Texas Freight Network
Technology and Operations Plan

Statewide Traffic Operations Center
Concept of Operations

Texas Department of Transportation, Freight Planning Branch

Final: December 2020
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**Acronyms**

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<th>Description</th>
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<tbody>
<tr>
<td>ADA</td>
<td>Americans with Disabilities Act</td>
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<tr>
<td>AMBER</td>
<td>America's Missing: Broadcast Emergency Response</td>
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<tr>
<td>API</td>
<td>Application Programming Interface</td>
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<tr>
<td>ATIS</td>
<td>Advanced Traveler Information System</td>
</tr>
<tr>
<td>ATMS</td>
<td>Advanced Traffic Management System</td>
</tr>
<tr>
<td>BNSF</td>
<td>BNSF Railway Company</td>
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<tr>
<td>C2C</td>
<td>Center-to-Center Communications</td>
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<td>CAT</td>
<td>Cooperative Automated Transportation</td>
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<tr>
<td>CCTV</td>
<td>Closed-Circuit Television</td>
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<tr>
<td>CMV</td>
<td>Commercial Motor Vehicle</td>
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<tr>
<td>ConOps</td>
<td>Concept of Operations Document</td>
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<tr>
<td>CRFC</td>
<td>Critical Rural Freight Corridor</td>
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<tr>
<td>CRIS</td>
<td>Crash Records Information System</td>
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<tr>
<td>CTECC</td>
<td>Austin’s Combined Transportation, Emergency &amp; Communications Center</td>
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<tr>
<td>CTRMA</td>
<td>Central Texas Regional Mobility Authority</td>
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<tr>
<td>CTT</td>
<td>Comparative Travel Time</td>
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<tr>
<td>CUFC</td>
<td>Critical Urban Freight Corridor</td>
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<tr>
<td>CV</td>
<td>Connected Vehicles</td>
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<tr>
<td>DMS</td>
<td>Dynamic Message Sign</td>
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<tr>
<td>ELD</td>
<td>Electronic Logging Device</td>
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<tr>
<td>FNTOP</td>
<td>Freight Network Technology and Operations Plan</td>
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<tr>
<td>FRATIS</td>
<td>Freight Advanced Traveler Information Systems</td>
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<tr>
<td>FSP</td>
<td>Freight Signal Priority</td>
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<td>GIWW</td>
<td>Gulf Intracoastal Waterway</td>
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<tr>
<td>HCRS</td>
<td>Highway Conditions Reporting System</td>
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<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
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<tr>
<td>ITS</td>
<td>Intelligent Transportation Systems</td>
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<tr>
<td>LOS</td>
<td>Level-Of-Service</td>
</tr>
<tr>
<td>METRO</td>
<td>Metropolitan Transit Authority of Harris County</td>
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<tr>
<td>MOU</td>
<td>Memorandum of Understanding</td>
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<tr>
<td>MSA</td>
<td>Metropolitan Statistical Area</td>
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<tr>
<td>NTCIP</td>
<td>National Transportation Communications for ITS Protocol</td>
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<tr>
<td>PAAC</td>
<td>Port Authority Advisory Committee</td>
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<tr>
<td>PII</td>
<td>Personally Identifiable Information</td>
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<td>RIMS</td>
<td>Regional Incident Management System</td>
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<tr>
<td>SOC</td>
<td>Statewide Operations Center</td>
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<tr>
<td>STOC</td>
<td>Statewide Traffic Operations Center</td>
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<tr>
<td>STRATIS</td>
<td>Laredo’s South Texas Regional Advanced Transportation Information System</td>
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<tr>
<td>SWRI</td>
<td>Southwest Research Institute</td>
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<td>TDEM</td>
<td>Texas Department of Emergency Management</td>
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<tr>
<td>TFMP</td>
<td>Texas Freight Mobility Plan</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
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<tr>
<td>THFN</td>
<td>Texas Highway Freight Network</td>
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<tr>
<td>TMC</td>
<td>Traffic Management Center</td>
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<tr>
<td>TMFN</td>
<td>Texas Multimodal Freight Network</td>
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<tr>
<td>TOC</td>
<td>Traffic Operations Center</td>
</tr>
<tr>
<td>TSMO</td>
<td>Transportation Systems Management and Operations</td>
</tr>
<tr>
<td>TTI</td>
<td>Texas A&amp;M Transportation Institute</td>
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<tr>
<td>TxDOT</td>
<td>Texas Department of Transportation</td>
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<tr>
<td>TxDPS</td>
<td>Department of Public Safety</td>
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<tr>
<td>USDOT</td>
<td>United States Department of Transportation</td>
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<tr>
<td>VC</td>
<td>Vehicle Classification</td>
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<tr>
<td>VPN</td>
<td>Virtual Private Network</td>
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<tr>
<td>WAN</td>
<td>Wide Area Network</td>
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<tr>
<td>WebEOC</td>
<td>Web Emergency Operations Center</td>
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<tr>
<td>WIM</td>
<td>Weigh-in-Motion</td>
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1.0 Introduction
The Freight Network Technology and Operations Plan (FNTOP) is anticipated to be the most comprehensive freight technology planning effort among state Departments of Transportation (DOTs) in the U.S. The FNTOP intends to outline potential strategies to guide technology- and operations-related investments on the Texas Multimodal Freight Network (TMFN). The FNTOP includes a review of current and future transportation challenges, opportunities, and the development of user needs informed by focused public and private sector engagement. The FNTOP is anticipated to be an invaluable resource to help public agencies and the private sector effectively plan for future deployments of freight technologies, working in partnership across all modes of freight transportation.

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

1.1 Project Overview
The primary goal of the FNTOP is to develop a comprehensive plan advising TxDOT on deploying technology based operational strategies to improve freight transportation safety and mobility in Texas. The main objectives of this project include:

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

The FNTOP and Concepts of Operations will guide Texas’s strategic development and deployment of innovative multimodal freight transportation technologies, techniques, research, and methods.

1.2 Project Reports

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

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

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

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

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

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

• **Strategies and Conceptual Framework Report.** Documented FNTOP identified strategies that are relevant to the goals and objectives of the FNTOP and based on documented FNTOP User Needs. Identified details of the FNTOP identified strategies, including how they are prioritized and how they could fit together as part of a larger conceptual framework that builds upon the existing Texas ITS program.
• **Concepts of Operations.** Developed in-depth concepts of desired operations and maintenance requirements for the six FNTOP recommended strategies selected for Concept of Operations (ConOps) development.

• **Implementation Plan.** Identified near-term, medium-term, and long-term actions, in addition to considerations necessary for the rollout of each of the 10 FNTOP recommended strategies as they are transitioned from planning to design.

• **Freight Network Technology and Operations Plan.** Summarizes the entire plan development tasks, as well as incorporates the technical and stakeholder engagement tasks completed throughout this project in a final plan.

### 1.3 Stakeholder Engagement

The FNTOP began with research on existing freight initiatives at TxDOT to gain a better understanding of the current challenges faced by the Texas freight community. A diverse group of stakeholders were also engaged to solicit feedback and opinions on the current state of freight operations in Texas and the possible application of technology to improve future freight operations. The stakeholder interviews verified and supported many of the issues identified by the FNTOP, while also helping identify and prioritize potential strategies to address system deficiencies.

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

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

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

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

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

1.4  **Texas Multimodal Freight Network**

The TMFN consists of the state’s freight assets that are most important for moving the largest volumes of freight and that serve the state’s key freight intensive industries. Per the 2018 TFMP\(^1\), these assets cover:

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

\(^1\) Texas Department of Transportation, *Texas Freight Mobility Plan 2018*, March 7, 2018.
• **Railroads:** With 10,539 track miles (all on the TMFN), Texas has more miles of rail and more railroad employees than any other state. Texas contains five of the seven rail crossings between the U.S. and Mexico, providing critical connections for trade between the two countries. Texas’ 49 shortline railroads serve as first or last mile railroads for Texas’ three Class I railroads (BNSF Railway, Kansas City Southern Railway Company, and Union Pacific Railroad), Texas’ maritime ports, and many of the state’s rail-served industries.

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

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

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

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

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

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

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

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

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

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

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

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

The Texas Multimodal Freight Network

Source: Texas Department of Transportation, Texas Freight Mobility Plan 2018 – Executive Summary, March 7, 2018.
The 2018 TFMP identified eight goals and associated objectives that help inform and articulate TxDOT’s freight investment priorities, help define freight system investment needs, and identify the desired future performance of the TMFN. Exhibit 4 summarizes these goals, some of which will be utilized later in this document to identify deficiencies in the existing system and justify deployment of the identified strategy.

### Exhibit 4: 2018 TFMP Goals

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

### 1.5 Summary of Existing Conditions and User Needs

The FNTOP reviewed the existing ITS program in Texas, which represents the vast majority of TxDOT’s real-time traffic management applications that serve roadway user needs, including freight. TxDOT utilizes Traffic Management Centers (TMC) as one of the key tools to operate and manage its road network. TxDOT is a participant in several advanced mobility initiatives, including an Integrated Corridor Management (ICM) program, a freight signal priority project, and several Connected Vehicle initiatives; still, the vast majority of the ITS and traffic management program resides in major metropolitan areas, with limited coverage or response capabilities in rural areas. Relevant ITS programs in the context of this strategy are discussed later in Section 2.2. Further details on these programs and others can be found in.
the FNTOP State of the Practice Assessment Report and FNTOP Inventory of Existing Conditions Report.

User Needs for the FNTOP were informed by the FNTOP Goals and Objectives, the FNTOP State of the Practice Assessment Report, the FNTOP Inventory of Existing Conditions Report, and input from stakeholders. Relevant user needs that apply to this strategy are presented in Section 2.5 to aid with traceability of strategy features described later in the document. A full list of User Needs can be found as part of the FNTOP User Needs Assessment Report.

1.6 Summary of Strategies and Conceptual Framework Technical Report

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

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

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

A total of six strategies were recommended to advance to Concept of Operations development. There was consistent agreement among TxDOT and its stakeholders that these strategies had opportunity for adding value to the TMFN and were likely to succeed in Texas. The other strategies developed as part of this effort were either underway as part of a separate effort or deferred due to another TxDOT initiative. Exhibit 5 reflects the final recommendations for each strategy.
<table>
<thead>
<tr>
<th>Identified Strategy</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck Parking Availability System</td>
<td>Underway&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>High-Resolution Freight Traveler Information System</td>
<td>Advanced to Concept of Operations</td>
</tr>
<tr>
<td>Centralized Data Repository for Freight Applications</td>
<td>Deferred&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>AV Infrastructure, Connected Signing, and Data Safety Warning Detection System</td>
<td>Advanced to Concept of Operations</td>
</tr>
<tr>
<td>Smart Freight Connector</td>
<td>Advanced to Concept of Operations</td>
</tr>
<tr>
<td>Blocked Rail Crossing Traffic Management System</td>
<td>Advanced to Concept of Operations</td>
</tr>
<tr>
<td>Smart Work Zone Information System</td>
<td>Underway&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>Statewide Traffic Operations Center</td>
<td>Advanced to Concept of Operations</td>
</tr>
<tr>
<td>Binational Traffic Operations Center</td>
<td>Deferred&lt;sup&gt;2&lt;/sup&gt;</td>
</tr>
<tr>
<td>Freight Integrated Corridor Management</td>
<td>Not Advanced&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td>Fiber Optic Cable Expansion</td>
<td>Not Advanced&lt;sup&gt;4&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

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

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

Exhibit 6 shows the relationship among integrated services and strategies.
Exhibit 6: Potential Integrated Services and Strategies

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

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

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

AV Infrastructure
- AV Infrastructure, Connected Signing, and Data

Real Time Traffic Data
Notifications

Binational Traffic Operations Center

High-Resolution Freight Traveler Information System
- Partner Agencies
- Nav/Map/Traffic Services
- Other Stakeholders
- Media Outlets
- Gov. Auth./Emerg. Serv.
- Data Subscribers
- Drive Texas ATIS

Real Time Traffic Data
Notifications

Regional Parking Availability System
- Safety Warning Detection System
- Smart Freight Connector
- Blocked Rail Crossing Traffic Management System
- Smart Work Zone Information System
1.7 Purpose of the Concept of Operations Document

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

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

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

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

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

**Exhibit 8: Systems Engineering V-Model**


Development of the ConOps document is the first major step of the Decomposition and Definition phase of the V-Model, where ITS project concepts become more defined. It helps

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2 Federal Highway Administration California Division and Caltrans, Systems Engineering Guidebook for ITS Version 3.0

Website
establish the simple expectations of the system so that stakeholders can understand what the project intends to do and understand how it will be later validated when complete.

1.8 Statewide Transportation Operations Center Overview

This ConOps is focused on a Statewide Traffic Operations Center (STOC). At a high level, the STOC would monitor traffic operations in areas of the THFN not currently supported by a TMC, coordinate on statewide freight movement, support local TMCs with their efforts as requested, improve conformity on planned road disruptions between Districts, and help establish an interoperable Advanced Traffic Management System (ATMS) platform and data-sharing protocols between remote ITS assets, the Districts, and the STOC. The goal of this system would be to improve freight mobility through increased coordination, improved information sharing, and better utilization of TxDOT assets.

Exhibit 9 provides an illustrative example of the STOC strategy as previously discussed in the FNTOP Strategies and Conceptual Framework Report.

Exhibit 9: Illustrative Example of Statewide Traffic Operations Center

Although the term “TMC” (Traffic Management Center) and “TOC” (Traffic Operations Center) are often used interchangeably in the industry, this ConOps treats “TMC” as a management authority over a road network (e.g. the TMC operators directly control all ITS assets under
their domain), whereas a “TOC” is more of a coordination service with limited or no authority\(^3\) over a road network (e.g. the TOC operators focus more on supporting law enforcement with incident response). This is an important difference because this strategy aims to provide an enhanced service statewide that supports the existing TxDOT TMCs that are in operation based on their needs, as opposed to overseeing their operations as a management entity.

At a high-level, some of the key objectives of the STOC include:

- Provide statewide messaging and strategies for general operations and major events, such as a hurricane evacuation, major route closure, or other disruptions;
- Improve mobility in and around rural areas and frequently traveled corridors outside the established coverage areas of TMCs;
- Utilize one unified ATMS platform or establish an interoperable platform to better exchange data, operate assets, and provide a consistent look and feel between TMCs;
- Adjust statewide operational strategies to serve freight-specific needs at advantageous times of day, based on freight movement;
- Publish strategic freight route and parking information at earlier decision points (i.e. publish messages on DMSs in one TxDOT TMC’s District for a route that is in another TxDOT TMC’s District);
- Provide real-time notifications to road users of potential delays ahead, allowing them to make informed travel decisions along their route;
- Provide rerouting alternatives to road users in rural areas;
- Decrease incident clearance times in rural areas;
- Decrease secondary incident occurrences in rural areas by helping reduce incident clearance times;

\(^3\) Authority is primarily in the context of incident management. TMCs in urban areas often have service patrols that can act as incident commanders and manage an incident in collaboration with the TMC. TOCs often contact local law enforcement when detecting an incident, allow law enforcement to be the incident manager, and respond in support of law enforcement’s direction. Both TMCs and TOCs utilize their ITS program during incidents to provide traveler information to help motorists make informed routing decisions.
• Improve inter-agency (within Texas, across state lines, or across national boundaries), District, and TMC coordination; and

• Provide historical and real-time data (e.g. reoccurring congestion) for better traffic operations and management.

1.9 Organization of the Report

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

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

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

• **Section 3 – Concept for the Proposed Statewide Traffic Operations Center.** This section contains a description of the desired system and high-level requirements, how it will address the concerns outlined in Section 2, how it will operate, and how users will interface with the system.

• **Section 4 – Benefits, Impacts, and Alternatives of the Statewide Traffic Operations Center.** This section describes the expected operational and organizational benefits and impacts of the essential features of the new STOC systems, the potential impacts during development, disadvantages and limitations of the proposed system, and alternatives and tradeoffs considered while developing the system concept.

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

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

• **Section 7 – References.** This section lists all references used in the creation of this document.
2.0 The Current Situation in Texas

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

2.1 Description of the Current Situation

This section discusses the current situation in Texas to help frame the deficiencies that could motivate deployment of a new system. According to the TFMP, 54 percent of total tonnage moving along the TMFN in 2016 moved by truck. As noted earlier, highways are the predominant mode for freight movement in the state and are expected to maintain that predominance in the future. Highways serve as critical first and last mile connections to rail facilities, ports, and airports, as well as serve long-haul trips within and beyond the state. While interstate highways are widely viewed as being some of the more popular routes, the vast majority of roadway miles in Texas are along local routes, state roads, and U.S. routes. Exhibit 10 reflects the breakout, as published in the 2018 TFMP.

Exhibit 10: Roadway Miles in Texas by Type

Approximately 70 percent of the land area representing 173 counties in Texas is classified as rural, according to the designated 2010 metropolitan statistical areas (MSAs) outlined by the U.S. Office of Management and Budget. Urban and rural counties are identified in Exhibit 11.
Exhibit 11: Texas Urban and Rural Counties

Texas Urban and Rural Counties

Source: U.S. Office of Management and Budget, 2010 Metropolitan Statistical Areas
These regions generally include Texas’ agricultural industry and increasingly the state’s energy and tourism sectors. Rural areas include roughly 50 percent of the 313,000 miles of public Texas roadways, and 10,677 miles (49 percent) of the 21,861 miles of the THFN.

Exhibit 12 shows the THFN.

**Exhibit 12: Texas Highway Freight Network**

Source: Texas Freight Mobility Plan 2018
Historically, TxDOT’s TMCs have been deployed to support urban traffic operations in and around the major metropolitan regions in Texas. These investments were driven by the relatively higher benefit-cost ratios associated with TMCs and ITS programs in urban areas. With constrained budgets, most traffic management investments have focused on urban centers, leaving the management and operation of rural systems to local government and law enforcement.

The under-representation of ITS strategies in rural areas is a challenge for many states. To help get ITS investments into the rural areas, the National Center for Rural Road Safety established the *Rural Intelligent Transportation System (ITS) Toolkit*, which is a resource of 42 technology-based countermeasures to improve rural mobility, safety, and efficiency. Countermeasures are divided among seven topic areas, which include:

- Crash Countermeasures;
- Traffic Management;
- Operations & Maintenance;
- Emergency Services;
- Surface Transportation & Weather;
- Rural Transit & Mobility; and
- Tourism & Travel Information.

While countermeasures and field assets are not the focus of this document, it is important to note that many of the proposed 42 countermeasures are standalone, isolated “spot” improvement devices, such as a curve warning system. In other words, even though major transportation network disruptions in rural areas do occur and can have widespread impacts on road users, few countermeasures focus on large-scale traffic operations and management best managed through a large-scale centralized system.

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4 Several TxDOT TMCs are housed in TxDOT-owned facilities (often with co-located external public sector agencies), but some are part of multi-agency collaborative TMCs (e.g. Houston TranStar, discussed later). Even though TxDOT operators may be co-located in a non-TxDOT facility, this document refers to “TxDOT TMCs” to represent TxDOT’s TMC operations program (e.g. the staff, operators, equipment, etc.), regardless of facility.

5 Source: National Center for Rural Road Safety, Rural ITS Toolkit.
The 2018 TFMP identifies a series of goals that articulate TxDOT’s freight investment priorities, help define freight system investment needs, and identify the desired future performance of the TMFN. Three of the goals and their associated objectives directly apply to the use of statewide traffic operations to improve freight movement in Texas, as outlined in Exhibit 13.

