Texas Freight Network
Technology and Operations Plan

Blocked Rail Crossing Traffic Management System Concept of Operations
Texas Department of Transportation, Freight Planning Branch

Final: December 2020
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<th>Description</th>
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<tbody>
<tr>
<td>AASHTO</td>
<td>American Association of State Highway and Transportation Officials</td>
</tr>
<tr>
<td>API</td>
<td>Application Programming Interfaces</td>
</tr>
<tr>
<td>ATIS</td>
<td>Advanced Traveler Information System</td>
</tr>
<tr>
<td>ATMS</td>
<td>Advanced Traffic Management System</td>
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<tr>
<td>CAT</td>
<td>Cooperative Automated Transportation</td>
</tr>
<tr>
<td>CCTV</td>
<td>Closed-Circuit Television</td>
</tr>
<tr>
<td>ConOps</td>
<td>Concept of Operations</td>
</tr>
<tr>
<td>CTECC</td>
<td>Combined Transportation, Emergency &amp; Communications Center</td>
</tr>
<tr>
<td>CTRMA</td>
<td>Central Texas Regional Mobility Authority</td>
</tr>
<tr>
<td>CTT</td>
<td>Comparative Travel Time</td>
</tr>
<tr>
<td>CV</td>
<td>Connected Vehicle</td>
</tr>
<tr>
<td>DART</td>
<td>Dallas Area Rapid Transit</td>
</tr>
<tr>
<td>DGNO</td>
<td>Garland &amp; Northeastern Railroad</td>
</tr>
<tr>
<td>DMS</td>
<td>Dynamic Message Sign</td>
</tr>
<tr>
<td>ETA</td>
<td>Estimated Time of Arrival</td>
</tr>
<tr>
<td>FHWA</td>
<td>Federal Highway Administration</td>
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<tr>
<td>FNTOP</td>
<td>Freight Network Technology and Operations Plan</td>
</tr>
<tr>
<td>FRA</td>
<td>Federal Railroad Administration</td>
</tr>
<tr>
<td>GIWW</td>
<td>Gulf Intracoastal Waterway</td>
</tr>
<tr>
<td>GUI</td>
<td>Graphical User Interface</td>
</tr>
<tr>
<td>HCRS</td>
<td>Highway Condition Reporting System</td>
</tr>
<tr>
<td>HOS</td>
<td>Hours-of-Service</td>
</tr>
<tr>
<td>I-35</td>
<td>Interstate 35</td>
</tr>
<tr>
<td>IEC</td>
<td>International Electrotechnical Commission</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronics Engineers</td>
</tr>
<tr>
<td>ISO</td>
<td>International Organization for Standardization</td>
</tr>
<tr>
<td>ITS</td>
<td>Intelligent Transportation System</td>
</tr>
<tr>
<td>M-69</td>
<td>Marine Highway 69</td>
</tr>
<tr>
<td>METRO</td>
<td>Metropolitan Transit Authority of Harris County</td>
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<tr>
<td>MPO</td>
<td>Metropolitan Planning Organization</td>
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<tr>
<td>MTP</td>
<td>Metropolitan Transportation Plan</td>
</tr>
<tr>
<td>MUTCD</td>
<td>Manual on Uniform Traffic Control Devices</td>
</tr>
<tr>
<td>O&amp;M</td>
<td>Operations and Maintenance</td>
</tr>
<tr>
<td>OBU</td>
<td>On-Board Unit</td>
</tr>
<tr>
<td>OEM</td>
<td>Original Equipment Manufacturer</td>
</tr>
<tr>
<td>PAAC</td>
<td>Port Authority Advisory Committee</td>
</tr>
<tr>
<td>PII</td>
<td>Personally Identifiable Information</td>
</tr>
<tr>
<td>PTC</td>
<td>Positive Train Control</td>
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<tr>
<td>RIMS</td>
<td>Regional Incident Management System</td>
</tr>
<tr>
<td>Acronym</td>
<td>Description</td>
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<tr>
<td>---------</td>
<td>-------------</td>
</tr>
<tr>
<td>ROW</td>
<td>Right of Way</td>
</tr>
<tr>
<td>RSU</td>
<td>Roadside Unit</td>
</tr>
<tr>
<td>SOP</td>
<td>Standard Operating Procedure</td>
</tr>
<tr>
<td>STRATIS</td>
<td>South Texas Regional Advanced Transportation Information System</td>
</tr>
<tr>
<td>SWRI</td>
<td>Southwest Research Institute</td>
</tr>
<tr>
<td>TFMP</td>
<td>Texas Freight Mobility Plan</td>
</tr>
<tr>
<td>THFN</td>
<td>Texas Highway Freight Network</td>
</tr>
<tr>
<td>TIP</td>
<td>Transportation Improvement Program</td>
</tr>
<tr>
<td>TMC</td>
<td>Traffic Management Center</td>
</tr>
<tr>
<td>TMFN</td>
<td>Texas Multimodal Freight Network</td>
</tr>
<tr>
<td>TMUTCD</td>
<td>Texas Manual on Uniform Traffic Control Devices</td>
</tr>
<tr>
<td>TTI</td>
<td>Texas Transportation Institute</td>
</tr>
<tr>
<td>TxDOT</td>
<td>Texas Department of Transportation</td>
</tr>
<tr>
<td>TxDPS</td>
<td>Texas Department of Public Safety</td>
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<tr>
<td>USDOT</td>
<td>United States Department of Transportation</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 Blocked Rail Crossing Traffic Management System strategy, which was one of the strategies identified in the FNTOP and recommended by stakeholders for advancement to the ConOps phase. The objective of a ConOps is to describe the operation of the proposed system in a non-technical and easy-to-understand manner. How the system is to be used and its anticipated benefits is described from multiple stakeholder viewpoints as a way to provide a bridge between the needs that motivated the project and the specific technical requirements.

