consistent with regional and state ITS system architectures, which will be extremely important for a strategy that is less mature (in terms of development and implementation experience) than other strategies. The system requirements...
document categorizes the functions, characteristics, and constraints of the strategy, while reflecting the preferences of applicable stakeholders, so that the strategy is carefully outlined before investment in implementation occurs.

8. **Plan the Pilot**: TxDOT should develop a more detailed pilot program based on identified user needs, a defined set of criteria that meets the regional context conditions, and AV program goals for an identified geography. TxDOT should develop a High-Level Design to support this pilot, which includes field and backoffice infrastructure.

9. **Determine Infrastructure Needs**: TxDOT should determine the infrastructure requirements for this strategy, such as establishing reliable communications to support the CV-enabled signs, RSUs, and OBUs for freight vehicles among others. Issues that may impact communications must be addressed early in the system design and throughout the deployment process.

10. **Develop Independent Cost Estimate**: TxDOT should prepare an independent implementation cost estimate for the pilot project. This would confirm the necessary expectations on cost as an RFP is prepared and would allow for proper funding allocations.

11. **Establish Standards and Agreements**: TxDOT should develop the necessary standards and agreements to help guide design.

12. **Select Procurement Approach and Prepare RFP**: TxDOT should review its standard procurement methods and identify the preferred procurement for this strategy. It is advised to review how projects with extensive software development are normally procured at TxDOT, but to also keep in mind that many of the roadside assets could be procured no differently than other ITS projects. If selecting the traditional design-bid-build procurement approach, TxDOT will need to develop an RFP for both the detailed design contract and the construction contract. The RFP will identify and establish the construction approach. If selecting alternative delivery methods like design-build, TxDOT will only need an RFP to secure the design and construction contracts for the scoped effort.

**Medium-Term Actions**

Medium-Term Actions for this strategy focus on implementation of this pilot. Medium-Term Actions should consider the following:

1. **Develop a Detailed Design**: The completed Near-Term Actions will have affirmed the deployment sites and requirements necessary for this piloted strategy to succeed. With these deployment sites, TxDOT should prepare detailed design plans to address the civil, structural, electrical, and system designs associated with equipment installation. Depending on the size and scale, this may be through one design contract or several design contracts.
2. **Integrate Existing Systems**: TxDOT should consider a phased integration approach with existing ITS systems to help incorporate new systems into the established architecture.

3. **Deploy and Test Pilot**: TxDOT should implement the pilot program and operate it for a predefined demonstration period, document what barriers remain and how to address them, and compile lessons learned to assist future AV technology deployments in the region.

**Long-Term Actions**

Long-Term Actions for this strategy focus on conducting the demonstration period, as well as maintaining and expanding the strategy based on outcomes of the pilot. Long-Term Actions should consider the following:

1. **Operate and Maintain the System**: TxDOT should operate and maintain this pilot and all associated hardware and software components deployed for this strategy. During the pilot project, TxDOT should observe and evaluate the effectiveness of the map processing system in accepting digital map updates from AV vehicles, as well as the dissemination of this information to aid vehicle navigation. On the CV infrastructure side, TxDOT should validate the ongoing effectiveness of the roadside signs in broadcasting messages to CV-equipped trucks and ensuring that the messages are received and acknowledged by the onboard system. The evaluation would provide TxDOT the basis to improve coordination with the private sector on data exchange processes to ensure the quality and depth of the digital map of the roadway environment meets system requirements.

2. **Expand the Strategy**: If the outcomes of the demonstration show that the system is operating and performing in accordance with the system requirements, TxDOT could elect to expand the strategy into an actual program that covers more freight routes. The system resources for the digital mapping component can be scaled as well to provide additional storage as the breadth and depth of the map increases over time as AVs in the field contribute inventory updates on the roadway environment.

3.5 **Safety Warning Detection System**

3.5.1 **Strategy Overview**

The Safety Warning Detection System is a notification system that alerts truckers and other road users of situations when a vehicle is operating beyond a safety threshold, such as being too tall, too heavy, or too fast. The goals of this system are to improve freight safety by providing greater awareness of potential safety issues, as well as improve asset preservation by reducing damage to infrastructure caused by unsafe operational behavior.

The system aims to implement spot technology-based safety improvements at strategic locations along freight routes using overheight vehicle detection systems, overweight
detection systems, overspeed detection systems, and/or intersection conflict warning systems. Data collected from these applications would be used in real-time and historic contexts, such as for safety evaluations, historic truck weight measuring, or enforcement screening. Additionally, this strategy would instrument infrastructure with collision detection systems to help report bridge strikes to the local district to allow for prompt response and evaluation. Exhibit 13 provides an illustrative example of the strategy.

TxDOT has spot treatments of these types of systems at various locations statewide, but the full FNTOP strategy—which focuses on widespread deployment as a critical countermeasure—has not been implemented to date.

**Exhibit 13: Illustrative Example of the Safety Warning Detection System**

3.5.2 Roles and Responsibilities

Relevant stakeholders for implementing the Safety Warning Detection System are listed in Exhibit 14. At the TxDOT Division level, TxDOT would act as owner with the administrative responsibility of providing project planning and implementation support in coordination with the TxDOT Districts. The TxDOT Districts would collaborate with the TxDOT Divisions to own, operate and maintain the systems installed on state-owned routes. The
TxDOT Districts and their affiliated TMCs would be key stakeholders in identifying where needs exist based on crash histories, infrastructure damage, and other considerations.

**Exhibit 14: Safety Warning Detection System Stakeholder Roles and Responsibilities**

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Strategy Impact</th>
</tr>
</thead>
</table>
| TxDOT Divisions (Owner, Key Stakeholder) | • Will work together and collaborate to determine which division will lead and support this strategy.  
• Will own and operate Weigh-in-Motion (WIM) stations where the overweight detection systems are deployed.  
• Will help guide and recommend strategic placement of WIM systems, based on strategic planning criteria.  
• Will utilize WIM data from existing and new station sites to provide inputs to TxDOT Districts for traffic forecasting, pavement design criteria, and for air and noise studies.  
• Will publish archived WIM data through the Statewide Traffic Analysis and Reporting System (STARS II) website.  
• Will help guide and recommend strategic placement of these systems, based on strategic planning criteria.  
• Will support project implementation by developing standards and specifications for ITS devices and system components.  
• Will support ATMS development efforts to integrate the new Safety Warning Detection subsystem by establishing statewide requirements.  
• Will utilize data from the detection systems to inform crash data analysis and roadway safety initiatives across the State. |
| TxDOT Districts (Owner / Key Stakeholder) | • Will collaborate with the TxDOT Divisions to establish agreements and MOUs regarding ownership, operation, and maintenance of any technological deployments as part of their ITS program.  
• Will respond to reported bridge strikes or other incidents that involve their infrastructure. |
3.5.3 Organizational and Policy Considerations
The implementation of the Safety Warning Detection System is not expected to require organizational changes within TxDOT, but some policy updates may be necessary in order to facilitate adoption and operation. TxDOT Districts would collaborate with the division to deploy, operate and maintain the systems in their respective regions.

Types of policies needed for this strategy include:

- Create SOPs to manage the system;
- Obtain permit application criteria to install detection systems and signs;
- Establish data sharing agreements with partner agencies and other third parties;
- Identify data QA requirements; and
- Adhere to applicable design standards and guides.

3.5.4 Advancing the Strategy
The Safety Warning Detection System strategy has an advanced level of readiness with a variety of ITS field elements already deployed across Texas to manage traffic and collect data for project planning and development. Primary elements of the strategy, such as the overheight vehicle detection systems and the WIM/Vehicle Classification (VC) stations for capturing data on overweight vehicles, are deployed in certain districts and along key corridors where freight activity and truck traffic are most significant. Supporting elements, such as the traffic sensors and DMS for the overspeed and intersection conflict safety applications, are deployed widely across the state and used by TxDOT District TMC operators to monitor traffic conditions and disseminate traveler information.

With parts of the infrastructure already in place, TxDOT can readily scale deployments to expand operational coverage to priority areas of the network that have a high frequency or density of truck crashes and where significant amounts of oversize/overweight (OS/OW) loads are transported, such as in the Permian Basin.

Near-Term Actions
Near-Term Actions for this strategy focus on efforts that advance towards Detail Design. As a starting point, it would utilize the ConOps document that was completed as part of the FNTOP. This effort should consider the following:

1. Generate System Requirements: TxDOT should create a set of system requirements that describes the functions and systems, as well as data quality specifications needed to implement this strategy in accordance with the user needs, either as a standalone system or integrated with the ATMS. TxDOT Districts should work together to streamline the process and avoid duplication of efforts.
2. **Develop a High-Level Design**: TxDOT should develop high-level system design documentation that describes how the system is developed and implemented at the architectural level for the various subsystems that corresponds to the four safety detection applications.