**Exhibit 13: Texas’ Freight Mobility Goals and Objectives Related to Statewide Traffic Operations**

<table>
<thead>
<tr>
<th>2018 TFMP Goals</th>
<th>Description</th>
<th>Objectives Related to Statewide Traffic Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility and Reliability</td>
<td>Reduce congestion and improve system efficiency and performance</td>
<td>• Reduce the number of Texas Highway Freight Network miles at unacceptable congestion levels (level-of-service D or worse).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Improve travel time reliability on the Texas Highway Freight Network.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Apply the most cost-effective methods to improve system capacity and reliability (including technology and operations).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Partner with U.S. and Mexican federal, state, regional, local, and private sector stakeholders to address Texas-Mexico border crossing challenges.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Support the development and deployment of integrated Texas-Mexico border crossing management through ITS.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Leverage technology to improve management and operations of the existing transportation system.</td>
</tr>
<tr>
<td>Asset Preservation and Utilization</td>
<td>Maintain and preserve infrastructure assets using cost-beneficial treatment</td>
<td>• Achieve and maintain a state of good repair on the Texas Highway Freight Network.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Improve the overall ratings of bridges on the Texas Highway Freight Network.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Increase the percent of pavement lane-miles in good condition on the Texas Highway Freight Network.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Leverage and utilize the Texas Multimodal Freight Network.</td>
</tr>
</tbody>
</table>
2018 TFMP Goals

<table>
<thead>
<tr>
<th>Description</th>
<th>Objectives Related to Statewide Traffic Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utilize technology to provide for the resiliency and security of the state’s multimodal freight transportation system in response to multi-hazard threats, including natural disasters and man-made threats.</td>
<td></td>
</tr>
</tbody>
</table>

Safety

<table>
<thead>
<tr>
<th>Description</th>
<th>Objectives Related to Statewide Traffic Operations</th>
</tr>
</thead>
</table>
| Improve multimodal transportation safety | • Reduce rates of truck-involved crashes, injuries and fatalities on the Texas Highway Freight Network.  
• Reduce the number of rail-related incidents, including crashes at at-grade highway/rail crossings.  
• Increase the resiliency and security of the state’s freight transportation system in response to multi-hazard threats, including natural disasters and man-made threats.  
• Support the deployment of innovative technologies to enhance the safety and efficiency of the TMFN. |

Descriptions of these current goals in the context of statewide traffic operations are discussed in greater detail in the following sections.

2.1.1 Mobility and Reliability

The 2018 TFMP analyzed congestion on the THFN, utilizing the qualitative Level-of-Service (LOS) ratings ranging from A to F that are traditionally used in the practice of traffic engineering. Exhibit 14 defines the LOS ratings that were used in the 2018 TFMP, with supplemental descriptions provided by the Highway Capacity Manual and the AASHTO Geometric Design of Highways and Streets (“Green” Book). Generally speaking, LOS A is considered the best, LOS E represents operations with traffic volumes nearing their maximum throughput (often at reduced speeds), and LOS F represents congested operations where throughput diminishes due to traffic slowing in response to congested densities. LOS C and LOS D are generally considered acceptable traffic operations, as road users would subjectively see traffic conditions that are associated with these ratings as busy (i.e. many other vehicles on the road), but traveling at or near the speed limit.
**Exhibit 14: Level-of-Service (LOS) Descriptions**

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

Source: Texas Freight Mobility Plan 2018

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

Exhibit 15 shows the 2016 daily LOS of the THFN, as presented in the 2018 TFMP. For reference, the 2016 data was the most recent data set available at the time of the TFMP.

THFN Level of Service

Legend
Level of Service 2016
- LOS A - Free flow
- LOS B - Stable flow with slight delays
- LOS C - Stable flow with delays
- LOS D - Approaching unstable flow
- LOS E - Unstable flow
- LOS F - Forced flow

Source: Texas Freight Mobility Plan 2018

Prepared by Cambridge Systematics
Data for planning purposes only.
November 6, 2017
To analyze TxDOT’s entire highway network, an updated 2018 data set was used to estimate daily LOS for all statewide TxDOT roads. This was the most recently available data set with full network coverage of corridors that could be supported as part of statewide traffic operations, which was viewed as more comprehensive than the 2016 data used in the TFMP that focused primarily on the THFN. The analysis performed was similar to the daily LOS analysis done for the THFN. LOS ratings were compared and contrasted between urban and rural counties to identify the distribution of ratings. For this analysis, rural counties were assumed to be part of the 173 counties identified earlier in Exhibit 11. Although this analysis is at a macroscopic forecast level, it provides a good assessment of LOS distribution for statewide traffic movements. Exhibit 16 shows the breakout of this distribution.

**Exhibit 16: Approximate Distribution of Daily LOS Ratings on Statewide TxDOT Roads, 2018**

<table>
<thead>
<tr>
<th>LOS Rating</th>
<th>Urban Counties</th>
<th>Rural Counties</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOS A</td>
<td>85%</td>
<td>99%</td>
</tr>
<tr>
<td>LOS B</td>
<td>12%</td>
<td>1%</td>
</tr>
<tr>
<td>LOS C</td>
<td>2%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>LOS D</td>
<td>1%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>LOS E</td>
<td>&lt;1%</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>LOS F</td>
<td>&lt;1%</td>
<td>&lt;1%</td>
</tr>
</tbody>
</table>

Source: Texas Statewide Analysis Model version 3 (SAM-V3) 2018, V/C Ratio

These statistics illustrate that average daily congestion issues are more closely associated with urban areas than rural areas, which supports the justification made of deploying TMC and ITS resources more in urban areas. It is important to reiterate that this only shows average daily congestion issues, which does not reflect peak-hour demand on its own or the effects of non-recurrent congestion (i.e. incidents, transportation system disruptions), but this average provides a good assessment of how the network performs in urban and rural counties. The 2018 TFMP notes that freight operations in the state are forecasted to grow, potentially increasing truck trips by nearly 50 percent by 2045. As such, the existing highway network is poised for additional strain to support this increase, which could result in mobility issues shifting outside of the urban areas to portions of the network that are not supported by TMC or ITS resources. Further details on these impacts are discussed in later sections.
2.1.2 Asset Preservation and Utilization

In addition to traditional roads and bridges, TxDOT owns and operates an extensive ITS program as part of its efforts to manage traffic, reduce incident clearance times, and improve safety on its roadways. Many of the assets used for real-time traffic management efforts—which are discussed in greater detail in Section 2.2.3—are deployed in urban areas or along highly traveled routes, as the greatest benefit to road users is often captured by focusing investments in these areas. For example, ITS programs to help manage incidents are often deployed in urban areas, as roadway incidents can very quickly lead to propagating system delays due to the high traffic flows in those areas. Since much of the early ITS program focused on incident management, this approach to deployment has resulted in high concentrations of ITS assets in urban areas.

TxDOT operates seven TMCs to manage traffic operations in respective jurisdictions, many with other real-time traffic agencies and incident management personnel working within the same facility. Greater details on these TMCs can be found in Section 2.2.1, but the general responsibilities of these TMCs are to monitor the transportation system in real-time and respond to issues that threaten to disrupt mobility and safety. Since TMCs are a costly investment, they have been implemented in locations where they can offer the greatest benefit, which typically corresponds to urban areas where recurrent and non-recurrent congestion is more frequent. Currently, all seven TxDOT TMCs are geographically located in urban counties.

The TxDOT ITS assets were compared and contrasted between urban and rural counties to identify the distribution of devices. Exhibit 17 shows the approximate breakout of this distribution in the urban and rural counties. It reflects devices used for real-time traffic management (e.g. CCTV cameras, DMS, vehicle detectors) and technology currently used for transportation planning (e.g. weigh-in-motion (WIM), permanent count stations) that may have capabilities in the future to aid in real-time traffic management. It is important to note that the TxDOT ITS program has other ITS applications that are used as spot treatments, but this illustration intentionally focuses on assets that are both common and part of a widespread program.
**Exhibit 17: Distribution of TxDOT ITS Assets Between Urban and Rural Texas Counties**

<table>
<thead>
<tr>
<th>ITS Asset</th>
<th>Urban Counties</th>
<th>Rural Counties</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCTV Cameras</td>
<td>2,607 (96%)</td>
<td>110 (4%)</td>
</tr>
<tr>
<td>Dynamic Message Signs (DMS)</td>
<td>904 (91%)</td>
<td>85 (9%)</td>
</tr>
<tr>
<td>Vehicle Detectors</td>
<td>2,441 (97%)</td>
<td>84 (3%)</td>
</tr>
<tr>
<td>Weigh-In-Motion (WIM)</td>
<td>22 (54%)</td>
<td>19 (46%)</td>
</tr>
<tr>
<td>Permanent Count Sites</td>
<td>265 (66%)</td>
<td>137 (34%)</td>
</tr>
</tbody>
</table>

Most of TxDOT’s ITS assets for real-time traffic management are located in the urban counties (i.e. 96 percent of the CCTV cameras, 91 percent of the DMS, and 97 percent of the vehicle detectors). These devices are associated with TxDOT TMCs where available. Programmatically, investments in both TMCs and ITS assets correlate to regions with larger congestion issues or poorer level-of-service that were noted in Section 2.1.1, where investments result in higher benefit/cost ratios. WIM and permanent count stations had a better urban-rural distribution, with 54 percent of the WIM stations and 66 percent of the permanent count stations being located in urban areas. However, since WIM and permanent count stations are traditionally used for long-term planning efforts and not real-time traffic management applications, a more geographically dispersed installation is not surprising.

**2.1.3 Safety**

The 2018 TFMP analyzed safety issues and crash histories on the THFN. For the three-year period from 2014 to 2016, 56 percent of the total commercial motor vehicle (CMV) crashes and 71 percent of CMV fatalities occurred on the THFN. The fatality rate was 1.7 percent of all crashes during that period, with an injury rate (incapacitating, non-incapacitating, or possible injury) of 26.6 percent. Seventy percent of CMV crashes occurred in urban areas, but only 44 percent of all CMV fatalities occurred in urban areas. Only 38 percent of the THFN is considered part of an urban area, indicating that a disproportionally high percentage of CMV crashes occur in urban areas.

Exhibit 18 illustrates a comprehensive examination of potential safety bottlenecks on the THFN from 2014 to 2016, which were part of the 2018 TFMP. One key finding is the categorization of segments with above average fatal and incapacitating injury crashes, which—despite most CMV crashes being focused on urban areas—can be found across the entire network, both urban and rural.
Exhibit 18: Texas Highway Freight Network Commercial Vehicle Safety Factors

THFN Commercial Vehicle Safety Factors

Legend:
- Texas Highway Freight Network
- Commercial Motor Vehicle Crash Per Mile:
  - 0 - 3
  - 3 - 16
  - 16 - 48
  - 48 - 166
  - More than 166
- Above Average Fatal Crashes
- Above Average Crashes with Inca. Injury

Source: Texas Freight Mobility Plan 2018

Prepared by Cambridge Systematics
Data for planning purposes only.
October 26, 2017
The above-average fatality and incapacitating injury segments from the 2018 TFMP were compared and contrasted between urban and rural counties to identify the distribution of safety performance. For this analysis, rural counties are assumed to be part of the 173 counties identified in Exhibit 11. Exhibit 19 shows the breakout of this distribution among THFN mileage in the urban and rural counties.

**Exhibit 19: Distribution of "Above Average" Safety Issues on the THFN Between Urban and Rural Texas Counties**

<table>
<thead>
<tr>
<th>Safety Issue</th>
<th>Urban Counties</th>
<th>Rural Counties</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Above Average” Fatality Segment</td>
<td>1,958 miles (38%)</td>
<td>3,251 miles (62%)</td>
</tr>
<tr>
<td>“Above Average” Incapacitating Injury Segment</td>
<td>1,907 miles (37%)</td>
<td>3,198 miles (63%)</td>
</tr>
</tbody>
</table>

Rural counties as a whole encompass a higher share of statewide segments that are classified as “above average” for fatalities and incapacitating injuries. These statistics illustrate that more serious crashes are problematic in both urban and rural environments, even though an overall higher quantity of crashes occur in urban areas. While the focus of this document is not on direct safety improvements, CMV-related crashes can have a disruptive impact on the transportation system, such as blocking a critical road or reducing available capacity. These crashes will have greater impacts in the future, affecting more roadway users as freight operations and traffic volumes grow.

### 2.2 Existing Systems

This section discusses the existing systems in Texas, highlighting systems that focus on highway traffic operations and the dissemination of traveler information. It is important to understand what systems and functionalities have already been deployed, so that wherever possible, the concept for the STOC described in Section 3.0 can utilize existing systems as a foundation for strategy implementation. Each existing system is briefly described in this ConOps; additional details on these systems can be found in the FNTOP Inventory of Existing Conditions Report.

#### 2.2.1 Traffic Management Centers

TxDOT utilizes TMCs as one of the key tools to operate and manage its road network. These TMCs utilize the ITS assets available in the District to improve traffic flow, respond to incidents, and provide public safety information at a region-wide level. Seven TMCs currently operate in Texas, which are strategically located in urban areas where traffic volumes are highest and road incidents are more frequent. These TMCs typically manage state-owned

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6 “Above average” is based on criteria used in the 2018 TFMP, which were defined as segments with a higher average of crashes than average based on data in the TxDOT Crash Records Information System (CRIS), 2014-2016.
roads in the District, and often manage the ITS assets for an adjacent District with no TMC. Exhibit 20 summarizes each of the TxDOT TMCs, while Exhibit 21 shows the location of each TMC.

**Exhibit 20: TxDOT Traffic Management Centers**

<table>
<thead>
<tr>
<th>TxDOT Traffic Management Centers</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austin Combined Transportation, Emergency &amp; Communications Center (CTECC)</td>
<td>Austin CTECC serves as the TMC for the Austin area; it also serves other centralized public safety operations. It involves a partnership between TxDOT, Travis County, the City of Austin, and the Capital Metropolitan Transit Authority.</td>
</tr>
<tr>
<td>Dallas DalTrans</td>
<td>Dallas DalTrans serves as the TMC for the Dallas area. It involves a partnership between three agencies including the City of Dallas, TxDOT, and Dallas Area Rapid Transit (DART).</td>
</tr>
<tr>
<td>El Paso TransVista</td>
<td>El Paso TransVista serves as the TMC for the El Paso area. Housed within the TxDOT El Paso District, this TMC provides traffic and emergency management information for the region.</td>
</tr>
<tr>
<td>Fort Worth TransVision</td>
<td>Fort Worth TransVision serves as the TMC for the Fort Worth area. It is managed and operated by the TxDOT Fort Worth District and provides traffic and emergency management information for the Fort Worth area and Tarrant County.</td>
</tr>
<tr>
<td>Houston TranStar</td>
<td>Houston TranStar serves as the TMC for the greater Houston area. It involves a partnership between the City of Houston, Harris County, TxDOT, and the Metropolitan Transit Authority of Harris County (METRO).</td>
</tr>
<tr>
<td>Laredo South Texas Regional Advanced Transportation Information System (STRATIS)</td>
<td>Laredo STRATIS serves as the TMC for the Laredo area. It is managed and operated by the TxDOT Laredo District and works in collaboration with the City of Laredo’s Traffic Management Center.</td>
</tr>
<tr>
<td>San Antonio TransGuide</td>
<td>San Antonio TransGuide serves as the TMC for the San Antonio region. It is managed and operated by the TxDOT San Antonio District and works in collaboration with local agencies.</td>
</tr>
</tbody>
</table>
Exhibit 21: TxDOT Traffic Management Centers

TxDOT Traffic Management Centers

Prepared by Cambridge Systematics.
Data for planning purposes only.
July 20, 2020
Some TxDOT Districts that do not have a formal TMC—typically those in rural parts of the state that are not near an urban center with a TxDOT TMC—have the capability to manage and operate the ITS devices within their specific region, typically at a single workstation, with ATMS software to deal with special events or emergencies, as opposed to real-time traffic management. This type of approach is very low cost because staff is only involved when needed (in response to a planned event or unplanned incident), but since it is not real-time and often does not have an extensive traffic management response plan, the ability to manage traffic is generally less robust than urban areas with TMCs.

As discussed later in this document, TxDOT’s TMCs operate as centralized operations at each of their seven locations, operating and managing ITS assets in their respective Districts and any adjacent Districts without a TMC that make up part of their urban area. Each TMC has separate server installations for its equipment, including its ATMS, which means that each TMC manages its own devices.

### 2.2.2 TxDOT ATMS Software

All TxDOT TMCs operate their ITS programs using ATMS software. The ATMS software brings multiple ITS devices into one single platform for easy operator use and management within each TMC. In the early days of the ITS program, traffic management agencies utilized vendor-specific software for each device, which was cumbersome for an operator to cycle through when attempting to manage an incident, such as concurrently viewing a camera and posting a message to a DMS. Modern ATMS platforms allow for several systems—including CCTV, DMS, and vehicle detectors of many different manufacturers and model years—to work collaboratively at the single press of a button or entry of a specific event type.

Exhibit 22 highlights the ATMS that is used in each of TxDOT’s TMCs. TxDOT primarily utilizes LoneStar, which is based on the ActiveITS system developed by the Southwest Research Institute (SWRI). An exception to LoneStar’s use in Texas is in the Houston TranStar facility, which also utilizes the Regional Incident Management System (RIMS) Platform, developed by the Texas Transportation Institute (TTI) to assist with traffic data collection and other activities like law enforcement reporting. RIMS contains more detailed reporting capabilities to support local law enforcement systems that operate out of Houston TranStar. While the ATMS may encompass the majority of the ITS devices that are controlled by a TMC, there are often devices that are operated under a separate software platform at the same facility, which can lead to gaps in data visibility.
### Exhibit 22: TxDOT TMCs and ATMS Platforms

<table>
<thead>
<tr>
<th>TxDOT TMC</th>
<th>ATMS Platform</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austin CTECC</td>
<td>LoneStar</td>
</tr>
<tr>
<td>Dallas DalTrans</td>
<td>LoneStar</td>
</tr>
<tr>
<td>El Paso TransVista</td>
<td>LoneStar</td>
</tr>
<tr>
<td>Fort Worth TransVision</td>
<td>LoneStar</td>
</tr>
<tr>
<td>Houston TranStar</td>
<td>RIMS, LoneStar</td>
</tr>
<tr>
<td>Laredo STRATIS</td>
<td>LoneStar</td>
</tr>
<tr>
<td>San Antonio TransGuide</td>
<td>LoneStar</td>
</tr>
</tbody>
</table>

#### 2.2.3 ITS Field Devices

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

- CCTV Cameras;
- DMS; and
- Vehicle Detectors.

##### 2.2.3.1 Closed-Circuit Television Cameras

CCTV cameras are roadside devices that provide visual coverage of locations along roadways. For highway applications, CCTV cameras are often strategically placed on high-volume corridors and near locations with high concentrations of crashes that require incident management and response. Exhibit 23 shows the deployment of cameras at a statewide level.

##### 2.2.3.2 Dynamic Message Signs

DMS are electronic roadside signs that can broadcast changeable messages to road users, which may include public safety announcements, traveler information, incident information, or other key information. In comparison to static signs, DMS can be changed in response to real-time events, which allows road users to make informed travel decisions to help improve their safety or mobility. Exhibit 24 shows the deployment of DMS at a statewide level.
2.2.3.3 Vehicle Detectors

Vehicle detectors, or sensors, are devices that detect vehicles passing or arriving at a certain point. They are used to evaluate flow, density, speed, and (depending on the type) vehicle classification. Detectors can be one of many types, including loop detectors, microwave radar, magnetometers, and video detection. Traffic-related data is often summarized in discrete intervals, such as 30-second blocks, and transmitted back to the appropriate District in real-time for use in TMC operations. Exhibit 25 shows the deployment of vehicle detection stations at a statewide level.
Exhibit 23: TxDOT ITS Inventory - CCTV Cameras

TxDOT ITS Inventory - CCTV Cameras

- CCTV Camera
- Texas Highway Freight Network

Source: TxDOT Traffic Safety Division

Prepared by Cambridge Systematics.
Data for planning purposes only.
May 29, 2020
Exhibit 24: TxDOT ITS Inventory - Dynamic Message Signs

Source: TxDOT Traffic Safety Division

Prepared by Cambridge Systematics.
Data for planning purposes only.
May 29, 2020
Exhibit 25: TxDOT ITS Inventory - Vehicle Detection Stations

TxDOT ITS Inventory - Vehicle Detection Station

Source: TxDOT Traffic Safety Division

Prepared by Cambridge Systematics.
Data for planning purposes only.
May 29, 2020
2.2.3.4 Weigh-In-Motion/Permanent Count Stations

TxDOT owns and operates WIM and permanent count stations around the state that are used to collect data on vehicle count, classification, and weights for planning purposes. WIM is a technology that estimates vehicle weights of at-speed trucks to:

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

Exhibit 26 shows the locations of permanent WIM and other permanent count stations statewide.
Exhibit 26: TxDOT ITS Inventory - Weigh-In-Motion and Other Permanent Count Stations

Source: TxDOT Transportation Planning and Programming Division

Prepared by Cambridge Systematics. Data for planning purposes only. November 04, 2020
2.2.4 DriveTexas

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

At a statewide level, as shown in Exhibit 27, it provides information regarding:

- Road and Lane Closures (current/planned in the near-term, typically out to 6 weeks⁷);
- Construction (current/planned);
- Ice/Snow;
- Traffic Conditions;
- Rest Area Locations;
- Travel Information Centers; and
- Other (conditions not listed, such as parades, special events, low visibility, etc.).