3. **Determine Infrastructure Needs**: TxDOT should assess the equipment types and communication infrastructure for existing sites that could potentially be upgraded (e.g., a permanent traffic data collection station is upgraded to WIM/VC capabilities). For sites that do not have any infrastructure, site-specific criteria should be considered, including wired and wireless options for field-to-center communications, grade, pavement type, line-of-sight, and options to bring power to the site components (e.g., wired utilities or solar).

4. **Prioritize and Select Sites**: TxDOT should identify potential sites along Texas truck routes, prioritizing locations with feasible alternate truck routes, high numbers of bridge strikes, safety issues, and other infrastructure damage.

5. **Develop Independent Cost Estimate**: TxDOT should generate cost estimates for system detailed design, deployment, and ongoing operations and maintenance. This estimate would confirm the necessary expectations on cost as an RFP is prepared and would allow for proper funding allocations.

6. **Establish Standards and Agreements**: TxDOT should develop the necessary standards and agreements to help guide design.

7. **Select Procurement Approach and Prepare RFP**: TxDOT should review its standard procurement methods and identify the preferred procurement for this strategy. The procurement approach for other ITS spot treatments would likely apply to this strategy, which often are done through the design-bid-build procurement approach. If selecting that approach, TxDOT will need to develop an RFP for both the detailed design contract and the construction contract. The RFP will identify and establish the construction approach. If selecting alternative delivery methods like design-build, TxDOT will only need an RFP to secure the design and construction contracts for the scoped effort.

**Medium-Term Actions**

Medium-Term Actions for this strategy focus on strategy implementation. Medium-Term Actions should consider the following:

1. **Develop a Detailed Design**: The completed Near-Term efforts will have affirmed the deployment sites and requirements necessary for this strategy to succeed. With these sites, TxDOT should prepare detailed design plans to address the civil, structural, and electrical designs associated with equipment installation. Depending on the size and scale, this may be through one design contract or several design contracts.
2. **Deploy the Strategy**: TxDOT should deploy this strategy in accordance with the site prioritization identified in the Near-Term Actions. This will likely be through a time-phased deployment that rolls out the high-priority sites statewide, most likely through multiple construction contracts. Each site deployment would need to be properly integrated into the TxDOT ITS program, depending on the applications, based on the system requirements and high-level design.

3. **Create SOPs**: Develop SOPs that outline the processes and procedures to manage the system uniformly across all regions.

**Long-Term Actions**

Long-Term Actions for this strategy focus on maintaining and expanding the strategy. Long-Term Actions should consider the following:

1. **Operate and Maintain the System**: TxDOT should operate and maintain the strategy, including all associated hardware and software components.

2. **Expand the Strategy**: TxDOT should leverage existing relationships with vendors and lessons learned from similar deployments to build a more robust program statewide. This may include expanding the number of deployed sites, based on successes from the initial high-priority deployments.

3.6 **Smart Freight Connector**

3.6.1 **Strategy Overview**

The Smart Freight Connector strategy aims to implement traffic management technologies on last-mile corridors that will efficiently manage operations along key freight routes that lead to large industrial or commercial areas and intermodal facilities. At a high level, this strategy will collect travel and freight-related data to determine the performance of a corridor and when needed, the existing arterial traffic signal system will be adjusted to better accommodate freight traffic. Where truck staging areas are available, this strategy will instrument these facilities with parking detection equipment in order to provide truckers with real-time parking availability options prior to their arrival. For certain routes, specific travel lanes could be operationally repurposed to provide dedicated truck travel lanes, such as for automated vehicles that drive exclusively between an intermodal terminal and staging lots. Exhibit 15 provides an illustrative example of this strategy.

TxDOT has been involved in conversations regarding improving traffic operations on last-mile intermodal connections, but the technology discussed in this FNTOP strategy has not been implemented with this specific application in mind to date.
3.6.2 Roles and Responsibilities

Relevant stakeholders for implementing the Smart Freight Connector strategy are listed in Exhibit 16. TxDOT Divisions and Districts would own, operate, and maintain parts of the system installed on state-owned routes. Depending on whether parts of the routes are locally owned, local communities may have an ownership role as well. If the intermodal terminal facilities opt to participate as part of a larger Freight Advanced Traveler Information Systems (FRATIS) application, they too would have direct involvement in the success of this strategy.

**Exhibit 16: Smart Freight Connector Stakeholder Roles and Responsibilities**

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Strategy Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>TxDOT Divisions (Owner)</td>
<td>• Will identify the TxDOT Division to manage and fund the strategy.</td>
</tr>
<tr>
<td></td>
<td>• Will collaborate with other TxDOT Divisions and Districts who might lead or support components of this effort.</td>
</tr>
<tr>
<td>Stakeholder</td>
<td>Strategy Impact</td>
</tr>
<tr>
<td>-------------</td>
<td>-----------------</td>
</tr>
</tbody>
</table>
| TxDOT Districts (Key Stakeholder) | - Will develop the strategy and identify funding needs for capital and operations and maintenance.  
- Will identify corridors for deployment.  
- Will identify how data collected under this strategy can support ongoing data collection efforts.  
- Will collaborate with the TxDOT Divisions to establish agreements and MOUs regarding ownership, operations, and maintenance of any technological deployments as part of their ITS program.  
- Will assist in determining corridors for technology deployments.  
- Will engage in interagency MOUs for equipment installed off of the TxDOT ROW. |
| Local Communities (Owner/ Key Stakeholder) | - Will assist in determining corridors for technology deployments.  
- Will support off-state system corridors receiving TxDOT equipment.  
- Will identify impacts of this strategy on local stakeholders. |
| Intermodal Terminal Operators (Key Stakeholder) | - Will assist in determining the specifics of this strategy.  
- May offer drayage-optimization scheduling systems as part of their operation to support FRATIS initiatives. |

### 3.6.3 Organizational and Policy Considerations

This strategy will not require organizational changes within TxDOT, but it will require extensive communication and coordination with partner agencies to ensure efficient operation of the system. Some policy updates are recommended in order to help facilitate adoption and operation of the strategy. TxDOT should consider the following types of policy updates:

- Establish SOPs to control ITS assets;  
- Establish MOUs for multi-jurisdictional operations;  
- Provide dedicated staff to support strategy’s functions;  
- Develop data sharing agreements for both public and private sector partners;
• Develop data distribution agreements;
• Address data security and privacy;
• Ensure data QA;
• Identify types of information that can be released to the public; and
• Coordinate with other external agencies.

3.6.4 Advancing the Strategy
The strategy utilizes current systems and functionalities that have already been deployed in Texas including TMCs and their ATMS, existing ITS field devices, and traffic management systems. The strategy builds upon these existing systems and requires TxDOT to invest in additional ITS infrastructure (e.g., traffic detectors, weather detectors, CV-related technologies) where gaps exists in order to collect and disseminate traffic and freight-related data. TxDOT also needs to advance the data processing capabilities of its ATMS or acquire standalone systems to be able to implement traffic management strategies, such as managed lanes and advanced traffic signal systems.

This strategy also requires interagency coordination to facilitate discussions and collaboration on ownership, operations, and maintenance of existing assets and new ITS elements, as well as integration with existing systems. It is critical that all stakeholders adopt standards and protocols through which information will be shared and disseminated.

Near-Term Actions
Near-Term Actions for this strategy focus on efforts that advance towards Detail Design. As a starting point, it would utilize the ConOps document that was completed as part of the FNTOP. This effort should consider the following:

1. Identify a Division to Lead the Implementation: TxDOT should identify a TxDOT Division to champion this strategy, to specifically help with project planning, program development, and to secure initial funding for this project.

2. Coordinate with Regional Partners: TxDOT should create a standard set of resources (e.g., data sharing guidelines and agreements, procurement documents, etc.) that can help ensure the structure and coordination of processes and procedures among participating stakeholders. TxDOT should coordinate the implementation of this strategy with complementary strategies (e.g., TPAS) to help minimize costs.

3. Generate System Requirements: TxDOT should generate a set of system requirements that map and translate the user needs developed in the ConOps to system functionality and requirements. The requirements should focus on what type of data need to be collected, what interface and integration requirements are needed to connect existing and new systems, how the data need to be managed, aggregated,
analyzed, and communicated and best suitable corridor sites. Requirements for data accuracy, timeliness, and reliability should also be identified.

4. **Develop a High-Level Design:** TxDOT should undertake a High-Level Design that describes the overall system framework, identifying and separating the subsystems into hardware and software components that meet the requirements. The resulting design elements will be used to guide the Detailed Design phase.

5. **Determine Infrastructure Needs:** TxDOT should conduct a communication and ITS infrastructure assessment to identify sites having in place or needing appropriate infrastructure (e.g., traffic detectors, parking sensors) to support this strategy. Communication needs must be addressed early in the design process.

6. **Prioritize and Select Corridors:** TxDOT should prioritize last-mile freight corridors where benefits can be realized. As part of the corridor selection, participating stakeholders (e.g., TxDOT, local road authorities, participating intermodal terminal operators) need to identify potential corridors and perform an assessment on those facilities. It is important to identify user needs and attributes for candidate sites, such as traffic volumes, traffic flow patterns, freight bottlenecks, capacity along surrounding arterials, adjacent truck parking facilities, and the feasibility of implementing traffic management strategies along those routes.

7. **Develop Independent Cost Estimate:** TxDOT should generate cost estimates for system detailed design, deployment, and ongoing operations and maintenance. This estimate would confirm the necessary expectations on cost as an RFP is prepared and would allow for proper funding allocations.

8. **Establish Standards and Agreements:** TxDOT should develop the necessary standards and agreements to help guide design.

9. **Select Procurement Approach and Prepare RFP:** TxDOT should review its standard procurement methods and identify the preferred procurement for this strategy. It is recommended to review other projects that deploy advanced traffic signal systems and other ITS spot improvements to determine which approach is best. If selecting the traditional design-bid-build approach, TxDOT will need to develop an RFP for both the detailed design contract and the construction contract. The RFP will identify and establish the construction approach. If selecting alternative delivery methods like design-build, TxDOT will only need an RFP to secure the design and construction contracts for the scoped effort.

*Medium-Term Actions*

Medium-Term Actions for this strategy focus on strategy implementation. Medium-Term Actions should consider the following:

1. **Develop a Detailed Design:** The completed Near-Term Actions will have affirmed the deployment sites/last-mile corridors and requirements necessary for this strategy to
succeed. With these sites, TxDOT should prepare detailed design plans to address the civil, structural, and electrical designs associated with equipment installation. Depending on the size and scale, this may be through one design contract or several design contracts.

2. **Deploy the Strategy:** TxDOT should deploy this strategy in accordance with the site prioritization conducted in the Near-Term Actions. This will likely be through a time-phased deployment that first rolls out high-priority sites statewide, most likely through multiple construction contracts. Deployments would require collaboration with local agencies and stakeholders to determine that the deployment and its operation aligns with the envisioned goals and objectives.

### Long-Term Actions

Long-Term Actions for this strategy focus on maintaining and expanding the strategy. Long-Term Actions should consider the following:

1. **Operate and Maintain the System:** TxDOT should operate and maintain the system, including all associated hardware and software components. TxDOT should hold recurring operational meetings with local stakeholders and intermodal facility operators to discuss performance and identify opportunities for greater efficiencies.

2. **Expand the Strategy:** TxDOT should leverage existing relationships with vendors and lessons learned from similar deployments to build a more robust statewide program. This will include expanding the number of corridors that deploy this strategy, based on successes from the initial high-priority deployments.

### 3.7 Blocked Rail Crossing Traffic Management System

#### 3.7.1 Strategy Overview

The Blocked Rail Crossing Traffic Management System is a notification system that alerts truckers and other road users when a highway-rail at-grade crossing has been blocked for an extended period of time. The system would focus on reporting delays at highway-rail at-grade crossings in advance of key decision points, providing truck drivers with the opportunity to detour onto an alternative freight route to avoid the blocked crossing. The system would monitor rail traffic and rail crossing use by installing ITS equipment at select sites. The new system infrastructure would detect events (e.g., delays, train approaching, congestion), inform TMC operators of the potential existence of disruptions, and generate and disseminate real-time notifications to road users to help them make informed route decisions. Information about delays and recommended routes would further be broadcast to roadway users via DMSs and other advanced traveler information systems. Additionally, historical information regarding recurrence of blockages at certain times of day would be provided to aid in pre-trip planning. Exhibit 17 provides an illustrative example of this strategy.
TxDOT has been involved in the conversation regarding the challenges associated with blocked highway-rail at-grade crossings on freight routes, including participating in studies to explore this strategy, but the application discussed in this FNTOP strategy has not been implemented to date by TxDOT. That said, some local Texas communities, including the City of Sugar Land, have implemented a version of this strategy that serve as a good example.

*Exhibit 17: Illustrative Example of the Blocked Rail Crossing Traffic*

![Exhibit 17: Illustrative Example of the Blocked Rail Crossing Traffic](image)

**Management System**

### 3.7.2 Roles and Responsibilities

Relevant stakeholders for implementing the Blocked Rail Crossing Traffic Management System are listed in Exhibit 18. TxDOT Divisions would help foster the strategy statewide, and would collaborate with TxDOT Districts to own, operate, and maintain the deployed systems, including hardware and software.
### 3.7.3 Organizational and Policy Considerations

The implementation of the Blocked Rail Crossing Traffic Management System will not require organizational changes within TxDOT. TxDOT Districts with the collaboration of TxDOT Divisions will be in charge of their own deployments, engaging their own personnel such as TMC operators, system administrators, system developers, and/or maintenance staff to operate and maintain each site. Some policies may need to be updated in order to help facilitate adoption and operation of the system. Some of the necessary policies include:

- Create SOPs to manage the system;
- Obtain permit application criteria to install detection systems and signs;
• Establish data sharing agreements with railroad companies to obtain train schedule information, if they are participating in the strategy;

• Establish MOUs to delineate roles and responsibilities between TxDOT and local public and private partners; and

• Identify data QA requirements.

If railroads agree to participate in the deployment of this strategy, additional MOUs and data sharing agreements would be required.

3.7.4 Advancing the Strategy
The Blocked Rail Crossing Traffic Management System strategy has not been deployed by TxDOT. However, there are several initiatives underway by TxDOT and its partners that are similar to this strategy. As mentioned earlier, the City of Sugar Land has an active system in place, and TxDOT is part of a study regarding real-time train monitoring at the Port of Beaumont. While TxDOT will need to plan how this strategy is to be implemented, there is a body of work that will support this strategy.

Near-Term Actions
Near-Term Actions for this strategy focus on efforts that advance towards Detail Design. As a starting point, it would utilize the ConOps document that was completed as part of the FNTOP. These efforts should consider the following:

1. **Generate System Requirements:** TxDOT should generate a set of system requirements that map to FNTOP User Needs and describe the functions and systems needed to implement this strategy. The requirements should focus on detection system functionality including provisions for the implementation of CV applications, and the capabilities of the ATMS platform to integrate these systems in a unified user interface. TxDOT Districts should work together to streamline the process and avoid duplication of efforts.

2. **Develop a High-Level Design:** TxDOT should undertake a High-Level Design, the first step in the system design phase. This document will describe the overall system framework identifying subsystems and components that meet the requirements. The resulting design elements will be used to guide the Detailed Design.

3. **Determine Infrastructure Needs:** TxDOT should conduct a communication and ITS infrastructure assessment to ensure that appropriate infrastructure is in place to support this strategy. Communication issues must be addressed early in the design process.

4. **Prioritize and Select Sites:** The effort should identify potential highway-rail at-grade-crossing sites along designated Texas truck routes, prioritizing crossing locations with feasible alternate truck routes, and determining if supplemental data collection
points along the rail line are beneficial for predicting the arrival of the train. The effort should also focus on crossings with the highest reported number of collisions.

5. **Develop Independent Cost Estimate**: TxDOT should generate cost estimates for deployment and ongoing operations and maintenance. The objective is to determine if TxDOT can move forward with the project based on the estimated costs and available funding, and issue an RFP to implement this strategy.

6. **Establish Standards and Agreements**: TxDOT should develop the necessary standards and agreements to help guide design.

7. **Select Procurement Approach and Prepare RFP**: TxDOT should review its standard procurement methods and identify the preferred procurement for this strategy. Other projects that deploy ITS spot improvements should be reviewed to determine which approach is best. If selecting the traditional design-bid-build approach, TxDOT will need to develop an RFP for both the detailed design contract and the construction contract. The RFP will identify and establish the construction approach. If selecting alternative delivery methods like design-build, TxDOT will only need an RFP to secure the design and construction contracts for the scoped effort.

*Medium-Term Actions*

Medium-Term Actions for this strategy focus on strategy implementation. Medium-Term Actions should consider the following:

1. **Develop a Detailed Design**: The completed Near-Term Actions will have affirmed the deployment sites and requirements necessary for this strategy to succeed. With these sites, TxDOT should prepare detailed design plans to address the civil, structural, and electrical designs associated with equipment installation. Depending on the size and scale, this may be through one design contract or several design contracts.

2. **Deploy the Strategy**: TxDOT should deploy this strategy in accordance with the site prioritization identified in the Near-Term Actions. This will likely be through a time-phased deployment that rolls out the system to high-priority highway-rail at-grade crossing sites statewide, most likely through multiple construction contracts. Each site deployment would need to be properly integrated into the TxDOT ITS program, depending on the application and as required by the system requirements and high-level design. TxDOT should continue to collaborate with local agencies regarding use of alternate freight routes.

*Long-Term Actions*

Long-Term Actions for this strategy focus on maintaining and expanding the strategy. Long-Term Actions should consider the following:

1. **Operate and Maintain the System**: TxDOT should operate and maintain the strategy, including all associated hardware and software components. TxDOT should hold
recurring operational meetings with local stakeholders to discuss performance and identify opportunities for greater efficiencies.

2. **Expand the Strategy:** TxDOT should leverage existing relationships with vendors and lessons learned from similar deployments to build a more robust program statewide. This may include expanding the number of rail crossings that are part of this system, based on successes from the initial high-priority deployments.