Exhibit 27: DriveTexas Website (Statewide)

Source: DriveTexas.org

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⁷ Districts can report planned closures beyond 6 weeks, but it only appears in DriveTexas when within 6 weeks.
2.2.5 TxDOT Closure Permitting
As part of construction projects to rebuild, rehab, or restore TxDOT’s existing highway and roadside infrastructure, road and lane closures are often requested. Road closure information is collected by local TxDOT Districts and entered into HCRS as an active or planned construction or maintenance project. This information is then reported as part of the DriveTexas platform, with color differentiation to signal when it is anticipated to occur. Districts may input all planned events, but DriveTexas only displays those occurring in the next six weeks. DriveTexas reports the description, start/end location, the days and times of the closure, and what facilities are affected (e.g. lane 1, lane 2, etc.). This information is shown as an icon on the DriveTexas map for visual reference.

2.3 Deficiencies in the Current Situation
The FNTOP State of the Practice Assessment Report and input from public agencies and private sector representatives helped to identify several common deficiencies in the existing system. This section summarizes these deficiencies, focusing on areas of improvement that align with the TFMP’s goals for a better freight system.

2.3.1.1 Mobility and Reliability
Managing Remote Disruptions
ITS programs ideally would provide complete coverage of a system, but—due to budgetary limitations and other constraints—a full coverage system is not realistic. ITS planning efforts have followed traditional transportation planning efforts, which prioritize the investment of a limited budget to locations that yield the highest benefits at reasonable costs (i.e. applications with high benefit-cost ratios get priority for deployment). As a result, most ITS applications are found on heavily-traveled urban routes, such as the Houston metro area freeway network, and high-volume suburban/rural corridors, such as along I-35 from Dallas to San Antonio. Rural areas, including many freight routes, often do not qualify. This is the case for ITS programs across the United States, as well as Texas, where only four percent of the TxDOT ITS devices are found in rural counties.

With the establishment of Transportation Systems Management and Operations (TSMO) programs in many states, the industry is shifting focus toward building resiliency in the transportation system. Resilience represents a system’s ability to continue to function at an acceptable level of efficiency in the face of disruptive or unexpected conditions, and it is influenced less so by the frequency of segment-based mobility issues, but rather systemwide impacts. Roadway incidents can happen anywhere, and while many in rural areas can be managed on a local basis using law enforcement and other supporting staff, incidents that create wider impacts (e.g. HazMat spills, multiple fatality road closures, etc.) necessitate access to traffic management tools and active coordination to manage the entire roadway network. Furthermore, maintaining awareness and coordination of traffic hotspots in rural
areas—even if moving less traffic than urban counterparts—can assist with maintaining resiliency.

Over the last few decades, congestion has spread out of cities, with vehicle-miles of travel growing faster in rural areas than in their urban counterparts. The ability to absorb this increase in traffic in rural areas is expected to diminish over time as excess capacity is consumed. As noted earlier, 72 percent of Texas’s interstate highway mainlines experiences traffic that is LOS D or better, as of 2016, with 28 percent of Texas’s interstate highway mainlines experiencing traffic that is LOS E or worse. By 2045, it is projected that congested highway miles along the THFN will increase by nearly 60 percent. While a majority of U.S. highways and state highways will operate at peak LOS of A or B, interstate highways are expected to experience higher levels of congestion, with nearly 43 percent reaching peak LOS of E or F.

Exhibit 28 illustrates the forecasted level-of-service in 2045 along the THFN, based on analysis done as part of the 2018 TFMP.

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Exhibit 28: Texas Highway Freight Network Estimated Level-of-Service, 2045
Utilizing the same methodology, daily LOS was calculated for the THFN for 2050. LOS ratings were compared and contrasted between urban and rural counties to identify differences. Rural counties consisted of the same 173 counties identified earlier. Although this analysis is a high-level approximation, it shows the forecasted changes in daily LOS between 2018 and 2050, which supports the notion that rural congestion is forecasted to increase. Exhibit 29 summarizes the anticipated changes in daily LOS between 2018 and 2050 for both urban and rural counties. The results overall are consistent with the 2045 THFN forecasts, with a worsening of daily LOS in both urban and rural parts of Texas. While the changes in rural counties is much less pronounced, congestion is expected to increase.

**Exhibit 29: Distribution of Daily LOS Ratings on the THFN Between Urban and Rural Texas Counties, 2050**

<table>
<thead>
<tr>
<th>LOS Rating</th>
<th>Urban Counties</th>
<th>Percent Change over 2018</th>
<th>Rural Counties</th>
<th>Percent Change over 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOS A</td>
<td>72%</td>
<td>-13%</td>
<td>97%</td>
<td>-2%</td>
</tr>
<tr>
<td>LOS B</td>
<td>18%</td>
<td>+6%</td>
<td>2%</td>
<td>+1%</td>
</tr>
<tr>
<td>LOS C</td>
<td>4%</td>
<td>+2%</td>
<td>&lt;1%</td>
<td>~0%</td>
</tr>
<tr>
<td>LOS D</td>
<td>2%</td>
<td>+1%</td>
<td>&lt;1%</td>
<td>~0%</td>
</tr>
<tr>
<td>LOS E</td>
<td>2%</td>
<td>+2%</td>
<td>&lt;1%</td>
<td>~0%</td>
</tr>
<tr>
<td>LOS F</td>
<td>1%</td>
<td>+1%</td>
<td>&lt;1%</td>
<td>~0%</td>
</tr>
</tbody>
</table>

Source: Texas Statewide Analysis Model version 3 (SAM-V30) 2050, V/C Ratio

Many road users traveling in rural areas are traveling on roadways that are not managed or operated by a TMC. In this setting, employing a form of wide-scale traffic operations would help identify congestion hotspots earlier—either through monitoring or coordination with local law enforcement—and allow a quicker, more coordinated mitigation response to provide road users with information and alternative routes for them to make informed travel decisions. Leaving this condition in its current form would result in increased travel delay, increased rates of emissions and fuel use, increased driver frustration, and stunt the ability of the THFN to support economic prosperity.

**Strategic Work Zone Planning**

Road construction is a necessary activity to maintain and improve a transportation system, despite being widely disliked by road users who are inconvenienced by restricted travel speeds and conditions, as well as the resultant traffic congestion. Road construction is a long-term investment for the transportation system, but it creates short-term mobility challenges for the THFN. These impacts can be exacerbated when road construction-related information is unknown or not shared, when the activity occurs over a long period of time, and when multiple improvements are underway simultaneously along one corridor without adequate coordination.
Currently, each TxDOT District reports their own active or planned road construction project into HCRS. This information is then reported as part of the DriveTexas platform, with color differentiation to signal when it is anticipated to occur. Districts may input all planned events, but DriveTexas only displays those occurring in the next six weeks. DriveTexas reports the description, start/end location, the days and times of the closure, and what facilities are affected (e.g. lane 1, lane 2, etc.), similar to what is shown in Exhibit 30. This information is shown as an icon on the DriveTexas map for visual reference.
### Exhibit 30: Highway Condition Reporting System

**Texas Department of Transportation**

#### IH35E North

<table>
<thead>
<tr>
<th>Description</th>
<th>Start Location</th>
<th>End Location</th>
<th>Days Closed in Red</th>
<th>Lanes Affected</th>
<th>Start Time</th>
<th>End Time</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unknown</td>
<td>IH35E North @ Marsalis Ave</td>
<td>Unknown</td>
<td>S M T W T F S</td>
<td>Main Lane 3</td>
<td>10/15/2020 at 9:30 AM</td>
<td>10/16/2020 at 3:30 PM</td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td>IH35E North @ Saner Ave</td>
<td>Unknown</td>
<td>S M T W T F S</td>
<td>Main Lane 0</td>
<td>10/15/2020 at 9:30 AM</td>
<td>10/16/2020 at 3:30 PM</td>
<td></td>
</tr>
<tr>
<td>TFW NITE EXC SAT</td>
<td>IH35E North @ Ann Arbor Ave</td>
<td>IH35E North @ East 8th St</td>
<td>S M T W T F S</td>
<td>Unknown</td>
<td>10/15/2020 at 8:00 PM</td>
<td>Daily until further notice at 5:00 AM</td>
<td>Periodic nightly lane closures.</td>
</tr>
<tr>
<td>TFW NITE EXC SUN</td>
<td>IH35E North @ Continental Ave</td>
<td>IH35E North @ H Line Dr / Victory Ave</td>
<td>S M T W T F S</td>
<td>Unknown</td>
<td>10/15/2020 at 8:00 PM</td>
<td>Daily until further notice at 5:00 AM</td>
<td>Periodic nightly lane closures.</td>
</tr>
</tbody>
</table>

#### IH35E South

<table>
<thead>
<tr>
<th>Description</th>
<th>Start Location</th>
<th>End Location</th>
<th>Days Closed in Red</th>
<th>Lanes Affected</th>
<th>Start Time</th>
<th>End Time</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>TFW NITE EXC SAT</td>
<td>IH35E South @ East 8th St</td>
<td>IH35E South @ US 99</td>
<td>S M T W T F S</td>
<td>Unknown</td>
<td>10/15/2020 at 8:00 PM</td>
<td>Daily until further notice at 5:00 AM</td>
<td>Periodic nightly lane closures.</td>
</tr>
</tbody>
</table>

#### IH635 East

<table>
<thead>
<tr>
<th>Description</th>
<th>Start Location</th>
<th>End Location</th>
<th>Days Closed in Red</th>
<th>Lanes Affected</th>
<th>Start Time</th>
<th>End Time</th>
<th>Notes</th>
</tr>
</thead>
</table>

**Source:** DriveTexas.org, 2020
While Districts have an in-depth understanding of what is planned for their roads, planning projects in isolation, especially within adjacent Districts, can result in some of the issues identified earlier. For example, two adjacent Districts may have planned road construction on the same roadway corridor without awareness of the other effort and—despite both being published on DriveTexas—each District only provides motorists with information regarding the closure in their own District. Similarly, two adjacent Districts may pursue lane closures on their key north-south routes, not realizing that this action has created parallel work zones for north-south traffic through the region. While some of these sequential or parallel work zones are unavoidable due to contractor scoping, a wide-scale multi-jurisdiction traffic operations system would allow for a review of planned and active closures to identify where there might be excessive recurrences and possibly help mitigate the impacts, either by working with the Districts to shift the timing of construction projects or to provide more specific traveler information, such as advanced signing of several construction zones, suggestions of alternatives, or deployment of temporary ITS assets to help monitor and manage forecasted travel delays. Without improved coordination, mobility challenges and driver frustrations will worsen as traffic continues to increase.

**Coordinated Response to Major Emergencies**

The Texas Department of Public Safety’s (TxDPS) Texas Division of Emergency Management’s (TDEM) 24/7 Statewide Operations Center (SOC)—which is discussed in Section 2.4.5—serves as the central communications hub responsible for collecting and disseminating information on warnings of threats, monitoring emergency situations, and providing real-time information. TxDOT supports the SOC efforts by having certain response-ready scenarios in their playbook that can be deployed to assist with an emergency; for example, TxDOT has strategies outlined for switching interstates to contraflow to assist in widescale evacuations.9

Although the SOC coordinates with TxDOT for transportation-related issues, the absence of a wide-scale statewide traffic operations system for all of Texas limits the ability of a more prompt and coordinated response for traffic-related issues, as well as limits quicker identification of real-time transportation issues that the SOC should be aware of, such as disruptive incidents that are worthy of attention. For example, disruptive hurricanes in one region of the state, such as Houston, will shift freight traffic to another region of the state, like I-35, which creates significant truck congestion that would be managed by each regional TMC instead of through a statewide coordinated approach. Depending on the selected deployment, statewide traffic operations functions could temporarily or permanently reside within the SOC. Without improved coordination, the ability to integrate TxDOT real-time large-scale emergency situation traffic data into SOC operations will remain limited.

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9 Source: Texas Department of Transportation, Hurricane Information.
Prioritizing Freight Movements
TxDOT’s responsibility is to provide a quality transportation system that serves all road users. Since some needs are in competition with one another, the transportation system is oriented in a manner that aims to serve the greater good; for example, pedestrians are given the right of way at crosswalks in an effort to improve safety, despite the mobility impacts to motor vehicles that have to stop. Certain ITS programs, such as Transit Signal Priority (TSP) or Freight Signal Priority (FSP), modify roadway operations in real-time to serve a specific type of vehicle, given an understanding that the specific vehicle yields a larger greater good if given priority service, such as better person-throughput, reduced hard braking events, and others.

As freight-based ITS applications are deployed across Texas, many of the local applications would be run from or managed by the local TMC. These applications may eventually spread across the entire state, creating a need for large-scale management of operations as freight moves from one region to another. A wide-scale statewide traffic operations system would help facilitate the deployment and operation of these assets, and provide opportunities to explore statewide freight management strategies; for example, if this traffic operations center was monitoring substantial freight movement from Austin to El Paso, or from Gulf ports to international land ports of entry, it could coordinate with any interconnected traffic signal systems to prioritize movements that support freight operations. Without improved connectivity of freight-based ITS applications, operations would be more localized, limiting the effective use of statewide freight operations in real-time.

2.3.1.2 Asset Preservation and Utilization

TMC Coverage
TxDOT’s seven TMCs are located in the major metropolitan areas to provide coverage where recurrent and non-recurrent congestion commonly occur. Additionally, these TMCs have access to remote ITS devices in adjacent Districts that can be used to assist with regional incidents. Exhibit 31 illustrates the approximate coverage areas of each of the TMCs’ ITS programs, based on information gathered through LoneStar as part of the FNTOP. It is likely that each TMC may have additional coverage areas as part of its operations (e.g. through Waze crowd-sourced incident services or third-party traffic data providers), but the focus of this subsection is on the real-world ITS deployments that TxDOT uses to manage and operate the transportation system. Coverage is based on the availability of real-time applications (i.e. CCTV cameras, DMS, vehicle detectors); those ITS assets that are not used for real-time data are excluded (i.e. WIM, permanent count stations) from this discussion.
Exhibit 31: TxDOT Traffic Management Centers – ITS Coverage (approximate)

TxDOT Traffic Management Centers - ITS Coverage

Source: TxDOT Traffic Safety Division

Prepared by Cambridge Systematics. Data for planning purposes only.
October 30, 2020

Source: TxDOT Traffic Safety Division
Although these coverage areas are approximate, they clearly illustrate that coverage gaps do exist in Texas. Exhibit 32 quantifies the estimated gap by looking at miles for the THFN, the CRFCs (denoted in the 2018 TFMP), and Texas roadways in general.

**Exhibit 32: Distribution of TMC Coverage**

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Total in Texas</th>
<th>Not Covered by Existing TMC(^{10})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Texas Highway Freight Network Miles</td>
<td>21,861 miles</td>
<td>15,579 miles (71%)</td>
</tr>
<tr>
<td>Critical Rural Freight Corridors Miles</td>
<td>745 miles</td>
<td>622 miles (84%)</td>
</tr>
<tr>
<td>Total Texas Roadway Miles</td>
<td>313,000 miles</td>
<td>237,000 miles (76%)</td>
</tr>
</tbody>
</table>

Based on these estimated coverage gaps, 71 percent of the THFN is not currently covered by a TxDOT TMC’s ITS program, and 84 percent of the CRFCs are not covered. These coverage gaps are not in insignificant areas either; a major lack of coverage exists between El Paso, Laredo, and the Rio Grande Valley, which account for a significant number of truck crossings each year. Truckers outside of TMC coverage areas are less likely to have assistance from TxDOT when a disruption occurs, such as receiving advanced notification, utilizing operational improvement strategies (e.g. prioritized green lights on alternate routes), or witnessing a rapid incident response like seen in the major metropolitan areas. These truckers may benefit from third-party traffic data services, routing applications, or crowd-sourced incident information to deal with the disruption, but the benefits of coordinated response and strategic traffic operations improvements from TxDOT are far less likely to occur where these gaps exist.

Implementing a wide-scale statewide traffic operations system would allow TxDOT to more quickly utilize public resources to identify incidents and traffic hotspots in these areas, as well as strategically coordinate with local law enforcement and deploy countermeasures to help mitigate impacts to travel and freight movement. For example, a wide-scale operation could utilize DMS assets to notify of an incident in an adjacent District, if the incident warranted a larger response; this would mitigate challenges associated with jurisdictional boundaries, with regional TMCs focusing only on parts of the network that they can manage. Without improvements, motorists would continue to respond to travel disruptions on their own, increasing a reliance on third-party applications to assist them. Additionally, regional TMCs that may be notified of a disruption slightly beyond their boundaries—such as through

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\(^{10}\) A section of road was viewed as not covered if it was not within 5 miles of an ITS device, which is an approximate influence range for most of the TxDOT real-time ITS devices (e.g. CCTV cameras, DMS, vehicle detectors, etc.)
a crowd-sourced application—may have limited options to assist, due to lack of established communications protocols and lack of knowledge of available ITS assets.

**Availability of ITS Applications**

Having ITS assets along a transportation network generally helps facilitate a situational understanding for operators at a regional TMC. As part of developing operational strategies for a region, transportation system managers look at the availability of the ITS program to assist. This can often help identify and justify new ITS deployments that would enhance traffic management capabilities. Operators who use the ITS program generally have a better understanding of where traffic issues exist, what is the cause-and-effect of deploying certain countermeasures, and what response strategies are most efficient for resolving issues.

As mentioned earlier, ITS planning efforts have followed traditional transportation planning efforts, which prioritize the investment of a limited budget to projects that yield high benefits at reasonable costs (i.e. applications with high benefit-cost ratios get priority for deployment). Most ITS investments have been deployed in urban areas where these high benefit-cost ratios exist. The development of regional TMCs has supported these investments. As additional programmatic and grant funding became available to deploy more ITS assets, managers of the regional TMCs had much success in justifying further deployment in these urban regions to improve response capabilities; much of the supporting infrastructure was present and additional investments would continue to generate good benefit-cost ratios, relative to a brand new system in an isolated rural area with no supporting infrastructure. Systematically, this has led to a mature ITS program in metropolitan areas, supported by regional TMCs. These investments have also led to an innate feedback cycle where continued investment naturally gravitates to areas already supported by a regional TMC due to the lower costs associated with existing supporting infrastructure, even if the benefits are lower than an alternative deployment.

Exhibit 33 graphically illustrates the concept of this feedback cycle.
For example, a CCTV camera may yield a greater benefit at “Site A” where no other cameras are deployed than “Site B” where many cameras are deployed, but it has better benefit-cost ratio at “Site B” because existing infrastructure (e.g. fiber optic cables for communication networks, power distribution points, existing TMC operators to manage the camera, existing maintenance program in the area) substantially reduces the initial capital cost. Without rural operational plans or rural ITS assets with initially high benefit-cost ratios to support potential operational plans, rural areas themselves generally do not have extensive ITS programs.