### 3.8 Smart Work Zone Information System

#### 3.8.1 Strategy Overview

This strategy aims to build upon the existing Texas Smart Work Zone program that deploys temporary ITS assets within work zones, as well as utilizes tools provided by the Connected Work Zone project. This strategy will incorporate these elements as part of a statewide application, factoring in specific needs that come from various truck route types and conditions. It will include the use of technology to provide clear alternative route information, such as instrumenting a parallel truck route to a construction zone and offering travel time information. Additionally, this strategy will provide ITS assets at smaller, short-term work zones that may have some kind of complicated geometry for larger trucks, as these types of smaller-scale work zones may not normally qualify under the existing Texas Go/No-Go Decision Tool as described in the FNTOP Strategies and Conceptual Framework Report. Exhibit 19 provides an illustrative example of this strategy.

TxDOT has had ongoing conversations about improving the Smart Work Zone program, including other initiatives—discussed in the FNTOP Inventory of Existing Conditions Report—to expand its technological applications. The full FNTOP strategy aims to continue those conversations with the goal of more thoroughly utilizing available technology now and in the future to help maximize the benefit to road users.
3.8.2 Roles and Responsibilities
Relevant stakeholders for implementing the Smart Work Zone program are listed in Exhibit 20. At the TxDOT Division level, TxDOT would act as owner with the administrative responsibility of providing project planning and implementation support in coordination with the TxDOT Districts. The TxDOT Districts would be responsible for managing the construction projects that will utilize these systems.

Exhibit 20: Smart Work Zone Information System Stakeholder Roles and Responsibilities

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Strategy Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>TxDOT Division Offices (Owner)</td>
<td>• Will set the policy for how and where Smart Work Zones are used, and what requirements they will follow in terms of data collection and use.</td>
</tr>
<tr>
<td>TxDOT Districts (Key Stakeholder)</td>
<td>• Will provide input on policy for how and where Smart Work Zones are deployed.</td>
</tr>
</tbody>
</table>
### 3.8.3 Organizational and Policy Considerations

Since this initiative is already in place, it will not require organizational changes within TxDOT, although it likely will require some modifications to SOPs and guiding policies that dictate when Smart Work Zones are used. Some policies may need to be updated in order to help facilitate adoption and operation of expanded features. These policies include the following:

- Coordinate with those responsible for incident management, in particular to determine how the system will work within each of their environments and within their existing procedures;
- Create a sign message strategy to prevent conflicting messages from being displayed upon approach to the work zone;
- Develop performance metrics prior to implementation to establish specific means of monitoring the efficiency of the system once it is in place;
- Define SOPs on how the system is expected to work; and
- Establish data archiving procedures to access information for monitoring and evaluation purposes.

### 3.8.4 Advancing the Strategy

This strategy expands on TxDOT’s existing Smart Work Zone program. Conversations are ongoing within TxDOT about opportunities to expand this program, but the challenges of expanding often stem from a lack of funding or difficulty conducting a pilot project for all available applications.

**Near-Term Actions**

Near-Term Actions for this strategy focus on efforts towards expanding the program. These efforts should consider the following:

1. **Monitor Existing Smart Work Zone Program:** TxDOT should continue supporting its Smart Work Zone program, including the current organizational structure and the Go/No-Go Decision Tool. Lessons learned from this program can help inform improvements that can be made under the Smart Work Zone Information System deployment.
2. **Define Strategy Purpose:** TxDOT should define the purpose for expanding the existing Smart Work Zone program. Any related challenges or opportunities should be identified as part of this effort.

3. **Generate a ConOps Document:** Based upon the agreed upon purpose and need for the system expansion, TxDOT should prepare a ConOps document to help inform how the enhancements would fit into the existing TxDOT ITS program. This may be an update of an existing ConOps.

4. **Update System Requirements to Accommodate Changes in Need:** TxDOT should develop or update a Systems Requirements document affiliated with the Smart Work Zone program. As deployment occurs, this document should be updated based on the lessons learned as needs change.

5. **Develop a High-Level Design:** TxDOT should undertake a High-Level Design to describe the overall system framework for the Smart Work Zone Information System strategy, including all the subsystems and their specific components. The resulting design elements will inform the specifications package that is ultimately used to procure the system.

6. **Develop Independent Cost Estimate:** For each proposed update of the Smart Work Zone Information System strategy, TxDOT should prepare an independent implementation cost estimate. This estimate would confirm the necessary expectations on cost as criteria are set for construction projects so as to keep these enhancements within a reasonable budget.

7. **Establish Standards and Agreements:** TxDOT should develop the necessary standards and agreements to help guide design.

8. **Select Procurement Approach:** TxDOT should review its standard procurement methods and identify the preferred procurement for this strategy. Given that Smart Work Zone systems currently are procured as part of a construction contract by the bidder, it is anticipated that this practice would continue in the future and that no change in procurement approach is necessary. If TxDOT elects to procure its own in-house Smart Work Zone system, this would likely occur through separate accounts used to purchase general work zone equipment and material.

**Medium-Term Actions**

Medium-Term Actions for this strategy focus on implementation of new applications and continual evaluation to seek further improvements. Medium-Term Actions should consider the following:

1. **Update the Smart Work Zone Specifications Package:** The completed Near-Term Actions will have affirmed the requirements necessary for this strategy to succeed. With these updated requirements, TxDOT should prepare a list of standard specifications that address the new applications to be used as part of the Smart
Work Zone program, as well as update the Go/No-Go Decision Tool to incorporate any new criteria. These new documents should be made available to TxDOT Districts, for incorporation into their construction contracts. Lessons learned should be documented to inform future updates to this program.

2. **Expand the Strategy:** TxDOT should leverage existing relationships with vendors and lessons learned from similar deployments to build a more robust program statewide. TxDOT should update the program as new applications are tested and proven.

**Long-Term Actions**

Long-Term Actions for this strategy focus on maintaining and continuously improving the strategy. Long-Term Actions should consider the following:

1. **Maintain the Smart Work Zone Program:** TxDOT should continue promoting use of the Smart Work Zone program by continuously reviewing whether benefits are being realized.

2. **Continue Updating the Smart Work Zone Program:** TxDOT should update the Smart Work Zone program on an ongoing basis as new technologies and applications become available, as well as based on lessons learned.

3.9 **Statewide Traffic Operations Center**

3.9.1 **Strategy Overview**

The STOC strategy will improve the conformity and consistency of traffic operations at the statewide level. Information sharing between TxDOT Districts will be improved by establishing an interoperable ATMS platform among all Districts and defining data-sharing protocols between the STOC and all statewide ITS assets. The STOC will focus primarily on rural roads not currently covered by an active traffic management program or regional TMC. This will create a more seamless coordination between TxDOT District operations and maintenance staff, law enforcement, rural communities, and other entities. The STOC is not meant to replace or control the existing TxDOT TMCs. This strategy is meant to foster cooperation between existing regional TMCs and provide the freight industry with a more comprehensive and consistent approach to traffic management across the State, particularly during periods of system disruption or heavy use, as well as expanded coverage on rural routes not currently managed in real-time by TxDOT. Exhibit 21 provides an illustration of the STOC strategy.

The full FNTOP strategy has not been implemented to date, although TxDOT has discussed this topic as part of other planning efforts.
3.9.2 Roles and Responsibilities
Relevant stakeholders for implementing the STOC are listed in Exhibit 22. This strategy envisions TxDOT Divisions as the owner that would internally identify the STOC on its organizational chart, collaborate internally to identify the TxDOT Division that is responsible, and work with stakeholders to bring it to fruition. TxDOT Districts, regional TMCs, and other public sector agencies would be key stakeholders in identifying how the STOC would enhance traffic operations in Texas and how to support their needs.
### Exhibit 22: Statewide Traffic Operations Center Stakeholders Roles and Responsibilities

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Strategy Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>TxDOT Divisions (Owner)</td>
<td>• Will identify the TxDOT Division to manage and fund the STOC, and identify the correct location on the organizational chart.</td>
</tr>
<tr>
<td></td>
<td>• Will fund and support the implementation of the STOC.</td>
</tr>
<tr>
<td></td>
<td>• Will collaborate with other TxDOT Divisions who might lead or support components of this effort.</td>
</tr>
<tr>
<td></td>
<td>• Will develop the STOC program and identify funding needs for capital and operations and maintenance.</td>
</tr>
<tr>
<td></td>
<td>• Will prioritize functions of the STOC with input from other stakeholder groups.</td>
</tr>
<tr>
<td></td>
<td>• Will manage the ATMS and monitor device operability.</td>
</tr>
<tr>
<td></td>
<td>• Will operate the STOC and associated statewide traffic operations program.</td>
</tr>
<tr>
<td></td>
<td>• Will report on system operations for performance monitoring purposes.</td>
</tr>
<tr>
<td></td>
<td>• Will implement data-sharing agreements with each regional TMC.</td>
</tr>
<tr>
<td>TxDOT TMCs (Key Stakeholder)</td>
<td>• Will work with the TxDOT Divisions to identify preferences, outline jurisdictional boundaries for operations and device sharing, and develop SOPs.</td>
</tr>
<tr>
<td></td>
<td>• Will work in real-time with the STOC to manage incidents, as applicable.</td>
</tr>
<tr>
<td></td>
<td>• Will request assistance from the STOC when deemed necessary by the TMC operators.</td>
</tr>
<tr>
<td>TxDOT Districts (Key Stakeholder)</td>
<td>• Will collaborate with the TxDOT Divisions to establish agreements and MOUs regarding ownership, operation, and maintenance of any technological deployments that are integrated into the TxDOT District ITS program.</td>
</tr>
<tr>
<td></td>
<td>• Will work with the STOC regarding management responsibilities of devices when no TMC is present in the TxDOT District.</td>
</tr>
<tr>
<td>Stakeholder</td>
<td>Strategy Impact</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>---------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Other non-TxDOT TMCs (Key Stakeholder)</td>
<td>• Will work with TxDOT STOC to determine how it can support their operations.</td>
</tr>
<tr>
<td></td>
<td>• Will coordinate in real-time with STOC for incidents that involve both parties.</td>
</tr>
</tbody>
</table>

### 3.9.3 Organizational and Policy Considerations

The STOC will require organizational and policy changes within TxDOT to define its operational parameters. The STOC will need to establish an organizational structure that defines where it fits within TxDOT, including key roles and responsibilities and how it will be staffed. Policies will need to be developed that define the scope of operations, including coverage areas, available technologies, and levels of jurisdictional authority. This will include SOPs, data sharing agreements, and other considerations.

From a development standpoint, it will be critical that all key stakeholders are engaged in key decisions. It is common for many state DOTs to have separate entities lead various elements (planning, design, construction, operation, and maintenance of services). In TxDOT, STOC leads may span across divisions and districts. In order to maximize the benefits of the STOC, it is important that all leads collaborate and implement an accepted architecture.

The STOC itself will carry out day-to-day operations that align with policies yet to be developed. Policy actions needed to support the STOC will likely include:

- Define how organizational decisions are made;
- Create SOPs for the STOC and for interoperability between the STOC and regional TMCs;
- Establish data sharing agreements among TMCs and between TMCs and the STOC;
- Define information sharing procedures and protocols;
- Define data QA requirements;
- Establish MOUs for multi-jurisdictional operations;
- Identify and define approved messaging information (e.g., approved alternate routes to bypass incidents);
- Define staffing approach for STOC operations (TxDOT staffed or contractor); and
- Define external agency interaction/coordination protocols.
A comprehensive program management process will be necessary to ensure successful implementation.

3.9.4 Advancing the Strategy
The STOC requires an extensive planning effort, commitment of financing, and lengthy construction timeline before it can be commissioned and operational. The ConOps has identified items for consideration, but the STOC will not be operational for at least a few years due to its larger construction effort, required collaboration, and adoption of organizational adjustments. Ensuring that time is spent to conduct careful planning and multi-agency coordination will help increase its long-term chances of success. Fortunately, TxDOT has been discussing this strategy among many initiatives that are being considered, so some interest and momentum has already been established to help facilitate further conversations.

Near-Term Actions
Near-Term Actions for this strategy focus on efforts that advance towards Detail Design. As a starting point, it would utilize the ConOps document that was completed as part of the FNTOP. These efforts should consider the following:

1. **Identify a TxDOT Division to lead the STOC implementation**: TxDOT should identify a TxDOT Division to champion the planning of the STOC. It is envisioned that support would be provided by other TxDOT Divisions, such as the Traffic Safety Division, which would help with project planning, program development, and initial funding of a statewide traffic operations program. Furthermore, TxDOT will need to modify their organizational chart to accommodate responsibility for the deployment and management of the STOC.

2. **Identify TxDOT’s Vision for STOC**: TxDOT should establish a vision for the STOC in collaboration with its partners, which includes identifying the coverage area, desired applications, functions, operational staffing needs, and procedural requirements. The following core components should be discussed before subsequent effort begins:
   a. TMC/TOC Business Concept – defines key functions and services, and desired functions and services for the center;
   b. Process Approach – documents an overall process for achieving the specified vision;
   c. Value Proposition/Benefit – explains the anticipated benefits resulting from achieving the objectives;
   d. Organization and Management – defines the roles and responsibilities of primary and partner agencies; and

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e. Financial Plan – estimates the budget for capital expenditures, as well as operations and maintenance costs.

3. **Assess the Existing ATMS Platform**: TxDOT should evaluate the existing ATMS functionality to determine if the current platform meets the desired vision for the STOC. Gaps and challenges should be clearly identified to help inform subsequent design efforts.

4. **Generate System Requirements**: TxDOT should develop a set of requirements that describe the functions and systems needed to implement the STOC. The requirements should focus on the capabilities of the ATMS platform, which will help manage the transportation system, aid in the collaboration with regional and local TMCs, and integrate internal and external systems. The requirements for the physical center, including whether it could be integrated into an existing facility, should also be defined.

5. **Develop a High-Level Design**: TxDOT should undertake a High-Level Design. This design document will describe the overall STOC framework identifying subsystems and breaking them down further into components that meet the requirements. Through the high-level design process, TxDOT will clearly define the capabilities of the STOC to ensure no duplication of activities with other regional TMCs. The resulting design elements will be used to guide the Detailed Design.

6. **Determine Infrastructure Needs**: TxDOT should determine the infrastructure needs of this strategy. It is envisioned that TxDOT will expand the ITS program to support real-time traffic management in rural areas. The STOC should be responsible for monitoring and managing reallocated assets from other TMCs, and any new assets that fall under its jurisdiction. This effort will require the identification of infrastructure gaps before the ITS program can be expanded. Communications need to be efficient and reliable to collect and monitor traffic data, and control and manage ITS devices.

7. **Select a STOC Model and Deployment Approach**: TxDOT should select the preferred model and deployment approach for the STOC. The STOC functions and systems should be based on identified user needs, which would provide a set of criteria to chose a deployment model and staffing plan.

8. **Select a Facility Site**: TxDOT should define the facility type (e.g., virtual, standalone, co-located) along with clearly articulated operational guidelines.

9. **Account for future expansion**: TxDOT should build excess capacity into the system to ensure that there is room for expansion. This design should enable the system to handle modifications and upgrades in technology as well as new devices and software when needed.
10. **Develop Independent Cost Estimate:** TxDOT should prepare cost estimates for the deployment and ongoing operations/maintenance of the STOC. The main objective is to forecast the overall costs for implementing this strategy, and in turn pursue proper funding to issue a RFP to the appropriate vendors/integrators.

11. **Establish Standards and Agreements:** TxDOT should develop the necessary standards and agreements to help guide design.

12. **Select Procurement Approach and Prepare RFP:** TxDOT should review its standard procurement methods and identify the preferred procurement for this strategy. Given the differences between procuring an ATMS and constructing a facility, more than one procurement method may apply. The ATMS would likely require a procurement RFP to be developed, which would utilize the System Requirements and High-Level Design to identify how the ATMS should function. For the STOC facility itself, a more elaborate design process will be needed beyond High-Level Design, which necessitates a different procurement method. TxDOT should review how procurements have historically been done for other facility construction projects, which may include the regional TMCs built in the past. If selecting the traditional design-bid-build approach for the STOC facility, TxDOT will need to develop an RFP for both the detailed design contract and the construction contract. The RFP will identify and establish the construction approach. If selecting alternative delivery methods for the STOC facility like design-build, TxDOT will only need an RFP to secure the design and construction contracts for the scoped effort.

**Medium-Term Actions**

Medium-Term Actions for this strategy focus on implementation of software systems and further planning and design for the physical STOC. Medium-Term Actions should consider the following:

1. **Implement the ATMS:** TxDOT should implement the statewide ATMS that meets or exceeds the requirements outlined in the System Requirements and High-Level Design packages. This would be regardless if TxDOT’s decision is to expand the existing LoneStar platform\(^3\) or pursue an alternative system. ATMS implementation will likely occur through several software releases, which would transition certain geographical or functional areas on an incremental basis. Several software releases allows for a more seamless transition into the new system. The first release would focus on deploying core functions and features that are relevant to the STOC itself, as well as to integrate any systems that are not currently supporting the regional TMCs or the existing ATMS software. The second release would add more complex features to the ATMS, establish data exchange with external systems, and roll out the ATMS implementation to all regional TMCs.

\(^3\) For more information, refer to the FNTOP Inventory of Existing Conditions Report.
2. **Develop a Detailed Design for the Physical STOC:** The completed Near-Term Actions will have affirmed the preferred design of the STOC. With this decision, TxDOT should prepare detailed design plans to address the civil, structural, electrical, architectural, and communication network-related designs associated with implementing the physical STOC. If an existing space were to be used or the STOC was co-located with another TMC, the detailed design phase may be shortened, as most of the effort is simply retrofitting the existing space, adding operator workstations, enhancing the communication network, and expanding video wall capabilities. Commissioning a brand-new standalone facility will require more extensive design, which would likely push back the start of construction for the STOC.