When looking at the distribution of ITS assets in Exhibit 31 that are managed in real-time by a TMC (including CCTV cameras, DMS, or vehicle detectors used as part of the real-time traffic management program), it can be seen that the bulk of the ITS assets reside near the TMC that manages them, which generally falls within the urban counties. While some devices are managed by the TMCs outside of the urban areas, these number of devices is significantly less. Similarly, as shown in Exhibit 12, a substantial number of THFN miles are present beyond these urban areas. An estimated 24 percent of the urban THFN is within one mile of an ITS device (CCTV camera, DMS, or vehicle detector used as part of the real-time traffic management program), whereas only an estimated two percent of the rural THFN is within one mile of a similar ITS device. Similarly, even on designated CRFCs, only seven percent of the mileage on these facilities are within one mile of an ITS device.
Clearly, rural parts of Texas outside of metropolitan areas are far less likely to be part of an ITS program that offers real-time traffic management capabilities. Even though the CRFCs from the 2018 TFMP have a higher likelihood of already being part of an ITS program than their other rural THFN counterparts, they still fall far short of the ITS coverage afforded to the urban portions of the THFN. A wide-scale statewide traffic operations system would not suddenly address that gap on “Day 1”; rather, such a program would help institutionalize the value of larger-scale traffic operations strategies. By having operations staff focused on the day-to-day statewide traffic operations, the needs and challenges with that effort would be part of the investment conversation, allowing prioritization of projects in areas that did not previously meet the benefit-cost requirements at a regional level. While the lack of a statewide traffic operations system would not preclude ITS investment in rural areas, the likelihood is much less given that the focus of current TMCs is primarily on the needs of an urban area.

Redundancy of TMC Systems

TxDOT’s TMCs operate as centralized operations at each of their seven locations, operating and managing ITS assets in their respective Districts and any adjacent Districts without a TMC that make up part of their urban area. LoneStar is operated at each TMC, but through separate server installations with minor module differences and an inability to connect to ITS assets in other TMCs. In other words, each TMC manages its own services. Centralized operations have several benefits including:

- generally lower capital and operational costs;
- greater data security; less backup complexity;
- co-location of all TMC equipment (e.g. LoneStar servers, network switches) to one site;
- minimized risk areas due to being on one network (e.g. one local network is easier from an IT standpoint to secure from outside malicious intrusions); and
- customization options that allow each TMC to make region-specific adjustments to support their day-to-day operations.

That said, there are many disadvantages with this approach, namely a risk of single-point failure that could disable the ITS program if the TMC experiences an outage, such as a physical catastrophe or a malicious network intrusion (e.g. ransomware). Additionally, a centralized operation for each region—while advantageous by allowing the local TMCs to determine their operation—challenges and limits the ability to manage large-scale traffic events. For example, if a TMC needs to broadcast a message on a DMS in another TMC’s jurisdiction, the two TMCs would need to verbally collaborate over the phone to post the message, which can take time away that is better spent on managing the incident itself.
TxDOT has identified a desire to unify the LoneStar ATMS platform as a single cloud-based platform to improve interoperability between TMCs and offer a more decentralized operation between Districts. Although certain local rules would govern operation (e.g. camera control may remain with the local TMC only), this would facilitate opportunities to streamline the center-to-center communications and operations. The Pennsylvania Department of Transportation—with a statewide TMC that assists regional TMCs—instituted an operational model similar to this that proved useful during the COVID-19 outbreak during 2020. In that particular instance, when a few TMCs in major metropolitan areas were shut down due to localized mandated lockdowns, the statewide TMC was able to receive all permissions to operate the local ITS program remotely from a part of the state that was not locked down.11

2.3.1.3 Safety
Both nationally and in Texas, rural fatalities due to traffic crashes meet or exceed the urban fatalities due to traffic crashes,12 despite rural areas representing less than 20 percent of the U.S. population.13 Disruptive crashes that create stopped traffic and delays increase the risk of secondary crashes at backs of queues or as a result of traffic diverting onto unfamiliar alternative routes. While most primary crashes can be managed quickly by local law enforcement, larger disruptions benefit from more strategic responses to route traffic around the disruption.

Managing the congestion that creates risk of secondary crashes requires coordination. A wide-scale statewide traffic operations system would help apply a uniform response plan and distribute critical messages consistently and widely, assisting local law enforcement. With no investment, regional TMCs would continue to be the lead for their area, law enforcement would continue to respond to incidents, and road users in rural areas would operate on less safe roadways.

2.4 Profiles of User Classes
The following contains a profile for users and stakeholders that would be involved with statewide traffic operations.

2.4.1 TxDOT Divisions
The TxDOT Division offices handle a wide range of services for the agency. For various TxDOT initiatives, these Divisions coordinate internally to serve as stakeholders and—depending on the topic—lead the initiative. These Divisions also may advocate for creation of new Divisions

11 Source: Pennsylvania Department of Transportation; Safety, Management Operations Successfully Transition To New Reality.


13 Source: US Department of Transportation, ITS JPO, ITS Benefits for Rural Communities.
for certain initiatives, usually for initiatives that require an expansion of the TxDOT organizational chart. Further details on the specific Divisions that are involved in freight, technology, and traffic initiatives can be found in the FNTO State of the Practice Assessment Report and FNTO Inventory of Existing Conditions Report.

Several Divisions would be relevant to this strategy. Given that many ITS assets and traffic management systems are involved, the Traffic Safety Division would likely be a key stakeholder in project planning, program development, and initial funding of a statewide traffic operations program. Given its efforts with establishing statewide ITS requirements, it would be the most informed in establishing a statewide traffic operations program. Since this statewide program would not be tied to one TxDOT District, the Traffic Safety Division would be instrumental in identifying the need, establishing how this program could fit into the TxDOT organizational chart, and pursuing a funding mechanism to support its operation. Since the Traffic Safety Division also has a goal of migrating the existing LoneStar ATMS platform to a cloud-based platform, it would also be a key stakeholder in identifying requirements, setting standards, and ensuring interoperability between user groups.

Other Divisions would include the Transportation Planning and Programming Division (TPP), given their interest in pursuing freight transportation improvements and their leadership of the FNTO. The Travel Information Division may be directly involved if DriveTexas is modified. Additionally, the Information Technology Division would likely have a role in fitting this strategy into the network architecture. Other Divisions would collaborate as well if the strategy overlaps with their efforts.

2.4.2 TxDOT Districts
TxDOT operates 25 Districts to manage the state-owned highway system across all geographical areas of Texas. Districts are further subdivided into area engineer offices and maintenance offices to cover specific sections of the District. Through this structure, TxDOT District offices offer local access to citizens who want to participate in the transportation development process. Public Information Offices serve as points of contact for citizens, news media, and various other entities. Districts with TMCs and ITS programs may follow directions issued from Central Office, such as for certain public safety or high-level evacuation information, but each District is responsible for managing its own ITS assets, such as CCTV cameras, DMSs, detectors, and traveler information dissemination systems. Additionally, Districts are responsible for road construction projects and the reporting of all road work information in HCRS.

TxDOT Districts would be a key stakeholder in a statewide traffic operations program. Districts with TMCs may be interested in establishing protocols that allow the Districts to maintain their management strategies, but have avenues for assistance when needed. Districts without TMCs may be interested in making sure any statewide traffic operations programs work well with their local District program and needs. Since all Districts have a
responsibility to report lane closures for construction projects, their input into how a collaborative system to reduce closures on the same highway in an adjacent District would be valuable to ensure they are able to carry out their duties. Additionally, some Districts—predominantly rural Districts that are outside of existing TMC coverage areas—would be interested in exploring how a statewide traffic operations program could make use of existing District ITS assets or necessitate additional ITS assets, as these Districts may previously have had limited options for running their ITS program in real-time if not supported by a regional TMC.

2.4.3 TxDOT TMCs
The core business of the seven District TMCs is managing traffic and incidents in their jurisdictions, and collaborating with other TMCs or external agencies to resolve issues that extend beyond their jurisdictions. TMCs manage the ITS program in real-time. This includes: operating traffic sensors, DMS, and CCTV cameras; managing freeway service patrols; monitoring activities of law enforcement; and collaborating with District engineers regarding infrastructure-related issues. TMCs work in their respective TxDOT District, but also may have management and control over certain ITS devices that are beyond their District boundaries.

A wide-scale traffic operation focused on statewide issues would require collaboration with regional TxDOT TMCs. As such, TxDOT TMCs would be key stakeholders in determining how a statewide initiative could work with their regional programs, how responsibilities could be clearly defined, and how this could assist with their efforts. Regional TMCs could benefit during times of extreme workload—when additional on-demand staff could be able to assist—or during larger-scale incidents that extend beyond regional jurisdictions.

2.4.4 Texas Department of Public Safety
TxDPS is responsible for statewide law enforcement and vehicle regulation. The goals of the TxDPS include enhancing highway and public safety, as well as statewide emergency management in Texas. Enforcement and inspections are conducted along the roadside or at designated enforcement location sites operated by the TxDPS.

TxDPS would be a key stakeholder by identifying ways for a statewide traffic operations program to assist their law enforcement efforts, similar to how regional TMCs collaborate with local and state police. Since many ITS programs in other states place law enforcement liaisons directly in TMCs, TxDPS may be interested in exploring opportunities to do the same as part of the STOC.

2.4.5 Texas Division of Emergency Management
TDEM, an operating division of the TxDPS, is the entity that manages hazardous events and large-scale emergency situations, collaborates with various jurisdictions, and explores ways to be more resilient to future natural or man-made disasters. TDEM operates the 24/7 SOC
in Austin, which serves as the state’s central point to communicate warnings of threats, monitor emergency situations, and provide real-time information. In a typical year, the SOC Daily Operations coordinates 3,000 to 4,000 incidents across Texas.\textsuperscript{14}

TDEM would be a key stakeholder in determining the roles for and/or integration of real-time statewide traffic operations, as many of those roles would influence the capabilities and operation of the SOC. TDEM’s interest would likely focus on how the statewide traffic operations center could assist the SOC during emergencies without duplicating efforts. It is very likely that these two centers would work in tandem during routine and non-routine operations, with the SOC requesting information and assistance from a statewide traffic operations group, such as strategic deployment of messaging on rural DMS near a major incident.

\textbf{2.4.6 Truckers}

Truckers are the end-user of the THFN. While traveling in regions managed or operated by a TMC, truckers benefit from the real-time traffic and incident management programs. These congestion mitigation and incident response programs help manage travel time reliability, reduce the risk of secondary crashes, and mitigate wasted fuel due to idling in stopped traffic, which all contribute greatly to the efficient operation of the THFN.

Expanding a traffic operations program to be statewide would extend those benefits to parts of the THFN that are currently not monitored, providing truckers with advanced notification of issues and identification of eligible alternative routes. This would include benefits gained by sharing information between the regional parts of Texas through which truckers may travel as part of their route. The program would help improve roadway safety by identifying incidents and poor traffic conditions, helping reduce secondary incidents and re-routing traffic when possible. During larger emergencies, a statewide traffic operations program could be instrumental in guiding truckers to a designated alternative route, based on feedback and insight from TDEM’s SOC to ensure consistent widespread messaging is going out across Texas. If freight signal priority corridors and a Freight Advanced Traveler Information Systems (FRATIS) application are pursued in the future, a statewide traffic operations program could help ensure that these systems get the best real-time and forecasted travel demands to assist their algorithms.

\textbf{2.4.7 Other Road Users}

Other road users experience many of the same challenges as truckers when traveling on parts of the Texas transportation system that are not managed or operated by a TMC. Although network disruptions due to crashes are more prevalent in urban areas, network disruptions in rural areas can occur and be extremely detrimental to mobility and safety.

\textsuperscript{14} Source: Texas Division of Emergency Management, Statewide Operations Center.
Other road users would be end-users of the statewide traffic operations program and would see similar benefits as experienced by truckers. These users would include, but not be limited to, cars, buses, light commercial vehicles, and motorcycles. Additionally, trucking company dispatchers would also benefit, as they would be able to offer assistance to their trucker groups with this supplemental information.

2.5 User Needs

As part of the FNTOP, the User Needs Assessment developed a comprehensive list of User Needs identified through a gap assessment and ongoing stakeholder engagement. The specific needs and gaps addressed by the STOC strategy are summarized in Exhibit 34. The assessment prioritized these needs based on relevance, plausibility, and alignment with the TFMP goals and objectives. The FNTOP User Needs were divided among seven high-level freight technology areas that were previously established in the FNTOP State of the Practice Assessment Report:

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

The naming convention for the user need ID includes the letter code listed above identifying the freight technology area for which it belongs to. For example, in Exhibit 34, UN-T1 represents the first user need for (T)raffic Management freight technology area. Each User Need is associated with one or more goals from the TFMP and is prioritized as follows:

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

More information about the FNTOP User Needs and how this strategy can address them is available in the FNTOP User Needs Assessment Report, as well as FNTOP Strategies and Conceptual Framework Report.
## Exhibit 34: Affiliated User Needs for Statewide Traffic Operations Center

<table>
<thead>
<tr>
<th>ID</th>
<th>Preliminary User Needs</th>
<th>Texas Freight Mobility Plan 2018 Goals</th>
<th>Priority</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Traffic Management Freight Technology Area</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UN-T1</td>
<td>Need for a Statewide Traffic Management Center (TMC) or Traffic Operations Center (TOC) to provide more efficient traffic operations.</td>
<td>Safety, Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>Stakeholder Interviews, State of the Practice, Inventory of Existing Conditions</td>
</tr>
<tr>
<td>UN-T7</td>
<td>Need for rural ITS in high-traffic freight areas to help support operations.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Inventory of Existing Conditions, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-T10</td>
<td>Need for more TxDOT-operated Traffic Management Centers throughout the State to improve operations.</td>
<td>Safety, Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>Inventory of Existing Conditions, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-T12</td>
<td>Need for a statewide integrated Incident Management System to improve traffic operations.</td>
<td>Safety, Mobility and Reliability,</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-T14</td>
<td>Need for technology to help support emergency evacuation.</td>
<td>Safety, Mobility and Reliability</td>
<td>Low</td>
<td>State of the Practice, Stakeholder Interviews</td>
</tr>
<tr>
<td></td>
<td><strong>Advanced Traveler Information Systems Freight Technology Area</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UN-A4</td>
<td>Need for more advanced notice of real-time traffic conditions (delays, incidents, construction, weather conditions) to improve routing decisions.</td>
<td>Safety, Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>State of the Practice, Stakeholder Interviews</td>
</tr>
<tr>
<td>ID</td>
<td>Preliminary User Needs</td>
<td>Texas Freight Mobility Plan 2018 Goals</td>
<td>Priority</td>
<td>Source</td>
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</tr>
<tr>
<td>UN-A6</td>
<td>Need for high-resolution delay and traffic information to help with freight operations and planning.</td>
<td>Economic Competitiveness, Mobility and Reliability, Multimodal Connectivity</td>
<td>High</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A7</td>
<td>Need for more accurate data on real-time freight traffic volumes, speed and congestion to improve freight planning.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A8</td>
<td>Need for advanced notice of available hazardous materials routes to provide routing options to truckers.</td>
<td>Safety, Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A14</td>
<td>Need for more advanced notice of special events disrupting freight routes for more efficient operations.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A16</td>
<td>Need to develop message prioritization and distribute it to certain geo-fenced areas to provide location-specific alerts.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>State of the Practice, Stakeholder Interviews</td>
</tr>
</tbody>
</table>

Data Integration and Analytics Freight Technology Area

| UN-DI8 | Need for more ITS in rural areas of Texas that lack connectivity and communication to provide better traffic management.                                                                                      | Safety, Asset Preservation and Utilization, Mobility and Reliability                                  | Low      | Inventory of Existing Conditions, Stakeholder Interviews |


2.6 Assumptions and Challenges
Several key assumptions and challenges would apply to a STOC in Texas. These assumptions and challenges are identified in the following sections.

2.6.1 Assumptions

- **Ongoing collaboration is a requirement** – For the STOC to succeed, it needs to work in partnership with—not in competition with—local and regional traffic operations groups. Early stakeholder coordination to establish standard operating procedures is a great first step, but it is assumed that recurrent, ongoing discussions and collaboration between groups would need to occur to share lessons learned, discuss discrepancies and issues, and explore opportunities to better serve the end-users of the Texas road network. Collaboration opportunities could include quarterly working groups and annual operational scenario workshops between key leadership groups.

- **Regional TMCs retain their full operational and management control of their local ITS and traffic operations programs** – Some states have established statewide TMCs to maintain widespread oversight of statewide traffic operations. Based on feedback from stakeholders, the Texas preference would be for regional TMCs to maintain their existing programs and inter-agency relationships, with the role of the STOC being to assist these regional TMCs as a supplementary service. Many details would need to be worked out between the STOC and the regional TMCs regarding standard operating procedures—such as when the STOC can get involved, what permissions over local devices it may have, and what chain-of-approvals need to come from the regional TMC to get the STOC engaged—but ultimately the regional TMCs would continue normal operations.

- **Portions of the THFN that currently lack TMC coverage may either be operated by the STOC or a regional TMC** – As noted earlier, 71 percent of the THFN is not currently within the coverage area of a TMC. The STOC would likely assume responsibility for traffic operations on these unmanaged sections, building relationships with local law enforcement and public safety stakeholders to identify opportunities to improve system operations. In some cases, as new ITS device investments occur, it may make
more sense for some of these currently unmanaged portions of the THFN to be transferred to a nearby regional TMC. Cases could include major changes in land use and traffic patterns, enhanced capabilities at that regional TMC, or some other type of relationship that benefits from regional collaboration as opposed to statewide. Continued collaboration between the STOC and regional TMCs is an expected requirement to ensure that the THFN is receiving the best combination of operational strategies that TxDOT can offer its end-users.

- **STOC would be deployed either as a physical facility or as a virtual traffic center** – Later in this document, the concept for the proposed system outlines several options for STOC operation, namely deployment as a physical facility (either a standalone STOC or one that is joined with the operations of a regional TMC) or as a virtual service. This would cover nearly all options available for a statewide traffic operations program.

- **ATMS platform has the capability of migrating to a unified operation** – The existing LoneStar ATMS is used at all TxDOT TMCs as separate server installations. As such, different versions of the same software are present, based on the equipment present in the respective TxDOT District. It is assumed that the LoneStar ATMS—or any future ATMS platform—has the capabilities to migrate to a unified structure, such as the cloud-based system that TxDOT is currently exploring. In other words, it contains no inherent issues that prevent migration to a unified statewide platform. Having a unified ATMS would allow the STOC and regional TMCs to work more closely in tandem with one another, and allow device permissions to be easily exchanged (e.g. regional TMC passes camera control over to STOC during a major emergency that benefits from STOC assistance).

- **Remote ITS devices can be integrated into a unified ATMS** – For each regional TMC, new vendor products often require specialized integration into the ATMS platform. Most ITS devices in a region should be integrated into the ATMS, although a few may not be (e.g. a legacy DMS with a vendor who is out of business). This may be more problematic in rural areas that are outside TMC coverage, as some devices may exist that were never integrated into the ATMS. It is assumed that the vast majority of TxDOT ITS devices outside of the current TMC coverage have the capability of being integrated into the LoneStar ATMS platform—or any future ATMS platform—and can be adopted successfully into a migration toward a unified platform.