**Long-Term Actions**

Long-Term Actions for this strategy focus on implementing the physical STOC, as well as maintaining and expanding the strategy. Long-Term Actions should consider the following:

1. **Deploy the Physical STOC:** TxDOT should deploy this strategy in accordance with the decisions made in the Detailed Design. Construction timelines will vary depending on the selected deployment (i.e., in an existing facility as opposed to a new structure). Prior to completion of the physical STOC, TxDOT should begin workload planning to staff the facility with operators and to work with stakeholders to establish SOPs. TxDOT should also confirm that the ATMS that is in operation can satisfactorily integrate into the new STOC’s equipment.

2. **Operate and Maintain the System:** TxDOT should operate and maintain the STOC, including all associated hardware and software components. Additionally, TxDOT should support and update the operational needs for staffing the center and other procedural requirements on an ongoing basis.

3. **Expand the Strategy:** Once the STOC is commissioned and demonstrated over a period of time, TxDOT should explore opportunities to expand the features and functionalities of this strategy. Existing relationships with vendors and lessons learned should be leveraged to build a more robust STOC.

### 3.10 Binational Traffic Operations Center

#### 3.10.1 Strategy Overview

This strategy aims to implement a Binational TOC that will oversee coordination for border crossings in Texas. This TOC would only have direct management authority over roadways that belong to its sponsoring agency, which would likely be TxDOT, and include all state-owned roads on the Texas side of the border. The success of this TOC will be defined by its ability to bring together a multi-jurisdictional team to coordinate border crossing activities. The team would likely include staff from the U.S. Customs and Border Protection (CBP), TxDPS, law enforcement, staff from the various Mexican road authorities, and bridge operators that actively manage crossings between the two countries. In real-time, these
groups would monitor the situation at the border, in terms of traffic flow, freight movement, security concerns, demand surges, and other relevant operations, and would work with their respective “home” agencies to collaboratively respond. For traffic management tools, each agency liaison would have remote access to their respective system and would be authorized to act on their agency’s behalf to activate and operate these devices. Exhibit 23 provides an illustrative example of this strategy.

TxDOT has had some discussions with stakeholders about the feasibility of this strategy, primarily as part of implementation of other border initiatives. Further details on this strategy’s relevance to current efforts are discussed later in this subsection.

Exhibit 23: Illustrative Example of Binational Traffic Operations Center

3.10.2 Roles and Responsibilities
Relevant stakeholders for implementing the Binational TOC are listed in Exhibit 24. TxDOT would own the administrative responsibility of providing project planning and implementation support in coordination with other participating agencies such as the Department of Homeland Security General Services Administration.
### Exhibit 24: Binational Traffic Operations Center Stakeholder Roles and Responsibilities

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Strategy Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Stakeholder</strong></td>
<td><strong>Strategy Impact</strong></td>
</tr>
</tbody>
</table>
| TxDOT Divisions (Owner, Key Stakeholder) | • Will identify the TxDOT Division to manage and fund the Binational TOC, and identify the location on the internal organizational chart.  
• Will fund and support the implementation of the Binational TOC.  
• Will collaborate with other TxDOT Divisions who might lead or support components of this effort.  
• Will develop Binational TOC program and identify funding needs for capital and operations and maintenance.  
• Will prioritize functions of the Binational TOC with input from other stakeholder groups.  
• Will own, operate, and maintain technological elements associated with this strategy.  
• Will report on system operations for performance monitoring purposes.  
• Will implement data-sharing agreements with adjacent border TMCs. |
| Department of Homeland Security General Services Administration (Owner, Key Stakeholder) | • Will own part of the Binational TOC in collaboration with TxDOT. |
| TxDOT Districts (Key Stakeholder) | • Border TxDOT Districts will help identify operational challenges and will identify how the ITS program could be expanded to assist with these challenges.  
• Will help identify how their enforcement activities could be improved through coordination.  
• Will collaborate in real-time as part of routine operations, and may offer staff to serve in a physical facility. |
<p>| TxDPS (Key Stakeholder) |<br />
| U.S. CBP (Key Stakeholder) | • Will operate and maintain part of the Binational TOC in collaboration with TxDOT. |</p>
<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Strategy Impact</th>
</tr>
</thead>
</table>
| Mexico - Servicio de Administración Tributaria (SAT) (Key Stakeholder)    | - Will help identify how their operations could be improved through coordination.  
- Will collaborate in real-time as part of routine operations, and may offer staff to serve in a physical facility.                                                                                                     |
| Mexico Secretaría de Comunicaciones y Transportes (SCT) (Key Stakeholder) | - Will work with its U.S. CBP counterpart to set policies and regulations.  
- Will help identify how their operations could be improved through coordination.  
- Will collaborate in real-time with the Binational TOC as part of routine operations, and may offer staff to serve in a physical facility.                                                                                 |
| Mexico-Texas border states: Chihuahua; Coahuila; Nuevo Leon; and Tamaulipas SCT (Key Stakeholder) | - Will help identify how their operations could be improved through coordination.  
- Will collaborate in real-time with the Binational TOC as part of routine operations, and may offer staff to serve in a physical facility.                                                                                 |
| Texas-Mexico International Bridges                                       | - Will help identify how their operations could be improved through coordination.  
- Will collaborate in real-time with the Binational TOC as part of routine operations.                                                                                                                        |
| Other Border Crossing Agencies (Key Stakeholder)                         | - Will help identify how their operations could be improved through coordination.  
- Will collaborate in real-time with the Binational TOC as part of routine operations.                                                                                                                        |
3.10.3 Organizational and Policy Considerations

This strategy will require organizational and policy updates within TxDOT to accommodate new roles and responsibilities for the Binational TOC. Key stakeholders will need to collaborate and agree on the Binational TOC organizational structure, including roles and responsibilities. This group of stakeholders will need to define the scope of operations for both U.S. and Mexican participating entities, available technology, and jurisdictional needs.

The Binational TOC itself will be the main liaison among the various border agencies, so policies need to align with its purpose. Types of policies needed for development include:

- Develop uniform procedures and protocols for participating entities;
- Establish SOPs for the Binational TOC;
- Establish data sharing agreements among participating agencies;
- Establish uniform data collection standards for use by both U.S. and Mexico;
- Define information sharing procedures – type of data and availability to obtain it;
- Define types of information that can be released to the public;
- Agree on the levels at which organizational decisions are made;
- Create MOUs for multi-jurisdictional operations;
- Identify data security requirements; and
- Establish data QA standards.

3.10.4 Advancing the Strategy

TxDOT, in collaboration with the Border Trade Advisory Committee, Binational Regional Steering Committees, binational federal and state agencies, and other stakeholders and public groups, is in the process of finalizing the Texas-Mexico Border Transportation Master Plan (BTMP). The BTMP identifies the cross-border challenges of moving people and goods and proposes policy, program, and project strategies to address those challenges and improve cross-border trade and transportation. A proposed Binational TOC aligns with many of the BTMP’s recommended policies and programs, particularly as they relate to mobility and reliability (operational efficiency, system capacity, binational coordination, new technologies, and performance monitoring), and cross-border resiliency.

Following adoption of the BTMP, TxDOT will begin to implement the BTMP recommendations. The BTMP implementation framework will help inform the scale of deployment, site selection, and binational agencies that should be involved in the Binational TOC. The Binational TOC will require an extensive planning effort, including a financing plan, followed

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4 Proposed final BTMP adoption is expected in January 2021.
by a significant construction timeline before it can be commissioned and become operational. The planning effort will require multi-agency and cross-border coordination. TxDOT’s first step is to develop a ConOps to identify high-level user needs and system capabilities with input from all relevant stakeholders.

Near-Term Actions
Near-Term Actions for this strategy focus on efforts that advance towards the preparation of a design RFP. Much of this may be undertaken as part of BTMP implementation, although it could be done separately. These efforts should consider the following:

1. **Monitor BTMP Implementation Activities:** TxDOT’s BTMP implementation framework will prioritize and begin to advance the policies, programs, and projects recommended at the border. Next steps toward implementation will be crucial in identifying necessary stakeholders and informing what capabilities need to be refined for the Binational TOC to be successful. Based on the results of this effort, TxDOT should update the strategy as necessary.

2. **Look for Partnerships:** TxDOT should look for partnerships among state, national, and international agencies and international bridge owners and operators. The implementation of the Binational TOC will require the coordination and support of external agencies and organizations. It will also rely heavily on the ability to coordinate and make decisions internally. This strategy can only fully succeed when all parties involved work together, and a strong sense of leadership is essential to keep all of those aspects organized and focused on the end goal.

3. **Identify the Strategy’s Vision:** TxDOT should work with partners to establish the vision for the Binational TOC. This effort would determine the necessary applications, the preferred deployment model (time-phased and geography-phased) for the facility, its staffing approach, and the location of the facility. TxDOT will need to identify which division will champion the planning of the Binational TOC, and would create a new role within this Division.