### 2.6.2 Challenges

- **Competing goals between statewide and regional entities** – As noted earlier, the success of this program depends on the STOC and regional TMCs working in partnership with—not in competition with—each other. That said, some differences would inherently remain between the goals of a statewide traffic operations program and a regional traffic operations program. For example, a statewide traffic operations
program would want a DMS to be used to notify of a major roadway disruption with widespread network impacts (i.e. a hurricane evacuation, a bridge collapse, a major hazardous event), whereas a regional traffic operations program may want that same DMS to be used to notify of a separate, less severe local incident (i.e. an overturned truck, a multiple vehicle crash) that requires alternate route use. Similarly, the STOC may wish to prohibit sequential or parallel construction zones on a highway that travels through multiple or adjacent Districts, but each District may view that road construction as a critical need to support their local highway system. Many of these what-if scenarios could be worked out through the quarterly working groups and annual operational scenario workshops, but some scenarios would always remain as competition for resources between these groups.

- **Agreement regarding responsibilities between statewide and regional entities** – It is assumed that regional TMCs would have primary control of their respective jurisdictions, and would utilize the STOC as a supporting service when needed; similarly, the STOC would focus on traffic operations that are outside of regional TMC jurisdictions and may request assistance from those TMCs as needed. The exact procedures, devices assigned to each entity, and chain-of-command would be worked out through quarterly working groups and annual operational scenario workshops, but a successful working relationship is contingent on all parties working collaboratively. Failure to participate in working groups may cause overlapping issues or gaps in operation, which could result in groups assigning blame and breaking down the collaborative trust between these operations. To mitigate this challenge, an initial step should be establishing commitment for all stakeholders to be involved in these working groups (e.g. through memorandums of understandings).

- **Finding qualified staff to support statewide traffic operations** – With over 313,000 highway miles, Texas’s road network covers an expansive territory and a countless number of unique nuances and challenges when it comes to operating such a system. In a successful TMC, some of the most skilled operators are those who acquire an intimate working knowledge of their road network and the cause-and-effect impacts of employing mitigation strategies at a specific location (e.g. a warning message on a certain DMS helps mitigate backups downstream). That said, most of these staff are familiar with the network because the area of coverage is reasonable, typically only a small fraction of the mileage found on the statewide road network. Careful planning would be necessary for the STOC to determine the best balance of staff resources to support this large of a network, as well as identifying the training necessary to familiarize them with the rural parts of the network and utilize the ITS devices to maximize usefulness to passenger vehicles, freight, and other traffic.

- **Difficulties with upgrading the ATMS** – One goal is to unify the ATMS platform between the STOC and the regional TMCs to allow for effective collaboration and device sharing. Depending on the current state of the ATMS in each TMC, upgrading
to a unified system could be a costly and complicated pursuit if many unique variances exist. Additionally, differences in stakeholder opinions between the Districts and the Divisions may necessitate customization of certain features, which would add to the cost and detract from the goal of uniformity.

- **Challenges with integrating STOC features with other agencies** – Certain STOC capabilities may offer data sharing with regional TMCs or other agencies, including TDEM’s SOC. However, these other groups may have different architectures that cannot properly accommodate the data flow, requiring either funding to support integration or the agency deciding not to use the new data source.

- **Cost of TMC equipment needed to implement this strategy** – Costs to construct a brand new TMC facility can be extensive. Operator stations, video walls, control systems, server rooms, and other room design elements require a substantial upfront investment. Some project costs can be mitigated by reusing an existing operations space, such as a large conference room or auditorium in an existing facility, but a brand new building or addition to an existing building requires more extensive structural, electrical, and architectural elements. Exploring virtual options further reduces costs, but may come with some reduction in capabilities by not having staff physically present in the same space to collaborate in real-time. Furthermore, the O&M costs associated with employing full-time operations staff and maintaining the system need to be carefully budgeted and funded in order to sustain longevity.

- **Cost of ITS equipment needed to support this strategy** – Updating existing ITS equipment or construct brand new ITS equipment in remote areas to support rural STOC capabilities can be costly. Although right of way can be more readily available, providing remote power and communications service can be more costly than in urban areas, as well as necessitate less robust service (e.g. solar power instead of line power, cellular communications instead of fiber optic communications). Additionally, ITS equipment needs to be supported by processing equipment, which may be costly to scale if needed.
3.0 Concept for the Proposed Statewide Traffic Operations Center

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

3.1 Objectives

The STOC is intended to be a wide-scale statewide traffic operations center to help manage statewide and large scale traffic management efforts. It aims to support traffic operations surrounding incidents and events in rural areas of the THFN that are not currently supported by a regional TMC, coordinate statewide freight operational strategies and other statewide initiatives, support regional TMCs when requested, coordinate planned work zones between Districts, and help establish an interoperable ATMS platform and data-sharing protocols between remote ITS assets, the Districts, and the STOC.

Exhibit 35 provides an illustrative example of the Statewide Traffic Operations Center strategy that was previously discussed in the FNTOP Strategies and Conceptual Framework Report.
3.2 Description of ConOps Essential Features, Capabilities, and Functions

This section describes the proposed system and improvements, based on the components identified herein. The descriptions are provided at a high-level, indicating the operational features and functionalities without specifying design details or technology-specific solutions. The main features and functions of the STOC are summarized in Exhibit 36, with a demonstration of features that address specific user needs applicable to this strategy as shown in Exhibit 34.

Exhibit 36: Statewide Traffic Operations Center Features and Functions

<table>
<thead>
<tr>
<th>Features</th>
<th>Main Functions</th>
<th>User Need(s) Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated ATMS</td>
<td>The platform would allow shared control of TxDOT’s existing (and future) ITS devices, facilitate data sharing among all TxDOT Districts and the STOC, and encourage use of the same software applications across all TMCs.</td>
<td>UN-T10, UN-T12, UN-T14, UN-A4</td>
</tr>
</tbody>
</table>
### Features

<table>
<thead>
<tr>
<th>Rural Traffic Operations Capabilities</th>
<th>Main Functions</th>
<th>User Need(s) Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The STOC would provide operational coverage in areas not currently covered by regional TMCs, primarily the rural parts of Texas. The STOC could employ working relationships with local traffic manager groups in cities and counties to employ incident mitigation response plans when rural areas are disrupted by incidents.</td>
<td>UN-T1, UN-T7, UN-T10, UN-T12, UN-A7, UN-A8, UN-A14 UN-DI8</td>
</tr>
<tr>
<td>Consistent and Coordinated Statewide Messaging</td>
<td>The STOC would serve statewide goals by being a single point for statewide messaging campaigns, such as public safety notices like “#EndTheStreakTX”. Through collaborative systems, the STOC could deploy these messages to TxDOT assets across the system and work with regional TMCs to make sure consistent messages are shown.</td>
<td>UN-T1, UN-T10, UN-T12, UN-A16</td>
</tr>
<tr>
<td>Coordination on Sequential or Parallel Work Zone Deployments</td>
<td>The STOC would serve statewide goals of reviewing closure information between multiple TxDOT Districts on a given segment of roadway. The STOC would identify if there were sequential or parallel work zones planned across multiple TxDOT Districts and coordinate with District staff to explore mitigation options in an effort to improve customer service to road users.</td>
<td>UN-T1, UN-T10, UN-T12, UN-A4, UN-A8, UN-A14 UN-I6</td>
</tr>
<tr>
<td>Operate Statewide Traffic Operations Priorities</td>
<td>The STOC would deploy and operate statewide priorities for traffic operations. Hurricane evacuation efforts on primary and secondary routes would be coordinated from the STOC. Efforts to prioritize freight movements during certain demand periods would be coordinated from the STOC, such as requesting prioritized traffic signal timings on popular freight routes when the STOC detects high freight traffic volumes.</td>
<td>UN-T1, UN-T10, UN-T12, UN-T14, UN-A6, UN-A7, UN-DI18, UN-I6</td>
</tr>
</tbody>
</table>

Since the STOC relies on technological processes, the general framework for implementation follows the requirements of a well-established ITS program. At a high level, a successful ITS program requires 1.) a means to collect data, 2.) a means to process the data, and 3.) a means to distribute that data to targeted user groups. As long as this process is followed, the STOC will have the necessary building blocks to succeed.
Although the process is straightforward, the means and methods to implement these requirements can vary widely. Unlike other strategies, the STOC offers support primarily in the “Information Processing” step of the framework. The regional TMCs in Texas currently provide this step, but only in the urban areas where they have been predominantly located. As noted earlier, the existing operational/systems environment leaves 71 percent of the THFN without active TMC coverage. As such, road users in these areas are left with a road network with less oversight, which can result in more frequent delays and limited mitigation guidance when incidents occur. Additionally, the lack of a real-time processing step means that data collected by ITS devices deployed in rural areas are not used regularly, such as devices only being activated by the TxDOT District when a major network disruption has occurred for an extended period of time. Implementation of a STOC would widen TxDOT’s traffic operations capabilities and provide a more consistent service without limitations created by District boundaries.

The following sections examine several key strategies to consider as part of the STOC. The intent is not to define one strategy as the sole approach for all components, but rather outline the key characteristics so that a given strategy can be correctly applied to a situation. The following processes are discussed in the following sections:

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

### 3.2.1 Data Collection

Data collection methods for the STOC aim to:

1. Utilize existing ITS assets that are not currently utilized by a regional TMC;
2. Utilize new ITS assets that are incentivized for deployment with the availability of a STOC to manage them;
3. Subscribe to shared data from ITS assets that are managed by a regional TMC.

These ITS field assets—while deployed independent of the STOC—would produce data that is processed by the ATMS software modules and utilized by the STOC operators, regional TMC

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15 As discussed in this ConOps, implementation of the STOC will help incentivize deployment of rural ITS over the medium- to long-term as part of separate efforts. Rural ITS will serve as “Information Collection” or “Information Distribution” processes.
operators, or any of the information distribution devices. Various components to support some or all of these goals are discussed in the following sections. These components are conceptual in order to illustrate certain general ideas, but other options could feasibly serve the same role.

### 3.2.1.1 Existing ITS Devices

TxDOT has an extensive network of ITS field devices as part of its traffic management programs in all 25 Districts, described in greater detail earlier in Section 2.2.3. Most ITS deployments are located near major urban centers or along highly traveled routes to help manage incidents in congested areas. The existing ITS devices (e.g. CCTVs, radar, loops, etc.) are used for various traffic management applications, including, but not limited to, incident management, congestion management, traffic flow monitoring, over-height vehicle management, rail crossing management, etc. While many Districts manage their devices in real-time through a TMC, many rural Districts only use their devices when a major event has already occurred. Additionally, some statewide assets (e.g. WIM, permanent count stations) are only used for long-range planning applications, as opposed to real-time data collection.

### 3.2.1.2 New ITS Devices

The early ITS program focused on incident management in mostly urban areas due to the high benefit-cost ratios that prioritized their deployment near an existing regional TMC. With a STOC to support rural applications being funded and deployed, it is anticipated that rural ITS asset deployments would be incentivized in the future. The type of ITS devices to be deployed would depend on the functions performed at the center. These new field devices would be managed and operated by the new STOC, and would need to interact with the ATMS platform. Some examples may include CCTV cameras, vehicle detectors, DMS, Truck Parking Availability Systems, high-water detection systems, and other rural-specific assets.

### 3.2.2 Data Processing

Data processing methods for the STOC aim to aggregate traffic information:

1. Through automated processes that pass processed data to field devices, such as from the ATMS to a DMS; and

2. Through manual processes that require operator review and confirmation, such as an alert of a major incident.

The vast majority of the features and functionalities for the STOC reside in this step of the process. Various components to support some or all of these information elements are discussed in the following sections. These components are conceptual in order to illustrate certain general ideas, but other options could feasibly serve the same role.

### 3.2.2.1 ATMS Platform

The ATMS software—discussed earlier in Section 2.2.2—collects and processes raw traffic data through real-time automated processes, allowing either automated responses to be
issued to field devices or real-time notifications to be issued to operators for further human-initiated actions. Regardless of method, the ATMS distributes information, such as traffic conditions, planned events, incidents, and other messages relevant to road users to help them make informed travel decisions. The ATMS platform manages these processes and response efforts under a single software platform, increasing ease-of-use for TMC operators. If TxDOT decides to expand the number of ITS field devices, particularly to accommodate rural highway needs, the ATMS platform would need to scale and accommodate the additional devices and functionality.

3.2.2.2 TMC Operators

TMC operators serve a role in the data processing step of the ITS program. For some notifications and response mitigation plans, a human-initiated response is generally the state of the practice, as certain sensitive issues are viewed as best handled by human intuition. For example, an ATMS may have the capability to detect high winds through a remote weather station on the side of a highway and automatically post the warning message to the DMS, but it may still be beneficial for the operator to manually confirm that, in fact, the wind is blowing and it is not a device malfunction, which would hurt TxDOT's credibility for posting messages. Despite widespread advances in automated detection and response capabilities, human operators continue to serve a key role in ensuring that TxDOT is reporting accurate information.

3.2.3 Information Distribution

Information distribution methods for the STOC aim to:

1. Utilize existing ITS assets that are not currently integrated into a regional TMC;
2. Utilize new ITS assets that are incentivized for deployment with the availability of a STOC to manage them;
3. Share data from ITS assets with regional TMCs that subscribe to the data feed; and
4. Utilize statewide ATIS services (e.g. DriveTexas) that may also support data distribution to third-party traffic data service providers.

These components are conceptual in order to illustrate certain general ideas, but other options could feasibly serve the same role.

3.2.3.1 Existing ITS Devices

As noted earlier, TxDOT has an extensive network of ITS field devices as part of its traffic management programs in all 25 Districts, discussed in Section 2.2.3. Data distribution devices—which primarily includes DMSs—exist predominantly in urban areas; rural DMS do exist in certain areas to be used by local Districts on an as-needed basis.
3.2.3.2 New ITS Devices
Similar to new devices for data collection, new data distribution devices would likely be deployed in the future and supported by the STOC, which could include DMSs or Connected Vehicle (CV) applications. These devices would be located throughout the state to alert road users of possible delays, travel times, and other relevant information affecting their trip. Some of these new devices may score higher when prioritizing applications, as the upfront costs of the STOC would be covered separately.

3.2.3.3 ATIS
This component disseminates real-time information including traffic, transit, weather, and work zone events via the web and mobile applications. In the context of the STOC, the ATIS (i.e. DriveTexas, discussed earlier in Section 2.2.4) would issue the notification of road conditions, traffic incidents, and work zones using information provided by the STOC, which could include enhanced mitigation strategies or other real-time response information.

This service would share data with other TMCs, expanding upon the current situation that shares ITS data between the Districts. Depending on APIs that are adopted as part of DriveTexas, this could facilitate movement of data to third-party applications, such as mobile navigational applications or freight-related services. While the STOC would not likely produce the public-facing API, having additional data service in rural areas would increase the volume of data that could be made publicly available by TxDOT.

3.3 Conceptual High-Level System Architecture
Based on the components highlighted previously, this section discusses the vision for the STOC’s high-level system architecture. To guide the development of the system, Exhibit 37 presents the high-level concept for the STOC architecture. The diagram illustrates the high-level systems diagram alongside the anticipated data flows between components. For more details on the ATMS component, refer to Section 2.2.2.
Exhibit 37: Systems Diagram

*The ATMS can be configured to allow permission-based access and/or control of ITS devices to specific centers. Configuration as shown supports traffic management through a physical facility or through remote access (virtual option), as discussed in this ConOps.*
This recommended high-level architecture utilizes the communications networks to facilitate the movement of information from the field to server/cloud-based ATMS, and then back out to the field devices. The STOC is shown figuratively in this architecture as an adjacent user of the ATMS, where operators may observe or respond to information that comes from the ATMS. This architecture does not intend to prescribe the exact equipment that is to be utilized. In particular, the supporting ITS equipment can vary widely based on how TxDOT invests in its ITS program in the coming years. Ultimately the end goal is to have a system that has a high level of reliability and accuracy when pairing all of the components together.

3.4  Deployment, Coverage, and Platform Options

3.4.1  TMC Deployment Models

Different TMC deployment models are used throughout the country. Each model offers different operational capabilities and is appropriate for certain objectives, features, functions, operational and organizational structures, and the jurisdiction. Four common TMC models\(^{16}\) include:

- Centralized;
- Decentralized;
- Virtual; and
- Hybrid.

Each of the four models is discussed in the following subsections.

Centralized TMC Model

In this model, all TMC systems and supporting ITS services are centralized into one location/datacenter, typically contained within the TMC. This includes domain authentication services, email, applications, shared files, and field devices. Usually, the center is located within an agency’s facility and staffed in-house, but the operations may also be outsourced. Most of TxDOT’s regional TMCs currently align with this model.

In a centralized deployment, the STOC’s goal is to function on its own and not share functions with any other TMCs. The operational focus would be strictly within its approved jurisdiction. If regional TMCs continued on a centralized model, they would focus only on their own local issues. The entire state of Texas would have traffic operations coverage, but it would be dependent on individual geographic territories to access the data.

Decentralized TMC Model
In this model, TMC systems and supporting ITS services are located in multiple locations and are shared between TMCs through communications networks. While each TMC retains some degree of a centralized model by operating its own server systems and local area network over ITS devices that are within its jurisdiction, having connectivity to other TMC server systems would expand the coverage capabilities. Each TMC may still host its own email server, manage applications, control its internet access, and host its own shared files. Many states utilize a decentralized TMC deployment.

In a decentralized deployment, the goal is to share functions (e.g. coverage outside operational hours for another TMC, disaster recovery) among District TMCs and the STOC. Operational focus would remain local to the TMC’s jurisdiction, but opportunities to share devices between TMCs would be possible. A primary advantage is that there is no single point of failure for the whole ITS program, as each location has the infrastructure to operate on its own as a centralized model if connectivity was not available. It would allow TxDOT to maximize its resources, increase efficiency, and reduce operational costs, although it would also require more unified systems in all TMCs.

Virtual TMC Model
In this model, TMC systems and supporting ITS services are hosted at any location (or in the cloud), but no physical traffic operations center is used to manage the transportation system. Access to the system is provided remotely, typically via a virtual private network (VPN) connection. The ITS architecture would be virtually the same otherwise.

In a virtual deployment, the goal is to manage the transportation system without the need for a large physical facility. It is most often used by transportation agencies with part-time needs, such as counties that only manage their road network when an issue is reported or a special event is ongoing. Use of the traffic operations program is more on-demand. Operators do not necessarily need to work full-time.

Hybrid TMC Model
This model is a combination of two or more models. For example, a transportation agency may perform certain functions using a centralized/decentralized TMC, but conduct other functions through a virtual TMC. This model may be used by a single large agency with multiple service requirements, where one part of the agency requires a full-time TMC to manage traffic operations while another part of the agency needs virtual access to certain devices on an intermittent basis.

3.4.2 Geographical Coverage
Generally, TMCs manage a certain geographic area based on their capabilities. The range and scope of its geographic area is dependent on the regional transportation needs, its host agency’s environment (institutional, political, and economic), and the scale/scope of its traffic operations program (i.e. location of devices, number of staffed operators at a TMC,
etc.). Certain geographic models are used by most TMCs. Four common geographic TMC models\(^\text{17}\) include:

- Single Jurisdiction;
- Multiple Jurisdiction;
- District/Regional; and
- Statewide.

Each of the four models is discussed in the following subsections.

**Single Jurisdiction**
Single-jurisdiction TMCs represent centers that operate within a limited political boundary, most often a single city or a rural county. These TMCs focus exclusively on the needs within their boundaries, such as traffic management applications to sequence green lights on key corridors or parking management solutions that guide motorists to parking lots where there is availability. For any neighboring communities with TMCs, these single-jurisdiction TMCs may coordinate certain events via telephone, email, or dedicated communications lines and networks. This type generally does not require extensive funding, project management, staffing, or maintenance agreements with other municipalities or agencies, but they also tend to only solve localized transportation issues as opposed to collective regional issues due to limited scope.

For reference, none of TxDOT’s regional TMCs qualify as single-jurisdiction TMCs, as their coverage areas extend beyond one single political subdivision. Some of Texas’s cities have local TMCs that may qualify in this category.

**Multiple Jurisdiction**
The multi-jurisdictional TMC represents centers that operate across several political boundaries, such as several sequential cities or a city/county combination. Similar to the single-jurisdiction TMCs, these multi-jurisdiction TMCs focus exclusively on the needs within their combined boundaries, such as traffic management applications to sequence green lights on key corridors or parking management solutions that guide motorists to parking lots where there is availability. The key difference is that the TMC collaborates across all jurisdictions in real-time. This type generally offers many benefits to the taxpayer through a coordinated traffic system, but requires more stakeholder collaboration and mechanisms to overcome competing needs.

For reference, none of TxDOT’s regional TMCs qualify as multiple-jurisdiction TMCs, as their coverage areas extend beyond a group of cities and counties. Similar to the single-jurisdiction TMC, some of Texas’ cities have local TMCs that may qualify in this category.

**District/Regional**
The District/Regional TMC is very similar to the multiple-jurisdiction TMC, but it encompasses additional non-metropolitan areas—such as rural county or state facilities outside the metropolitan area. District/Regional TMCs may have operational responsibilities beyond urban traffic management, such as suburban corridors and rural highway facilities. Geographic areas of this type tend to align with District boundaries or metropolitan planning areas. This type comes with efficiencies in cost by having one TMC cover a large geographic area and combine capital, staffing, and operations expenses, but requires more stakeholder collaboration and mechanisms to overcome competing needs than the multi-jurisdiction TMC type.

All TxDOT regional TMCs qualify as this type, as their coverage areas extend across their respective District boundaries and beyond.

**Statewide**
A Statewide TMC expands the District/Regional TMC type to cover the entire geographic area of the state. Statewide TMCs adopt many different roles depending on the culture of the sponsoring agency; roles could include managing rural ITS assets, standardizing statewide initiatives, and supporting regional TMC partners. This type comes with many efficiencies in cost by consolidating responsibilities—which may include state police and other traffic management groups—into one facility, but requires extensive network communications to support a large number of remote assets and many interagency agreements to demarcate jurisdictional responsibilities, both internal and external to the agency.

The proposed STOC concept would align with this type.

**3.4.3 ATMS Platform**
TxDOT operates and maintains its ITS program through various versions of the LoneStar ATMS platform. Houston TranStar also utilizes the RIMS ATMS platform, but LoneStar still plays a role in controlling the Houston ITS program. Additionally, several rural Districts manage and operate ITS assets within their boundaries for special events and emergencies, even though they do not have a TMC facility. With multiple LoneStar versions, RIMS, and vendor-specific software packages, TMCs are unable to currently see and manage each other’s assets. This limits capabilities in the future to share assets and provide any on-demand support.

In order for a statewide traffic operations program to evolve, it would be advantageous to unify the ATMS platform to a single entity. A unified platform would integrate and interface
with multiple systems and applications from any point in the TxDOT traffic operations program, either at a regional TMC or at the proposed STOC. An operator would have access to:

- Other Districts’ devices and data (e.g. DMS, vehicle detector stations) – limited by use permissions established through stakeholder collaboration between TMCs;
- Regional partners’ systems (e.g. computer-aided dispatch) – full viewing capability of relevant transportation-related information at any location statewide;
- Rural areas systems (e.g. asset management, FEMA’s Web Emergency Operations Center\(^{18}\)) – full viewing capability of relevant transportation-related information at any location statewide; and
- Rural ITS field devices (e.g. CCTVs, DMS) – limited by use permissions established through stakeholder collaboration between TMCs and rural Districts.

The key element to note is that information would be related to the transportation system and that user permissions would dictate access and functionality, such as whether a remote party has viewing capabilities or device control permissions. Benefits of these capabilities would include: permitting quick turnover of responsibilities should the need arise, increasing awareness of other statewide issues, and reducing cost challenges by having only one version of the ATMS in operation (as opposed to multiple versions that cause incompatibility issues).

### 3.4.4 Alternative Conceptual Architectures

Based on the available models, this section presents several alternative concepts that could be implemented as part of the STOC strategy architecture that was defined in Section 3.3. These deployment alternatives would fit the objectives, features, and operational framework envisioned for the STOC:

1. Standalone STOC;
2. Existing TMC with expanded STOC services; and
3. Virtual STOC.

#### 3.4.4.1 Alternative Architecture 1 – Standalone STOC

This alternative architecture would establish a dedicated facility to conduct statewide traffic management operations. The STOC would likely be housed in its own new facility or within an existing TxDOT facility. TxDOT staff would operate the facility, but it may be assisted by staff from other state agencies, such as the Texas Highway Patrol. Its primary focus would

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be to monitor and manage rural areas not covered by regional TMCs. Some of the most common functions could include: incident management, congestion management, special event management, traffic flow monitoring, emergency management, coordination with service patrols that might be operating in rural areas, traveler information dissemination, and support for advanced technology capabilities that are developed as part of other TxDOT statewide initiatives.

The STOC would operate the ITS field devices using an ATMS platform. The ATMS itself could be rolled out to support either a centralized or decentralized operation, depending on how TxDOT elects to operate its TMCs. A centralized operation would have the STOC operate only the rural areas (i.e. areas not covered by regional TMCs) via the ATMS, whereas a decentralized operation would allow the STOC to potentially utilize another TMC’s ITS assets or allow the STOC to assist that regional TMC with its operations. From an operations standpoint, the decentralized model would be far more advantageous to TxDOT, although it would require bringing all TMCs onto the same ATMS platform and providing interconnections between their services.

Exhibit 38 and Exhibit 39 illustrate the high-level diagram of a centralized and decentralized model, respectively, for this alternative.
Exhibit 38: Alternative Architecture 1 – Standalone Traffic Operation Center (Centralized Model)

Standalone STOC

Other Agencies

Centralized / ATMS Software

Field Comm

ITS Field Devices

Operator Workstations

World Wide Web

Field Communications

ATIS

Advanced Traveler Information Systems
Exhibit 39: Alternative Architecture 1 – Standalone Traffic Operation Center (Decentralized Model)
3.4.4.2 Alternative Architecture 2 – Existing TMC with Expanded STOC Services

This alternative architecture would expand the operations center of one or more of the regional TMCs to include workstations dedicated for statewide traffic operations staff. These workstations would act as the STOC, but in a shared space at the regional TMC. Responsibilities between the two groups may be divided and separate if institutional funding dictates that type of approach (i.e. District would fund the regional TMC, but a statewide Division would fund the STOC), but opportunities do exist to fuse the operations together and essentially expand the regional TMC’s capabilities to focus on statewide initiatives. Advantages to this alternative focus primarily on reutilizing existing TMC space in lieu of constructing a new facility, which reduces the capital costs associated with this strategy. Staffing in the dual facilities may also benefit by having in-person communication between parties, which helps foster trusting relationships between groups, although it also may cast a negative perception that the particular “metropolitan” regional TMC is now managing rural needs in a distant part of Texas.

Similar to the previous alternative, the STOC would operate the ITS field devices using an ATMS platform. The ATMS itself could be rolled out to support either a centralized or decentralized operation, depending on how TxDOT elects to operate its TMCs. A centralized operation would have the STOC operate only the rural areas (i.e. areas not covered by regional TMCs) via the ATMS, whereas a decentralized operation would allow the STOC to potentially utilize another TMC’s ITS assets or allow the STOC to assist that regional TMC with its operations. From an operations standpoint, the decentralized model would be far more advantageous to TxDOT, although it would require bringing all TMCs onto the same ATMS platform and providing interconnections between their services.

Exhibit 40 and Exhibit 41 illustrate the high-level diagram of a centralized and decentralized model, respectively, for this alternative.
Exhibit 40: Alternative Architecture 2 – Existing TMC with Expanded STOC Services (Centralized Model)
Exhibit 41: Alternative Architecture 2 – Existing TMC with Expanded STOC Services (Decentralized Model)
3.4.4.3 Alternative Architecture 3 - Virtual STOC

This alternative architecture would deploy an ATMS platform/system application without the addition of a physical facility. Staff needing to access the STOC would do so remotely, utilizing their own computers to open the ATMS and operate the statewide ITS program. Virtual access to the system may include TxDOT, interagency personnel, and authorized external stakeholders, depending on how statewide traffic operations are envisioned.

A virtual STOC needs to be supported with the proper ITS and communication infrastructure, and system security. Its capabilities depend on the scoped coverage area, staffing model (e.g. full-time vs. on-demand operators), and the systems in place that are chosen for the center. Operators may not need to access the system until an alert has been made, such as a remote ITS device reporting an issue or another stakeholder (i.e. law enforcement) reporting an incident. Aside from a substantial reduction in capital costs, the virtual STOC offers capabilities for staff to work at any location, which could be advantageous if a primary facility were shut down due to an emergency or health threat.

This model is a feasible option for agencies looking to open a new TMC, monitoring rural areas not covered by other District TMCs, or wanting to enhance their backup or emergency operations. Similar to the other alternatives, the virtual STOC would operate the ITS field devices using an ATMS platform, with the only difference being that this ATMS would likely be a thin client\(^{19}\) or VPN version to support remote capabilities. The ATMS itself could be rolled out to support either a centralized or decentralized operation, depending on how TxDOT elects to operate its other TMCs. A centralized operation would have the virtual STOC operate only the rural areas (i.e. areas not covered by regional TMCs) via the ATMS, whereas a decentralized operation would allow the virtual STOC to potentially utilize another TMC’s ITS assets or allow the virtual STOC to assist that regional TMC with its operations. From an operations standpoint, the decentralized model would be far more advantageous to TxDOT, although it would require bringing all TMCs onto the same ATMS platform and providing interconnections between their services. Depending on how a unified ATMS is envisioned, virtual capabilities may be a feature that is included as part of the other alternatives. This would allow a physical STOC to operate with some operators having access to the system remotely through a virtual ATMS client. This would align with the Hybrid TMC model identified earlier and, while the most costly of the group, would provide the most resilient option for TxDOT to operate its statewide traffic operations program. Exhibit 42 illustrates the high-level diagram for this alternative.

\(^{19}\) Thin client refers to a web-based application available using a standard web browser from any location over a secure internet protocol
Exhibit 42: Alternative Architecture 3 – Virtual STOC

Virtual STOC

ATMS Platform

Firewall

External Systems

Field Comm

ITS Field Devices

ATIS

WWW

STOC Operator

STOC Operator

World Wide Web

Field Communications

ATIS Advanced Traveler Information Systems
3.5 **Support Environment**
This section discusses the major components of the environment supporting the STOC including:

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

### 3.5.1 Supporting Subsystems
There are various subsystems that form part of the supporting services for the STOC. Their design would ultimately affect the design of the center. Key subsystems to consider are identified in Exhibit 43.

**Exhibit 43: Supporting Subsystems**

<table>
<thead>
<tr>
<th>Supporting Subsystem</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>ITS Field Devices</td>
<td>This subsystem refers to any existing or newly deployed ITS field device in the STOC coverage area (e.g. CCTVs, sensors, DMS).</td>
</tr>
<tr>
<td>Security</td>
<td>This subsystem relates to robust firewalls, intrusion detection systems, and encryption technologies that protect the STOC systems from potential risks and exposures from unauthorized access (internal or external).</td>
</tr>
<tr>
<td>Virtual Private Networks (VPN)</td>
<td>This subsystem allows connectivity to remote users to the STOC systems in a private and secure manner, restricting access to include only authorized users.</td>
</tr>
<tr>
<td>Service Monitoring Subsystem</td>
<td>This subsystem alerts TMC operators or maintenance staff of system issues and provides them with information on how to address or isolate the identified issues. This subsystem provides alerts to help facilitate the required maintenance and does not need to be integrated with a maintenance management system.</td>
</tr>
<tr>
<td>Communication Subsystem</td>
<td>This subsystem provides network communications between the field elements and STOC. Traffic data is provided in real-time. Typically, fiber communications are used in an environment with accessible and reliable communications while wireless communication may be used in remote/rural sites.</td>
</tr>
<tr>
<td>Supporting Subsystem</td>
<td>Purpose</td>
</tr>
<tr>
<td>--------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Center-to-Center (C2C) Communications</td>
<td>This subsystem performs real-time data exchange between TMCs, the proposed STOC, and external systems.</td>
</tr>
</tbody>
</table>

### 3.5.2 Supporting Personnel

TxDOT traffic operations staff, maintenance staff, system administrators, and system developers are the key personnel required to support the STOC. Primary functions for supporting personnel are outlined in Exhibit 44.

**Exhibit 44: Supporting Personnel**

<table>
<thead>
<tr>
<th>User Group</th>
<th>Primary Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>STOC Operator</td>
<td>Manages the ITS program through the ATMS, monitors roadways, monitors operational status or ITS devices, and coordinates with other stakeholders (e.g. regional TMCs, law enforcement) in real-time.</td>
</tr>
<tr>
<td>System Administrators</td>
<td>Monitors ATMS performance, configures ITS devices in the ATMS, oversees ITS asset management, and coordinates response to system issues.</td>
</tr>
<tr>
<td>System Developers</td>
<td>Develops new and maintains existing ATMS applications.</td>
</tr>
<tr>
<td>Maintenance Staff</td>
<td>Supports and maintains ITS hardware.</td>
</tr>
</tbody>
</table>

### 3.5.3 Supporting Processes

The following are processes required to support the STOC:

- **Standard Operating Procedures**: Develop or modify standard operating procedures to accommodate the new STOC functions and establish responsibilities and reporting lines. Implement the necessary Memorandum of Understanding (MOU) documents to support roles and responsibilities with other agencies that are part of the standard operating procedures.

- **Staffing Plan**: The STOC—whether a physical or virtual environment—will need to be staffed. Staffing will depend on the scope of operations.

- **Software Support and Updates**: Establish processes to ensure that all the required software are available and up-to-date for the ATMS platform, either within the STOC or as part of an integrated solution with regional TMCs, as applicable.
4.0 Benefits, Impacts, and Alternatives of the Statewide Traffic Operations Center

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

4.1 Benefits

This subsection summarizes some of the key benefits that TxDOT should expect from deployment of the STOC. From a benefits perspective, the implementation of the STOC would offer the following:

- **Increased opportunities to operate a successful rural ITS program** – One of the key tasks for the STOC is to operate the rural THFN. As noted in Section 2.3.1.2, rural ITS programs often have not been extensive because of higher upfront costs to implement a rural TMC. Investment in the STOC would mitigate some of these upfront costs, allowing the benefit-cost ratios of a rural ITS project to become more favorable when competing with other statewide needs for funding. This would position TxDOT to be a new leader in rural ITS, allowing for a rural program that goes beyond the traditional remote applications like high-water alert system treatments or other “spot” safety treatments. During major network disruptions (e.g. a hurricane or other natural disaster), the STOC for rural operations working in collaboration with regional TMCs for urban operations would increase network resiliency for recovering from disruptions, which allows the supply chain to be restored more quickly and maintain good economic efficiency for the state.

- **Increased opportunities to manage coverage** – The STOC would allow for opportunities of not only providing coverage over new geographical areas—namely the 71 percent of the THFN with no current coverage, predominantly in rural areas—but also opportunities for providing increased coverage time. For TxDOT (or possibly non-TxDOT) TMCs that do not provide continuous coverage (i.e. 24/7 operation), the STOC could take responsibility of that region during their non-operational periods. This also could allow regional TMCs to explore downgrading their operational service time to something less than 24/7, depending on what their overnight needs entail, which could be a cost savings for a local District and local agencies. Additionally, while the STOC is anticipated to provide on-demand staff to aid regional TMCs during major incidents, the regional TMCs—during overnight hours when the workload is lighter—could utilize the unified ATMS to monitor and manage the rural areas that the STOC operates during the day, allowing the STOC to reduce its staff during overnight hours. These opportunities to maximize both geographic and temporal coverage while efficiently using staff would maximize the benefit to road users while reducing average costs for TxDOT.
• **Increased efficiencies for collaborating with local and regional traffic managers, law enforcement, and adjacent states** – The STOC would position TxDOT to be more of a real-time traffic operations stakeholder for rural parts of the THFN. Law enforcement and local traffic managers historically have managed real-time operations and incident management. This would likely remain the case, but the STOC would aid these groups by implementing mitigation strategies during incidents and other disruptions, as well as inform them of disruptions in other parts of the state that might impact their region. Law enforcement and local traffic managers would have a single point-of-contact at the STOC to quickly request assistance, and the STOC operators would have an inventory of all local points-of-contact when detecting issues on their own. This would allow more traffic operations capabilities along rural parts of the THFN compared to the current situation, as well as help establish a single data standard through the STOC to share data.

• **Increased efficiencies in distributing messaging statewide** – The STOC would be the real-time delivery system for statewide messaging. By filling in the voids between the regional TMCs (e.g. by operating rural ITS devices, by supporting exchange of information between regional TMCs, by providing one unified ATMS platform), the STOC would further bridge a gap between TxDOT’s statewide initiatives and the actual devices on the road. Regional TMCs would retain primary control of their assets and program, and would coordinate with the STOC to receive and manage statewide directives and messages. This would improve the efficiency and standardization of message distribution over the current situation.

• **Increased capabilities to manage statewide work zone planning to avoid sequential or parallel work zones** – The STOC would monitor planned network disruptions at a comprehensive statewide level, as opposed to on a District basis. The STOC would identify planned work zones that appear in different Districts on the same highway and be able to work with District engineers to adjust the timing of projects to reduce sequential or parallel work zones for motorists when possible. This review could facilitate development of an automated process to screen and identify conflicting work zone projects, such as through artificial intelligence or other advanced analytics capabilities.

4.2 **Impacts**
This subsection describes the impacts that TxDOT and its stakeholders should expect as a result of the STOC deployment. First, impacts to the operational and institutional policies and constraints are highlighted, which TxDOT should review as part of the planning process for this strategy. Then it highlights the operational and organizational impacts that TxDOT should expect during deployment, as well as any impacts incurred as part of development. Lastly, it documents expected impacts to the stakeholder groups identified earlier.
4.2.1 Policies
The following summarizes some of the key operational and institutional policies necessary to support development of the STOC:

- **Traffic Management** – The STOC shall establish TxDOT standard operating procedures for traffic management functions and tasks in collaboration with regional TMCs. The STOC must not interfere with tasks that are managed by regional TMCs.

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

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

- **Data Latency** – Any investment in the STOC and ATMS shall be of a design that minimizes data latency between the facility and other systems (e.g. regional TMCs, remote ITS devices). These components should have a supporting network infrastructure that can sufficiently move data in a timely fashion.

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

- **System Architecture Design** – The deployment of the STOC will require flexibility in the system architecture design to respond to changing conditions, improved technology, and other technological developments. The design should include updating existing data formats and communication protocols to industry standards, as applicable.

- **Operational Response** – Coordination between the STOC and regional TMCs must be well-defined in order to support operations such as control of assets and data, data resources, data feeds, backup support, emergency support, disaster recovery, etc. Coordination must include technical and administrative policies.

- **Compliance with Design Standards** – The STOC must utilize infrastructure that is designed in compliance with any applicable design standards or guides, including the National Transportation Communications for ITS Protocol (NTCIP), Americans with Disabilities Act (ADA), Section 508 Compliance, applicable Texas building codes, TxDOT IT Cybersecurity, and all applicable International Organization for Standardization (ISO) standards for control room and operator ergonomic design.
4.2.2 Constraints
The following summarizes some of the key operational constraints for STOC implementation:

- **Budget** – Funding will be needed to deploy and operate the STOC. The level of funding will vary depending on the chosen facility and systems, operational hours, staffing levels, and overall scope of work for the center for properly managing the transportation network.

- **Staffing** – Dedicated staff will be required if a physical STOC is deployed. TxDOT may decide to utilize existing staff or add new personnel. Staffing requirements will depend on the traffic management functions for the center deemed necessary to properly manage the transportation network. STOC staff will be required to monitor and manage the ATMS system deployed at the physical center.