4. **Develop a ConOps and System Requirements:** TxDOT should generate a ConOps document and a System Requirements document. These documents will take into account the functions, characteristics, and constraints of the strategy, while reflecting needs and preferences of key stakeholders. These documents will further advance the strategy, helping facilitate further efforts that define the planned approach, organization, and financial plan. They should be informed by findings from the BTMP. TxDOT should look to the ConOps and System Requirements documents that are developed for other FNTOP strategies, particularly the STOC, to identify the lessons learned and to incorporate best practices.

5. **Develop a High-Level Design:** TxDOT should undertake a High-Level Design to describe the overall strategy framework. The resulting design elements will be used to guide the Detailed Design.
6. **Develop Independent Cost Estimate:** For the proposed time-phased implementation of the Binational TOC, TxDOT should prepare an independent implementation cost estimate. This estimate would confirm the necessary expectations on cost as an RFP is prepared and would allow for proper funding allocations.

**Medium-Term Actions**

Medium-Term Actions for this strategy continue the planning efforts in coordination with BTMP implementation. Medium-Term Actions should consider the following:

1. **Coordinate Strategy with Other Border Implementation Planning Efforts:** TxDOT should coordinate the Binational TOC effort with the BTMP implementation efforts to ensure that it accommodates the goals and objectives of that initiative. Coordination with activities undertaken by this effort will ensure that TxDOT receives a comprehensive solution for managing freight at the border.

2. **Document Lessons Learned from other Initiatives:** TxDOT should document lessons learned from other border-related TMC efforts, as well as other FNTOP strategies that implement freight-focused technological solutions. In particular, if the STOC is advanced, many pieces of information learned under that strategy would apply to the Binational TOC.

3. **Establish Standards and Agreements:** TxDOT should develop the necessary standards and agreements to help guide design.

4. **Select Procurement Approach and Prepare RFP:** TxDOT should review its standard procurement methods and identify the preferred procurement for this strategy. With added complexity of a potential facility, the Binational TOC needs a more elaborate design process beyond High-Level Design, which necessitates use of procurement strategies with a detailed design phase. TxDOT should review how procurements have historically been done for other facility construction projects, which may include the regional TMCs built in the past. If selecting the traditional design-bid-build approach for the Binational TOC facility, TxDOT will need to develop an RFP for both the detailed design contract and the construction contract. The RFP will identify and establish the construction approach. If selecting alternative delivery methods for the Binational TOC facility like design-build, TxDOT will only need an RFP to secure the design and construction contracts for the scoped effort.

**Long-Term Actions**

Long-Term Actions for this strategy focus on implementing the strategy, as well as on maintaining and expanding the strategy. Long-Term Actions should consider the following:

1. **Develop a Detailed Design for the Binational TOC:** The completed Medium-Term Actions will have affirmed the preferred design and role of the Binational TOC. With this decision, TxDOT should prepare detailed design plans to address the civil,
structural, electrical, architectural, and communication network-related designs
associated with implementing the physical Binational TOC.

2. **Deploy the Strategy:** TxDOT should deploy this strategy in accordance with the
decisions made in the Medium-Term Actions. Construction timelines will vary
depending on the selected deployment (i.e., in an existing facility as opposed to a
new structure). Prior to completion of the physical Binational TOC, TxDOT and other
partner stakeholders should begin workload planning to staff the facility with
operators and should work with stakeholders to establish SOPs.

3. **Operate and Maintain the System:** TxDOT and partners should operate and maintain
the Binational TOC, including all associated hardware and software components.
Additionally, TxDOT should support and update the operational needs for staffing the
center and other procedural requirements on an ongoing basis.
4.0 Implementation Action Plan

This section outlines a time-phased series of activities that are needed to accomplish the planning, implementation, and eventual full deployment of the 10 FNTOP recommended strategies. The recommendations from this section were developed using the framework described in Section 2.0 and are considered time-phased next steps with an FNTOP completion in late 2020. These activities are summarized across three phases as follows:

- **Near-Term Actions for Strategy Implementation.** This presents the set of activities referred to as *Advancing the FNTOP Concepts of Operations*, that can be conducted within two years—once the implementation planning activities commence—that will provide the planning and systems engineering baseline such that TxDOT will be able to move forward with site selection and system deployment/procurement for the six FNTOP strategies selected for ConOps development.

- **Medium-Term Actions for Strategy Implementation.** This presents the steps that can be conducted within two to five years of implementation for the six FNTOP ConOps strategies, encompassing initial deployments, pilot projects, and phased rollouts of these strategies, while the recommended Near-Term Actions for Strategy Implementation could be applied to the other four FNTOP recommended strategies.

- **Long-Term Actions for Strategy Implementation.** This presents the steps associated with the long-term sustained operations and maintenance activities that can be conducted within five to seven years of implementation and are needed to support full deployment of the strategies.

Five key recommended supporting actions to facilitate successful strategy implementation are as follows:

- Leverage the current FNTOP momentum that has been established to continue collaboration within the TxDOT Divisions to support the implementation planning activities;

- Expand TxDOT internal stakeholder involvement in the FNTOP to the TxDOT Districts to identify site opportunities for pilot project deployment and to develop regional champions;

- Leverage the FNTOP stakeholder participation, expanding both external public sector agency involvement and private sector freight transportation and technology involvement and buy-in as relevant to the individual strategies;

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5 The six FNTOP strategies selected for ConOps development include Safety Warning Detection System; Statewide Traffic Operations Center; Smart Freight Connector; Blocked Rail Crossing Traffic Management System; AV Infrastructure, Connected Signing, and Data; and High-Resolution Freight Traveler Information System.

6 The other four FNTOP recommended strategies include Truck Parking Availability System; Smart Work Zone Information System; Centralized Data Repository for Freight Applications; and Binational Traffic Operations Center.
• Coordinate within TxDOT regarding funding sources. Identify internal sources, regional partnerships to support deployment (e.g., public and private sector in-kind match through data sharing), and USDOT grant program funding; and

• Formalize a FNTOP Working Group or leverage an existing related working group and conduct regular meetings (e.g., at least bi-annually); this public-private group would act as a stakeholder advisory committee for the FNTOP Implementation Plan.

The final recommendation in the list above—formalize a FNTOP Working Group—represents a longer term recommended action that should begin at the onset of and continue beyond the Near-Term Actions for strategy implementation, and would support all implementation phases. Over time, this group can be leveraged to recommend supplemental technologies, data sharing opportunities, new technology projects, and stakeholder outreach based on the changing nature of transportation and technologies in Texas and in the U.S.

4.1 Near-Term Actions for Strategy Implementation

For TxDOT to be able to deploy any or all of the FNTOP recommended strategies in the medium-term, the Near-Term Actions—conducted over a two-year period—should focus on the set of implementation planning activities necessary to prepare each of the six FNTOP ConOps strategies for implementation. These next steps would include the systems engineering processes that will bring TxDOT to a decision-point position of deploying these strategies in the near-term. Since these strategies can operate independently of one another, TxDOT does not have to implement all of the strategies at the same time. However, TxDOT would benefit greatly by completing this implementation planning as part of Advancing the FNTOP Concept of Operations; as there will be economies of scale and opportunities to explore the integration of some or all strategies at varying levels.

These Near-Term Action activities, which may differ slightly between each strategy as outlined in Section 3.0, include the following:

• Identify lead TxDOT Divisions and agency champions;

• Coordinate with regional partners, including TxDOT Districts, local supporting agencies (e.g., MPOs), and private sector partners on planning for strategy deployment;

• Assess TxDOT system capabilities that need to be integrated (including those systems that are part of the private sector), as well as the condition of the existing equipment and FNTOP-identified adjustments to existing TxDOT policies (e.g., regarding network security and liability) that may be necessary upon activation of these strategies;

• Perform a site selection assessment (including initial and phased roll-out locations);
• Determine/finalize infrastructure and equipment, as well as data needs (not only for strategy functionality, but also to inform performance measures and storage needs), and standards;

• Develop formal System Requirements Specification documentation;

• Develop High-Level Design documentation\(^7\);

• Develop an independent implementation cost estimate;

• Develop scope inputs to support TxDOT moving forward with deployment/pilot project procurement;

• Develop performance metrics to evaluate the effectiveness of each strategy, support benefit-cost analyses, and help address federal reporting requirements; and

• Develop a cross-cutting Communications Plan with protocols for communications and data sharing between TxDOT Divisions, Districts, regional partners, local supporting agencies, and private sector partners; this Communications Plan will also help provide education regarding the technologies included in each strategy.