- **Limited Rural ITS Capabilities** – While TxDOT does have rural ITS devices that the STOC could adopt at the beginning, implementation of future devices to expand rural traffic mitigation strategies would necessitate further funding to the ITS program for capital and O&M costs. This requires institutional funding to expand the ITS program, which competes with funding for other TxDOT civil, structural, and environmental initiatives.

- **Facility Design** – If TxDOT elects to construct a physical STOC in lieu of alternative options, it will need to plan for a facility to house the STOC, as well as all systems and staff needed to perform traffic management and administrative functions.

- **Deployment Timeline** – The timeline for the delivery of a physical STOC is lengthier than most ITS projects due to extensive facility work. Longer projects require extensive planning, design, and construction management to mitigate risks.

- **Hardware Installation and Maintenance** – The STOC will require new ITS hardware that will need ongoing maintenance and upkeep. This will require effort from TxDOT staff or a TxDOT-funded maintenance contractor to dedicate time for the new system upkeep.

- **Center-to-Center Network Communications (C2C)** – C2C will be required for a unified ATMS platform that allows the STOC to collaborate with other regional TMCs. This is usually accomplished through a shared implementation of a wide area network (WAN).

- **ATMS Integration** – TxDOT’s ATMS (i.e. LoneStar) is not currently an integrated solution, but rather each TMC runs its own ATMS version. Deploying a unified ATMS will require extensive work to align all versions of the ATMS into one operation, or require a new ATMS to be procured.
4.2.3 Operational Impacts

From an operational perspective, the implementation of the STOC would have the following impacts:

- **Increased operational coverage of rural areas** – Currently, TxDOT has limited real-time operational capabilities along rural parts of the THFN that fall outside the existing jurisdictions of the regional TMCs. The STOC would support those parts of the THFN. This could facilitate operational responses to assist local traffic managers that deal with disruptive rural incidents. Additionally, it would encourage future investments in ITS for parts of the THFN that could benefit, offering expanded real-time services to road users.

- **On-demand availability of traffic management support for regional TMCs during major incidents** – Depending on the operating model selected, the STOC could provide on-demand assistance to regional TMCs that request assistance to cover unanticipated workload that exceeds their manpower capabilities. Regional TMCs would continue to prioritize their efforts to the most critical incidents, but would be able to request assistance to help support the remaining incidents. Additionally, the regional TMC—for certain major incident types—could request the STOC post advance messaging outside of their regional jurisdiction or conduct some other type of notification to help manage traffic away from the incident. Currently, TMCs instruct their staff to prioritize critical incidents. In the cases where workload exceeds the manpower, less critical incidents may take longer to resolve.

- **Availability of service redundancy to support TMC outages** – Regional TMCs that experience a loss of service capabilities would be able to call on the STOC to assume their roles and responsibilities as a backup. Events like facility damage due to a hurricane, a cybersecurity hack, or a localized pandemic outbreak (e.g. COVID-19 during its early days of cases appearing primarily in metropolitan areas) could allow the STOC to immediately assume all responsibilities from the regional TMC and provide uninterrupted service to Texas road users. Displaced staff from the regional TMC could ultimately relocate to the STOC if deemed appropriate, or could explore other options (e.g. remote access) while the STOC maintains their program. Although this is a rare situation, TMCs in the current situation would have limited options to maintain their full operation if their facility went offline.

- **Availability of a single unified ATMS platform statewide** – Streamlining the ATMS to be a single unified platform would facilitate software management of the traffic operations program. Rather than having multiple variants of the same software at each TMC, each with its own combination of modules, settings, and customizations, a unified ATMS would be a standard consistent platform that to which the rest of the ITS program would conform. Operators who are given permission to view or access another TMCs’ devices would be able to do so seamlessly, as the ATMS would be set up to accommodate all device types and vendors uniformly. With standardized look-
and-feel options, operators would be able to relocate to different centers as needed (e.g. regional TMC relocates temporarily to STOC due to hurricane damage to its facility) without needing to relearn the ATMS itself. A unified platform would also allow for remote access—with the proper permissions—for either remote operators (e.g. TMC staff who have to be relocated to work-from-home due to a pandemic) or for TxDOT management to remotely view certain incidents. Currently, the ATMS is a standalone system in each TMC and primarily can only be utilized by the operators in that local area network.

- **Increased real-time traffic operations capabilities at a statewide level during state of emergencies** – The STOC would have a role in coordinating with TDEM’s SOC during states of emergency in Texas. The STOC would assist the SOC by providing consistent messaging on the emergency throughout the state of Texas, such as by working with regional TMCs to ensure that all parties are issuing the same notices. For larger-scale incidents identified by the SOC, the STOC would be charged with managing traffic, such as directing motorists away from certain roadways and encouraging use of alternate routes. Currently, the SOC manages statewide emergencies through coordination with TxDOT and its regional TMCs, but it has limited or less efficient capabilities in managing rural parts of the THFN that might also be affected by the emergency.

- **Ability to adopt statewide priorities regarding traffic operations, such as freight prioritization, over a large area** – The STOC would be the part of TxDOT that could deploy statewide priorities and initiatives, as well as be the resource for managing real-time traffic operations strategies at a statewide level. Distribution of statewide public safety campaigns (e.g. #EndTheStreak) would likely start from the STOC, with collaboration from the regional TMCs as well. Operational strategies like rural freight signal priority corridors in areas outside of regional TMC coverage would likely be managed by the STOC, either through operator control or automated algorithms. Opportunities like coordinating and tracking HazMat movements could be led by the STOC. As Big Data applications become more widespread (e.g. truck ELD data to support travel demand forecasting), the STOC would likely assume the key role of processing this information and distributing it to the regional TMCs. Currently, regional TMCs manage the statewide priorities in their respective jurisdiction and rural operational strategies are being deployed, but the lack of a statewide traffic operations program limits the efficiency and effectiveness of this effort.

- **Available entity to serve as go-to resource for managing non-District specific technology initiatives** – The STOC would be the default entity that could adopt technology initiatives and programs that do not fit with a specific District. While instances exist where some TxDOT Districts would want to manage a certain application or program, most larger initiatives make more sense to be operated by a traffic operations group that is focused on statewide initiatives. For example, some
states have a portable DMS program with hundreds of assets that are moved to strategic locations statewide, such as for construction projects, evacuation routes, or other planned disruptions; in those cases, the STOC could manage that program in collaboration with local partners. Texas programs like the Connected Work Zone, the Texas Connected Freight Corridors, and the I-10 Truck Parking Availability System (in development) may also benefit from having the STOC manage and operate the assets in real-time.

4.2.4 Organizational Impacts
From an organizational perspective, the implementation of the STOC would primarily impact the public sector, although there also would be some positive impacts for the private sector.

4.2.4.1 Public Sector
The STOC would represent TxDOT’s real-time traffic operations program at a statewide level, allowing statewide initiatives and incident management strategies to have a greater role in policy, planning, and deployment. This would shift TxDOT’s role from being simply a steel- and concrete-based infrastructure provider in the rural parts of the state to an active roadway operator with a focus on improving safety and mobility while preserving assets. This would support the statewide TSMO vision, mission, goals, and objectives identified in the 2018 TSMO Statewide Strategic Plan, as well as support goals and objectives in other TxDOT plans like the TFMP.

Based on stakeholder feedback, regional TMCs would retain their current traffic and incident management programs, and would be given an opportunity to collaborate with the planning of the STOC’s role in traffic operations. Regional TMCs would have an opportunity to optimize their operations, such as expanding/contracting their preferred jurisdictional coverage, increasing/decreasing operator manpower or 24/7 coverage periods, and identifying efficiencies/deficiencies in their existing ATMS platform that could be standardized at a statewide level to aid with their operational programs. It would be extremely important to engage the regional TMCs throughout this planning process to ensure that the STOC is culturally adopted as a collaborative traffic operations service, rather than as a competitor for limited resources.

Local towns, cities, and counties with their own TMCs would see minor changes in certain standard operating procedures, but organizationally should experience minimal impacts as a result of TxDOT implementing the STOC. For any local public sector TMC in a metropolitan area, the coordination protocols would likely remain with the regional TMC, but there may be isolated use cases where the STOC would be the preferred point of contact. In rural areas, any non-TxDOT TMCs would likely coordinate with the STOC, whereas they previously may

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20 Source: Texas Department of Transportation, Statewide TSMO Strategic Plan, July 2018.
have contacted another entity in TxDOT with fewer real-time response capabilities (e.g. TMC contacts bridge engineer to do a structural check due to major incident). These standard operating procedures between local and TxDOT TMCs—both regional and statewide—would need to be reviewed and updated to best serve the interests of both groups. Local towns, cities, and counties would overall benefit from the STOC—including those without local or regional TMCs currently—by having improved traffic operations capabilities, particularly in rural areas where these capabilities are currently very limited.

Within TxDOT, the STOC’s role on the organizational chart is critical to define prior to any implementation, as this would dictate the reporting and funding structure. With O&M being one of the larger expenditures for a STOC, funding would need to be secured on an annual basis.

4.2.4.2 Private Sector
From a day-to-day operations perspective, private-sector truckers would benefit from better travel options provided by the newly-enhanced TxDOT traffic operations program. They would see no impacts to their organization and would continue to operate as they currently do, albeit with more informed routing decisions.

4.2.5 Impacts During Development
No major disruptions are anticipated to any of TxDOT’s traffic operations and incident management programs as a result of development of the STOC. If new standard operating procedures are adopted, some learning curves are to be expected as operators take on new activities, but these are anticipated to be minimal. Additional learning curves may be expected if the unified ATMS platform has different processes than its isolated predecessors.

Continued involvement of key TxDOT stakeholders in STOC development is strongly recommended in order to validate that user needs are being met, interim deliverables align with their vision, and useful relationships are established early on. Ongoing involvement requires time from these stakeholders, but the outcome of this investment would be a more resilient program that is culturally adopted into the TxDOT traffic operations program.

4.2.6 Impacts to Stakeholders
Relevant stakeholders for the STOC are listed in Exhibit 45. Stakeholders are denoted by roles of owner, key stakeholder, and/or end-user. This strategy envisions TxDOT Divisions as the owner(s) that would internally identify the STOC on its organizational chart, collaborate internally to identify the 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 support their needs. End-users would primarily be the private sector truckers and other road
users who would benefit from improved traffic operations and incident mitigation efforts, particularly in the rural areas where limited activities exist today.

**Exhibit 45: Relevant Stakeholders for the Statewide Traffic Operations Center**

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Role</th>
<th>Strategy Impact</th>
</tr>
</thead>
</table>
| **TxDOT Division(s)**             | Owner        | • Will identify the Division to manage and fund the STOC, and identify location on organizational chart. Will collaborate with other Divisions who might lead this effort.  
• Will develop STOC program and identify funding needs for capital and O&M.  
• Will prioritize functions of the STOC with input from other stakeholder groups.  
• Will manage the ATMS and monitor device operability.  
• Will operate the STOC and associated statewide traffic operations program.  
• Will report on system operations for performance monitoring purposes.  
• Will implement data-sharing agreements with each regional TMC and other governmental entities.  
• Will fund and support the implementation of the STOC. |
| **TxDOT TMCs**                    | Key Stakeholder /End-User | • Will work with the TxDOT Divisions to identify preferences, outline jurisdictional boundaries for operations and device sharing, and develop Standard Operating Procedures.  
• Will work in real-time with the STOC to manage incidents, as applicable.  
• Will request assistance from the STOC when deemed necessary by the TMC operators. |
| **TxDOT Districts**               | Key Stakeholder | • Will construct and maintain ITS assets.  
• Will work with the STOC regarding management responsibilities of devices when no TMC is present in the District. |
<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Role</th>
<th>Strategy Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>TxDPS</td>
<td>Key Stakeholder</td>
<td>• Will conduct law enforcement and public safety efforts with assistance from the STOC.</td>
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<tr>
<td></td>
<td></td>
<td>• Will use STOC historical data to assist with planning exercises for emergency responders whose coverage area is within the STOC jurisdiction.</td>
</tr>
<tr>
<td>TDEM</td>
<td>End-User</td>
<td>• Will manage the SOC and collaborate with the STOC when needed.</td>
</tr>
<tr>
<td>Other non-TxDOT TMCs</td>
<td>Key Stakeholder /End-User</td>
<td>• Will work with TxDOT STOC to determine how it can support their operations.</td>
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<tr>
<td></td>
<td></td>
<td>• Will coordinate in real-time with STOC for incidents that involve both parties.</td>
</tr>
<tr>
<td>Truckers</td>
<td>End-User</td>
<td>• Will operate on the THFN and experience fewer traffic operations issues due to effective traffic management from the STOC.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Will be informed of incidents and congestion reported and managed by the STOC via DMS, the ATIS website, mobile device apps, social media, and information rebroadcasted by the media and third-party providers.</td>
</tr>
<tr>
<td>Trucking Companies/Dispatchers</td>
<td>End-User</td>
<td>• Will experience more travel time reliability of trucks traveling in rural parts of the state.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Will receive more traveler information from the STOC in rural areas via the ATIS System.</td>
</tr>
<tr>
<td>Emergency Responders</td>
<td>End-User</td>
<td>• Dispatchers will receive more comprehensive notifications via the ATIS System. This would allow them to make informed decisions regarding which personnel are needed to respond to an incident.</td>
</tr>
<tr>
<td>Other Road Users</td>
<td>End-User</td>
<td>• Will operate on the THFN and experience fewer traffic operations issues due to traffic management from the STOC.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Will be informed of incidents and congestion reported and managed by the STOC via DMS, the ATIS website, mobile device apps, social media, and information rebroadcasted by the media and third-party providers.</td>
</tr>
</tbody>
</table>
4.3 Alternatives To This Strategy

This proposed ConOps for the STOC comes with many benefits and impacts, but it inherently comes with prerequisite requirements in order to be successful in the long-term. While it meets the goals and objectives defined in the FNTOP strategy for a STOC, it is not the only option available. This subsection identifies the inherent disadvantages and limitations of this strategy, and then contrasts the strategy against candidate alternatives that would also satisfy the intent, but were rejected due to being less advantageous.

4.3.1 Disadvantages and Limitations

The proposed STOC in this strategy is expected to have several disadvantages and limitations, which form prerequisite requirements that TxDOT will need to satisfy for the STOC to fully succeed. Unlike the policy and constraint considerations identified earlier, these disadvantages and limitations will need to be continuously addressed.

- **Dependency on Cultural Adoption within TxDOT** – The STOC’s success is highly dependent on cultural adoption within TxDOT’s organizational structure. Regional TMCs and other traffic management groups must accept the STOC’s roles and responsibilities as being collaborative, not competitive – as noted earlier, the STOC’s role is to support regional TMCs upon request, but this requires regional TMC staff to view the STOC in that role (as opposed to an undesired oversight group). Financial resources must be annually provided to support O&M costs for operations and staffing. TxDOT management must recognize that the STOC’s value in improving rural traffic operations is dependent on TxDOT’s ability to work with local traffic managers and deploy a rural ITS program to support mitigation strategies, which may not all rollout in the first year of the STOC’s operation.

- **Extensive Rural ITS Coverage is Needed** – Rural ITS coverage is limited in the current situation, relative to the number of highway miles in the rural parts of Texas. While having the STOC would help encourage rural ITS investment, this would not happen quickly (i.e. in the first year) and would still not cover the full network, given how large the ITS gaps are in the rural areas, as shown in Exhibit 31. This may be mitigated through other applications like third-party traffic data or through Big Data services.

- **Full Benefits Require Implementation of Both STOC and Decentralized ATMS** – This ConOps document presents the STOC as having a unified statewide ATMS platform; this will maximize the benefit to TxDOT’s statewide traffic operations program. By only building the STOC (either as a physical facility or dedicated operations staff to serve statewide applications) or the standalone ATMS platform, the benefits of this strategy are substantially reduced. It is recommended that this strategy develop both pieces, despite the higher cost.

4.3.2 Alternatives and Tradeoffs Considered

Given the above disadvantages and limitations, alternative options and tradeoffs were examined in lieu of the STOC in its proposed form. The alternative options listed below
explore different approaches to a statewide traffic operations program. It is important to note that some of these alternatives may seem intuitively nonsensical, but they are worth noting to confirm that all options have been explored and rejected for the stated reasons.

4.3.2.1 Alternative 1: “Do Nothing” Approach
This alternative would maintain the current situation, which would require no changes to the existing program, no increases in costs, and require no additional staff. TxDOT’s existing traffic operations program would continue to provide the same level of service, although it may require additional funding and staffing in the future as traffic volumes increase. Rural traffic operations would remain extremely limited, as the rural ITS program would continue to need significant upfront investment to make it competitive. Regional TMCs would have limited support during major incidents or disruptions that exceed their manpower capabilities. Mobility initiatives (i.e. freight movement prioritization) would be operated only at a regional level. If this alternative is pursued, TxDOT would expect to maintain the status quo highlighted in Section 2.1, capturing none of the benefits outlined in Section 4.1.

This alternative is not recommended because it maintains the same shortcomings of the current situation.

4.3.2.2 Alternative 2: STOC Manages Entire State
This alternative would absorb all regional TxDOT TMCs into a centralized STOC, establishing a program similar to other states where one TMC operates the entire state. Operators with regional experience would likely be assigned to groups to manage each metropolitan area or rural region of Texas, based on the mitigation strategies adopted by the STOC. TxDOT as a whole would see some reductions in infrastructure and workforce costs by consolidating all operations to one location, as well as capture benefits that the STOC would provide as identified in Section 4.1 (expansion of rural ITS and traffic operations program, etc.). However, given that the regional TMCs have been in operation for over a decade, many of the local working partnerships with local and regional authorities would be disrupted or lost, as would certain working relationships between local TMC operations staff and the planning, engineering, maintenance, and responder personnel who work out of each TxDOT District. Additionally, having one facility for the whole state bears the risk of losing all capabilities to manage traffic statewide if the facility must be evacuated, such as after damage from a hurricane or a terrorist event. If this alternative is pursued, TxDOT would expect to see some reductions in overall costs, but also reductions in regional traffic operations capabilities as a result of not having the same degree of working relationships with local partners.

This alternative is not recommended because it would conflict with the local working relationships established in the existing TMCs between multi-agency groups. Additionally, with one operations center, a higher risk exists of comprehensive system failure during a single event, such as if a natural disaster or cyber-attack affects the STOC facility.
4.3.2.3 Alternative 3: Expand Regional TMC’s Coverage
This alternative would expand each of the seven regional TMC’s coverage—through careful planning—until the entire state of Texas has full TMC coverage. No STOC would be built in this alternative. Each regional TMC would be responsible for operating rural areas that are in its new coverage, which would necessitate adding staff and developing rural incident mitigation strategies in order to serve these areas. The regional TMCs would maintain full authority over their region while working with adjacent TMCs on their boundaries, which may now be in rural areas. Rural traffic operations would see improvements as expected with the STOC, but with an expectation of less consistency at a statewide level because each regional TMC may take a different style of approach, have different incident mitigation strategies, or have different priorities. Regional TMCs would have limited support during major incidents or disruptions that exceed their staff capabilities. Mobility initiatives (i.e. freight movement prioritization) would be operated only at a regional level. If this alternative is pursued, TxDOT would expect to see comparable overall O&M cost increases as the STOC in order to accommodate the additional staff and coverage area at each TMC, but these cost increases would be without the workload balancing and facility redundancy benefits that a STOC could offer, nor would it provide statewide consistency on managing rural traffic operations that the STOC would provide.

This alternative is not recommended because, while covering more of the rural areas, it maintains the regional organizational structure that does not provide for cohesive implementation of statewide initiatives.

4.3.2.4 Alternative 4: Build More Regional TMCs
This alternative would construct new regional TMCs—through careful planning—to fill all existing regional TMC coverage gaps until the entire state of Texas has full TMC coverage. No STOC would be built in this alternative. Each existing regional TMC would maintain their current coverage and staffing workload, and each new regional TMC would cover their newly-defined coverage area and add staff to support the workload. Each regional TMC would maintain full authority over their region while working with adjacent TMCs on their boundaries. Rural traffic operations would see improvements like those expected with the STOC, but with an expectation of less consistency at a statewide level because each regional TMC may take a different style of approach, have different incident mitigation strategies, or have different priorities. Regional TMCs would have limited support during major incidents or disruptions that exceed their manpower capabilities. Mobility initiatives (i.e. freight movement prioritization) would be operated only at a regional level. If this alternative is pursued, TxDOT would expect to see a substantial increase in capital and O&M costs in order to fund these additional TMC facilities while only gaining marginal benefits of local staff who are familiar with the region relative to what could be offered by the STOC.

This alternative is not recommended because it is costly and experiences the same issues as the previous alternative.
5.0 Operational Scenarios

This section presents eight operational scenarios that describe situations in which the STOC could significantly improve the safety, mobility, and travel time reliability of users on the TMFN. Each operational scenario describes the users involved and the issues that are intended to be addressed, as well as the outcomes or benefits the users are expected to experience through the deployment of this strategy. The following operational scenarios do not address all of the desired STOC improvements, nor do they represent a comprehensive set of use cases, but rather demonstrate some of the key situations that this system could help serve and improve. Exhibit 46 summarizes the operational scenarios presented in this section.

Exhibit 46: Summary of Operational Scenarios

<table>
<thead>
<tr>
<th>#</th>
<th>Scenario</th>
<th>FNTOP Stakeholders Involved</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rural Incident Response</td>
<td>STOC Operator, TxDPS</td>
</tr>
<tr>
<td>2</td>
<td>Statewide Messaging (AMBER Alert)</td>
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5.1 Rural Incident Detection/Management

John is an operator at the Texas STOC. It is a Monday morning at 10 a.m. and, so far, it has been a routine day without any major incidents. Since all seven of TxDOT’s regional TMCs are operational at this time and covering the incidents in their respective jurisdictions with their own staff, John’s current responsibilities focus on routine monitoring. Today, his focus is on major rural routes that are not covered by the regional TMCs, which include high-volume, rural routes in west Texas, between Fort Worth, San Antonio, and El Paso.

About 15 minutes later, John is informed by the state police dispatch that a 911 call was received on U.S. Route 67 near San Angelo regarding a crash. The reported crash has been loaded into John’s ATMS map through a connection with the state police’s CAD system. John immediately notices that a CCTV camera is available near the reported crash. He pulls up the view from that camera and identifies the two vehicles that are involved in this crash.
John informs the state police dispatch that they can view the camera, as the police is granted access to the video via their secure connection with the STOC.

The City of San Angelo police and fire departments are the first responders to the scene. City dispatchers and traffic managers are also able to remotely access the video feeds via their secure connection with the STOC. Due to multiple injuries and the extent of damage, first responders determine that one lane on U.S. 67 must be closed for an extended period of time. John receives this report from the local incident commander and takes immediate action. He confirms the lane closure in the ATMS, which automatically disseminates the crash location and the lane closure information to DriveTexas. Many motorists use third-party navigation systems that receive some of their data from DriveTexas, so this automatically notifies these rural road users of a potential delay. The ATMS also automatically identifies DMSs located along U.S. 67, several miles upstream of the crash. John elects to post a message on the DMSs to notify the traveling public of the lane closure. The message on its own helps increase driver awareness of the issue, which helps reduce secondary incidents. Additionally, with the STOC previously identifying this area as a good location for use of traffic management strategies, drivers are informed of alternative routes and their respective travel times, which are faster than driving through the incident. This encourages other drivers to use the alternate route, including truck drivers who appreciate TxDOT providing an approved alternative truck route.

In two hours, first responders have cleared the incident and U.S. 67 is fully reopened. In the STOC, John confirms that the road is open and removes all messaging from the DMSs. He recalls in years past, prior to the deployment of the STOC, that rural incidents were only managed by local first responders. He remembers hearing about horrifying issues, where other motorists would collide with first responders who were tending to the crash scene because they did not expect a lane closure. While John knows that inattentive driving remains a concern, he realizes that his ability to notify motorists through the DMSs and DriveTexas has helped to potentially mitigate a number of these issues simply by increasing driver awareness of what to expect on the road ahead.

5.2 Statewide Messaging (AMBER Alert)
Jane has been working as an operator at the Texas STOC since it became operational a few weeks ago. During this time, she has gained valuable experience in dealing with different types of incidents and road closures both in rural parts of the State, as well as assisting her traffic operations peers in Houston and San Antonio when they need more widespread support.

It is a Wednesday night at 10 p.m. and Jane is nearing the end of a busy shift when she receives a call from the Houston TranStar Traffic Management Center. The TranStar operator informs Jane that the Houston Police Department has issued an AMBER Alert for a missing child. Houston police have already contacted state authorities, but have indicated
that there is reason to believe the missing child may have been taken out of the Houston area. Houston TranStar has disseminated the AMBER alert to drivers throughout the metropolitan region, but has reason to believe that additional coverage is needed.

Jane immediately defaults to the established standard operating procedures that were previously worked out between the STOC and regional TMC stakeholders for dealing with this type of event. Through the ATMS, Jane pulls up Houston TranStar’s AMBER alert message. She immediately populates the AMBER alert to 15 rural DMSs that fall outside of TranStar’s coverage area. She also sends the information to several portable DMSs that were deployed into the field as part of a pilot project to aid with rural hurricane evacuation. Since the portable DMSs are not currently in use, she is able to reformat the message to fit on these devices. Additionally, she sends a message request via the ATMS to San Antonio TransGuide, Austin CTECC, and Laredo STRATIS TMCs, and then follows up with a phone call to operators in each center to confirm the request. All the while, Houston TranStar is able to continue with their operations while minimizing redundant efforts.

With nearly all DMSs in southeastern Texas displaying the AMBER alert in urban, suburban, and rural locations, the public is more widely informed of the situation to assist in locating the missing child. Houston TranStar is able to focus their efforts on regional needs while the STOC works with partners outside the region. In the meantime, a truck driver in a rural part of Texas happens to see the AMBER alert on a DMS that normally was blank due to being far from a TMC. He recognizes the license plate and make/model of vehicle to match a vehicle that is traveling directly in front of him. He immediately contacts 911 and law enforcement is able to intercept the vehicle successfully, returning the missing child safely.

5.3 Statewide Messaging (Public Safety Campaign)

It’s 5:30 a.m. on a Monday morning and Mike has just arrived for his shift at the Texas STOC. Like any routine day, Mike meets with his supervisor before starting his shift. His supervisor tells him that the overnight shift was uneventful and there are not any ongoing incidents. Additionally, Mike’s supervisor notes that TxDOT administration is requesting a bigger push on the “#EndTheStreakTX” public safety campaign. With an uptick in roadway fatalities over the previous few months, TxDOT administration hopes that an aggressive campaign would increase awareness of unsafe behavior, and are requesting that all TxDOT DMSs be used to publish this message. The STOC supervisor directs Mike to implement the public safety message statewide.

At his operator workstation, Mike receives the preferred message of “#EndTheStreakTX” from TxDOT administration (via the Traffic Safety Division). He does a quick check that it follows TMUTCD guidelines. As he loads the message into the ATMS, he follows the standard operating procedures that were established between the STOC and the regional TMCs in regard to how statewide messages could be loaded onto DMSs in the metropolitan areas. In this instance, the regional TMCs agreed that any statewide public safety message could be
automatically loaded from the STOC, but as the lowest priority message. Mike follows this procedure without question and transmits the message to DMSs that are under the jurisdiction of regional TMCs. At each regional TMC, the message loads into their local ATMS as a low priority message, and operators at the regional TMCs receive a notification that the STOC has taken this action. If any messages were already posted on the DMSs, no changes would occur. For any DMSs that were blank, they now post the public safety message and would do so until either the STOC’s message expires (i.e. exceeds the time limit for the message as designated by the STOC) or the regional TMC overrides it with a more urgent regional message.

Mike is also able to send the message to all rural DMSs that are not managed by a regional TMC. Since the STOC primarily operates these signs, the message posts to the DMSs like normal. Additionally, Mike is able to access any currently unused portable DMSs that are connected to the TxDOT network to post the message.

Looking at the statewide ITS asset map, Mike sees the message appear on many signs. Instead of appearing blank when there is no traffic information to disseminate, DMSs throughout the state will promote the public safety campaign instead.

5.4 After Hours Operation
Brianna has worked as an operator at a regional TxDOT TMC for over 10 years. Over the years, Brianna’s TMC has operated as a 24/7 facility and has been working with management to find the right balance of staffing to workload. The TMC is very busy during peak hours, as operators are spending their time managing incidents. However, during overnight hours, it is surprisingly uneventful, with incidents only occurring once or twice a month. Operators routinely cite “boredom” as a motivation for requesting daytime shifts, and the overnight shift is widely viewed as a poor use of the TMC’s limited resources. That said, TxDOT management has adopted a policy of providing good customer service to motorists, even if it requires operators to be idle while waiting to assist with rare overnight incidents.

With the newly-commissioned STOC, the conversation regarding staffing balance resumes. The STOC is planning to have operators present 24 hours a day in order to support both rural incidents and assist regional TMCs. By having the on-demand service available, TxDOT management warms to the idea of downsizing the regional TMC’s level of operations. Instead of operating 24/7, running a 16/7 operation from 5 a.m. until 9 p.m. daily and then transferring all control over to the STOC for the late night hours. This would eliminate the overnight shift, but still offer an avenue to provide incident management when incidents do occur. This approach is vetted by key stakeholders at both the STOC and regional TMC through careful planning, and it is decided to be adopted as standard operating procedure.

It’s currently a Friday evening at 8:45 p.m. and Brianna is finishing up another successful shift. It’s been a busy day, but she feels as though she has handled all the incidents in a
timely manner. As Brianna concludes her shift, she contacts Mike over at the Texas STOC. Every evening, Brianna transfers operations of her regional TMC over to Mike and a few of his coworkers. She briefs him on any ongoing incidents he should be aware of. Although it’s been a busy day, there are currently no active crashes or lane closures. Mike is relieved that he will have a smooth beginning to his overnight shift managing traffic in this region.

5.5  Local TMC Unable to Operate Due to Hurricane
It’s 7 a.m. on a cloudy Tuesday morning. Over the past few days, meteorologists and coastal city governments in Texas have been monitoring a hurricane forming in the Gulf of Mexico. Originally a tropical thunderstorm, Hurricane Mitchel has now developed into a Category 3 hurricane. Still a few hundred miles off the coast of Texas, it is difficult to determine whether the hurricane will directly hit Texas’ coastal areas or take another path before weakening, but there are grave concerns that this storm could be a repeat of Hurricane Harvey in 2017. As a precaution, TDEM’s SOC has activated a hurricane monitoring plan, and is coordinating directly with the TxDOT STOC to receive traffic management support in anticipation of a larger event.

Jeff, an operator at the Houston TranStar traffic management center, is on the front lines, managing traffic in hopes that it will be another normal day. An hour into his shift, Jeff’s supervisor requests that all operators stop working temporarily so he can make an announcement. Hurricane Mitchel has graduated to a Category 4 hurricane, and Harris County along with adjacent counties have declared a state of emergency. The county will follow an outlined hurricane evacuation plan, with Houston TranStar being in an affected area. TranStar will follow the standard operating procedure for this type of situation as other officials set up the contraflow lanes to evacuate the region. Jeff speaks briefly with operators at the STOC, who indicate to him that they are closely working with TDEM’s SOC and are willing and able to assist in any way that they can.

Toward the end of his shift, Hurricane Mitchel directly strikes the Houston area at its full intensity. Jeff stays on to support operations, but the situation is very dire. Major swaths of land are flooded, buildings sustain damage, and economic damage is widespread. The Houston TranStar building suffers a direct impact from the storm, knocking all of its primary and secondary power and communication systems offline and inflicting minor structural damage on the exterior. Fortunately, nobody is hurt, but Houston TranStar is essentially out of operation for an extended period of time.

The STOC has been monitoring the situation remotely. Knowing that Houston TranStar has gone offline, the STOC augments its staff to take over traffic management responsibilities with portions of the ITS program that have not gone offline. This had been outlined in standard operating procedures that were developed by the STOC and regional TMC stakeholders, so all parties know what to do, who to contact, and when they should
intervene. Jeff is able to contact the STOC and work with operators there to assess the damage and forward any ongoing issues.

Hurricane Mitchel dissipates, but the damage remains. Jeff volunteers to relocate to the STOC to continue his duties there, as the STOC was far enough inland to not sustain any damage. The STOC manages the Houston area as a support service to the SOC until TranStar is brought back online and can resume operations.

5.6 **Local TMC Requests Assistance**

It’s 11 p.m. on a Saturday night at the DalTrans TMC. The overnight shift is generally very uneventful. Most of the operators have already gone home, leaving three operators until the next shift begins at 6 a.m. Megan is one of these three operators. She has worked as an operator at DalTrans for over five years and so far, tonight has been a typical overnight shift. While conducting routine ITS device checks, Megan receives a call regarding a large overturned truck of hazardous materials on I-35E near the Dallas Zoo. As Megan and her fellow operators begin posting messages and coordinating with local responders, more reports come in about a multi-vehicle crash on I-45 near downtown, with potentially multiple injuries and a fatality. Megan takes the lead on managing that incident when, yet again, reports of secondary crashes along I-45 due to congestion from the primary incident start coming in, as well as additional reports of other incidents on I-30. Suddenly, DalTrans is managing six incidents, with I-35E shut down to deal with the hazardous materials and I-45 down to a single lane. Making matters worse, the threat of inclement weather, namely icy conditions, has become part of the weather forecast.

Megan posts messages on all DMSs in the Dallas region, but realizes it will not be enough. She immediately contacts the STOC to request additional messaging outside of the DalTrans region to notify the traveling public of I-35E being closed. Several standard operating procedures had been established through coordination with STOC and regional TMC stakeholders, so Megan knows exactly what calls to make in this situation. The STOC assists by providing messaging outside of the DalTrans monitoring area to notify motorists well in advance of the I-35E closure. They indicate that they are able to assist further if needed.

In the meantime, those six incidents have increased dramatically to 14 incidents, and reports of additional issues around the network are coming in. First responders are requesting a lot of assistance from DalTrans because motorists are not diverting away from their scene, causing widespread congestion and secondary incidents. Megan and her team are working tirelessly to assist further when a major incident is reported on U.S. 175 near Seagoville, with multiple fatalities and a full road closure. Realizing that DalTrans cannot successfully accommodate all of these incidents simultaneously, Megan immediately contacts the STOC and requests operator assistance on the U.S. 175 incident. STOC operators have viewing capabilities of all DalTrans ITS devices, as well as the playbook for managing incidents in certain areas, so they are able to quickly jump in to assist Megan’s
In the ATMS, Megan assigns control of certain regional devices to the STOC who are able to manage the U.S. 175 incident from their facility. The STOC stays in constant communication with Megan to keep her informed of how that incident is being resolved and logs all information into the ATMS.

Over the next hour, Megan and her coworkers at DalTrans diligently work to resolve the incident on I-35E and I-45. With such a major event, it’s crucial they focus on providing efficient alternate routes for motorists and handle any secondary crashes. Fortunately, the icy rain never falls, helping prevent additional issues. After many long hours, law enforcement and emergency personnel are able to clear the incident and reopen up both roadways to full operations. Meanwhile, the STOC has successfully managed and cleared the U.S. 175 incident, providing confirmation to Megan that the incident has been cleared and returning all device control back to DalTrans. Megan is relieved that the STOC was put into service, as having the extra staff available to assist allowed her team to continue serving Dallas-area motorists despite the number of simultaneous incidents.

5.7 Managing Statewide Freight Operations during Disruptions
Meteorologists had forecasted that the above-average rainfall this year would be over by May, but storm after storm continued deep into the summer, causing rivers all around Texas to experience intermittent flooding. Many Texas highways—including a good number that are designated as part of the THFN—experience sudden flooding due to rainfall in some other part of the State. TxDOT is monitoring the situation on a daily basis, but localized flooding problems mean local traffic managers can get overwhelmed with closures very quickly.

On a particular Tuesday, the San Antonio region is experiencing a record amount of flooding and roadway closures, which has affected portions of I-10. The San Antonio TransGuide TMC is focusing on managing regional traffic and incidents associated with these closures. At a wider scale, Tuesday is a particularly busy day for truck traffic from the west coast into Houston along I-10. At the STOC, operators are aware of higher truck traffic along I-10 through data collected from the vehicle detectors. Since maintaining the efficient movement of goods is a statewide priority for TxDOT, the STOC shifts its priorities to managing freight operations while San Antonio TransGuide focuses on the regional traffic. The STOC reviews its “I-10 Closure” countermeasure and works to reroute freight traffic through parallel freight routes that bypass San Antonio. This becomes tricky given the amount of flooding, but the STOC has good situational awareness through its collaboration with San Antonio TransGuide and local traffic management groups in the area. Through strategic messaging via DMSs and advanced notification through DriveTexas, the STOC is able to reduce the volume of truck traffic traveling through San Antonio, which helps TransGuide restore their transportation network with fewer issues.

Eventually, the floodwaters recede and the road network is returned to full operation. The STOC confirms with the TransGuide TMC that the roads around San Antonio are operating
once again. With that confirmation, the STOC deactivates their mitigation plan and removes the notifications from the rural DMSs.

5.8 Accommodating Remote Management during Public Health Crisis

When the first cases of a new public health concern were reported, few people believed that it would graduate to a global crisis that would create many economic, social, and political impacts. However, cases begin to appear in the United States and state and local officials in Texas start generating plans for keeping their citizens safe. Harris County elects to initiate a stay-at-home policy to help discourage people from congregating. The Houston TranStar TMC is located within Harris County and there are concerns about community virus spread with staff collaborating so closely together. Managers review the operations and realize that they want to implement a working environment that meets safe social distancing requirements, but know that means that they will need to reduce the number of staff physically present at TranStar. One manager asks the question that is on everyone’s minds: “How are we going to manage our transportation system if staff cannot physically be in-house?”

TxDOT managers feel strongly about staff safety and develop a plan to transition to home-based operations. In the immediate term, the STOC—which is located outside Harris County and not currently in a county with a stay-at-home policy—would operate and manage the Houston area so that TranStar operators do not have to work in the same space. TranStar operators, in the meantime, would receive TxDOT-provided workstations and phone service at their own home to create a virtual workspace from which to manage the transportation network. With a unified ATMS platform, remote access can be done from anywhere that is within TxDOT’s network, including VPN access. Operators that are at home can still view the cameras, add or remove messages to the DMSs, and conduct other activities. Using their home phones, operators are able to collaborate with one another and operate the system.

TranStar operators could also physically relocate to the STOC, but with the public health crisis spreading to all counties, the stay-at-home order would likely affect the STOC as well. Still, by having the unified ATMS platform, TxDOT TMC operators, managers, and administration can access the ITS program and manage the network remotely. Operators work from the comforts of their own homes on their own workstations, making good use of their phones to coordinate their activities with their partners still working in TranStar. Even though operators face the same challenges as others who work from home, TxDOT is able to maintain a good quality of service in traffic management and incident response.
6.0 Next Steps

This STOC ConOps is one of six ConOps documents being prepared as part of the FNTOP. As noted earlier, these six strategies were chosen through a selection process that vetted a total of 10 identified strategies with key stakeholders. Each ConOps intends to further answer how each specific strategy would operate, which systems it would interface with, and how various user groups would be impacted by the introduction of the strategy. Based on this document, this strategy is ready for TxDOT to advance to implementation planning in the future, which would include the development of system requirements and high-level design (detailed further in the Implementation Plan as shown in Exhibit 47).

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

Exhibit 47: Next Steps in the Texas FNTOP
7.0 References
The following is a list of relevant documents, standards, and references used in preparing this document:

- Texas Department of Transportation, Texas Freight Mobility Plan 2018, March 7, 2018.