The Near-Term Actions in Exhibit 25 represent the efforts needed for Advancing the FNTOP Concepts of Operations. These efforts will build on the findings of the comprehensive freight technology planning effort of the FNTOP carried out by TxDOT. The FNTOP identified and prioritized 10 technology-based strategies based on identified user needs. The six FNTOP strategies selected for ConOps development are the focus of the Advancing the FNTOP Concepts of Operations effort outlined in this section. Once the implementation planning activities commence, this effort would have a duration of two years, and would complete all of the stakeholder outreach, planning, and systems engineering steps necessary for TxDOT to proceed with design and deployment in the medium- and long-term implementation phases. These efforts will define the scale, site selection and prioritization, and implementation approach for each strategy, and would work in coordination with other strategy-related initiatives (e.g., Texas Connected Freight Corridors developments). Many of the strategies build on existing TxDOT programs and encompass significant integration and coordination across the TxDOT Divisions and Districts. These efforts will also provide TxDOT the basis for future budget formulation to support procurement activities that precede deployment.

These efforts would conduct all activities across all strategies that TxDOT elects to move forward into the planning phase. As noted earlier, many benefits are gained by conducting the planning studies concurrently for all desired strategies. Some benefits include consolidation of stakeholder outreach to prevent stakeholder fatigue and keep stakeholders engaged with all of TxDOT’s freight technology initiatives; capturing high-level design

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\(^7\) This document is a not an engineering-level design, but rather a design guidance document that can be used to support a future TxDOT scope-of-work for engineering contractor(s) to support future implementation.
benefits by envisioning the changes to TxDOT’s existing program if all FNTOP ConOps strategies are introduced; and the economies of scale resulting in costs savings for the planning activities.

Exhibit 25 presents an overview of Near-Term Actions by strategy, including identification of any existing TxDOT programs in place today that would support implementation activities.

### Exhibit 25: Summary of Near-Term Actions for Strategy Implementation

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Existing TxDOT Program/Initial Next Steps</th>
<th>Summary of Near-Term Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 High-Resolution Freight Traveler Information System</td>
<td>No; coordinate internally between TxDOT Divisions and regional partners</td>
<td>• Advancing the FNTOP ConOps (System Requirements and High-Level Design)</td>
</tr>
<tr>
<td>2 AV Infrastructure, Connected Signing, and Data</td>
<td>No; monitor regulatory environment and pilot programs, participate in the development of national standards, and collaborate with AV industry</td>
<td>• Advancing the FNTOP ConOps (System Requirements and High-Level Design)</td>
</tr>
<tr>
<td>3 Safety Warning Detection System</td>
<td>Yes; expand the number of system deployments</td>
<td>• Advancing the FNTOP ConOps (System Requirements and High-Level Design)</td>
</tr>
<tr>
<td>4 Smart Freight Connector</td>
<td>No; coordinate with key local stakeholders</td>
<td>• Advancing the FNTOP ConOps (System Requirements and High-Level Design)</td>
</tr>
<tr>
<td>5 Blocked Rail Crossing Traffic Management System</td>
<td>No; coordinate with existing local agency programs</td>
<td>• Advancing the FNTOP ConOps (System Requirements and High-Level Design)</td>
</tr>
<tr>
<td>6 Statewide Traffic Operations Center</td>
<td>No; coordinate with regional partners to establish STOC vision</td>
<td>• Advancing the FNTOP ConOps (System Requirements and High-Level Design)</td>
</tr>
</tbody>
</table>
4.2 Medium-Term Actions for Strategy Implementation

Once Advancing the FNTOP Concepts of Operations is complete, the six FNTOP ConOps strategies would advance into procurement and implementation, while the recommended Near-Term Actions could be applied to the other four FNTOP recommended strategies. In the medium-term, many of the FNTOP recommended strategies could be partially or fully implemented. This effort would include development of any necessary civil and structural drawings to support the strategy, now that the sites have been selected and agreed upon. The phased implementation may include both a detailed design and construction phase. The implementation of the Binational TOC would be dependent on international relations. Exhibit 26 shows the Medium-Term Actions that TxDOT should take for each of the ten FNTOP recommended strategies, if each strategy has gone through its predecessor planning phase.

Exhibit 26: Summary of Medium-Term Actions for Strategy Implementation

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Summary of Medium-Term Actions</th>
</tr>
</thead>
</table>
| 1 Truck Parking Availability System | • Advancing the FNTOP ConOps as part of I-10 TPAS and Statewide Truck Parking Implementation (ConOps update, System Requirements update, and High-Level Design)  
• Statewide TPAS Deployment Implementation Efforts (Detailed Design, Deployment) |
| 2 High-Resolution Freight Traveler Information System | • Implementation and integration with DriveTexas (Detailed Design, Deployment) |
| 3 Central Data Repository for Freight Applications | • Advancing the FNTOP ConOps (ConOps, System Requirements, and High-Level Design)  
• Implementation (Detailed Design, Deployment) |
| 4 AV Infrastructure, Connected Signing, and Data | • Implementation (Detailed Design, Deployment) |
| 5 Safety Warning Detection System | • Program Expansion (Detailed Design, Deployment) |
| 6 Smart Freight Connector | • Implementation (Detailed Design, Deployment) |
| 7 Blocked Rail Crossing Traffic Management System | • Implementation (Detailed Design, Deployment) |
| 8 Smart Work Zone Information System | • Advancing the FNTOP ConOps (ConOps, System Requirements, and High-Level Design) |
The implementation of these strategies would be based on the materials developed during the Near-Term Actions, outlined in Section 0. Those materials—including the system requirements, high-level design, site selection findings, design scope, and independent cost estimate—will provide TxDOT with the information needed to support procurement efforts for implementation, such as design-bid-build, design-build, or alternative methods of initial deployment (e.g., PPPs, grant-supported projects). The only strategy that may not be ready for implementation is the Binational TOC, since it is part of the larger international border planning work undertaken by TxDOT.

4.3 Long-Term Actions for Strategy Implementation

Following implementation, most or all of the FNTOP recommended strategies enter the Operations and Maintenance phase. At this point, all aspects of the strategies have been deployed, with some strategies receiving incremental expansions as new sites are brought online. Some of the more complex strategies (namely the STOC’s physical facility) would be constructed at this point.

As part of the Long-Term Actions, TxDOT should maintain funding to support the programs, as well as document lessons learned to support future technology initiatives or offer guidance to peer states looking to implement similar systems. Additionally, the FNTOP Implementation Plan should be revisited, updated, and revised periodically, both to reflect the evolution of the program, and to be responsive to freight transportation stakeholders and developments in freight transportation and information systems. Exhibit 27 shows the Long-Term Actions for each of the ten strategies.
### Exhibit 27: Summary of Long-Term Actions for Strategy Implementation

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Summary of Long-Term Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Truck Parking Availability System</td>
<td>• Incremental Strategy Expansion (adding new sites to existing system)</td>
</tr>
<tr>
<td></td>
<td>• Ongoing Operations and Maintenance</td>
</tr>
<tr>
<td>2 High-Resolution Freight Traveler Information System</td>
<td>• Incremental Strategy Expansion (continue adding new traffic data to deployed system)</td>
</tr>
<tr>
<td></td>
<td>• Ongoing Operations and Maintenance</td>
</tr>
<tr>
<td>3 Central Data Repository for Freight Applications</td>
<td>• Incremental Strategy Expansion (continue adding new data services to deployed system)</td>
</tr>
<tr>
<td></td>
<td>• Ongoing Operations and Maintenance</td>
</tr>
<tr>
<td>4 AV Infrastructure, Connected Signing, and Data</td>
<td>• Incremental Strategy Expansion (continue adding new corridors, AV infrastructure, and other digital map elements to deployed system)</td>
</tr>
<tr>
<td></td>
<td>• Ongoing Operations and Maintenance</td>
</tr>
<tr>
<td>5 Safety Warning Detection System</td>
<td>• Incremental Strategy Expansion (adding new devices/locations to existing system)</td>
</tr>
<tr>
<td></td>
<td>• Ongoing Operations and Maintenance</td>
</tr>
<tr>
<td>6 Smart Freight Connector</td>
<td>• Incremental Strategy Expansion (continue adding new corridors to deployed system)</td>
</tr>
<tr>
<td></td>
<td>• Ongoing Operations and Maintenance</td>
</tr>
<tr>
<td>7 Blocked Rail Crossing Traffic Management System</td>
<td>• Incremental Strategy Expansion (continue adding new sites to deployed system)</td>
</tr>
<tr>
<td></td>
<td>• Ongoing Operations and Maintenance</td>
</tr>
<tr>
<td>8 Smart Work Zone Information System</td>
<td>• Incremental Strategy Expansion (adding new applications to existing program, expand to higher share of construction projects)</td>
</tr>
<tr>
<td></td>
<td>• Ongoing Operations and Maintenance</td>
</tr>
<tr>
<td>9 Statewide Traffic Operations Center</td>
<td>• STOC Facility Implementation</td>
</tr>
<tr>
<td></td>
<td>• Ongoing Operations and Maintenance</td>
</tr>
<tr>
<td>Strategy</td>
<td>Summary of Long-Term Actions</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>-----------------------------------------------------------</td>
</tr>
<tr>
<td>10 Binational Traffic Operations Center</td>
<td>• Binational TOC Implementation (Detailed Design, Deployment)</td>
</tr>
<tr>
<td></td>
<td>• Ongoing Operations and Maintenance</td>
</tr>
</tbody>
</table>
5.0 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.