1.1 Project Overview
The primary goal of 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 (DMS), connected vehicle (CVs) roadside units, etc.) and related infrastructure, digital framework and related infrastructure, operations, staffing and expertise, and statewide, corridor, urban, and rural needs and partnerships;
- Assess the TMFN’s current and future technological and operational needs, as well as its readiness and adaptability potential associated with the impacts of existing and emerging technologies;
- Develop strategies, policies, programs, and projects to address technological and operational needs; and
• Develop an Implementation Plan and a set of Concept of Operations documents, with each focused on a near-term freight network technology “early win” deployment concept.

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

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

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

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

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

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

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

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

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

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

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

1.3 **Stakeholder Engagement**

The FNTOP began with research on existing freight initiatives at TxDOT to gain a better understanding of the current challenges faced by the Texas freight community. TxDOT then reached out to a diverse group of stakeholders with a goal to solicit feedback and opinions on the current state of freight operations in Texas and the vision for the application of technology to support future freight operations. The stakeholder interviews verified and supported many of the issues identified by the FNTOP, while also informing the prioritization of potential strategies to address deficiencies in the system.

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

\(^1\) Texas Department of Transportation, *Texas Freight Mobility Plan 2018*, March 7, 2018.
Critical Rural Freight Corridors and another 372 miles designated as Critical Urban Freight Corridors. In 2016, trucks accounted for 54 percent of total tonnage moved in Texas. Intrastate trucking tonnage is anticipated to grow significantly as more residents, businesses, and freight locate within the state.

- **Railroads:** With 10,539 track miles (all on the TMFN), Texas has more miles of rail and more railroad employees than any other state. Texas contains five of the seven rail 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, maritime ports and waterways, airports, and international border crossings. Exhibit 3 maps out where these assets are located in Texas. The TMFN is important because it identifies the key corridors that facilitate the efficient and safe movement of goods in Texas and are the most critical for focused investment.
Exhibit 2: Overview of Texas Multimodal Freight Network Assets

- **313,000** roadway centerline miles
  - 21,861 miles on the Texas Highway Freight Network
  - 749 miles of Critical Rural Freight Corridor
  - 372 miles of Critical Urban Freight Corridor

- **10,539** miles of railroads on the TMFN
  - 3 Class I railroads
  - 49 Class II or shorterline railroads

- **21** ports and the Gulf Intracoastal Waterway system
  - 12 deepwater ports
  - 9 shallow draft ports
  - 1 included on TMFN
  - 879 miles of GIWW, all on TMFN

- **24** commercial airports
  - 7 air cargo airports on TMFN

- **426,000** miles of pipeline
  - 59% intrastate
  - 41% interstate

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

**Transporting**
- 1.2 billion tons
- 441 million tons
- 598 million tons
- 1.8 million tons
- 837 million tons
- 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 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>
</tr>
</thead>
<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 &amp; Reliability</td>
<td>Reduce congestion and improve system efficiency and performance</td>
</tr>
<tr>
<td>Multimodal Connectivity</td>
<td>Provide transportation choices and improve system connectivity for all freight modes</td>
</tr>
<tr>
<td>Stewardship</td>
<td>Manage environmental and TxDOT resources responsibly and be accountable in decision-making</td>
</tr>
<tr>
<td>Customer Service</td>
<td>Understand and incorporate citizen feedback in decision-making processes and be transparent in all TxDOT communications</td>
</tr>
<tr>
<td>Sustainable Funding</td>
<td>Identify sustainable funding sources for all freight transportation modes</td>
</tr>
</tbody>
</table>

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

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

The FNTOP reviewed the existing ITS program in Texas, which represents the vast majority of TxDOT’s real-time traffic management applications that serve roadway user needs, including freight. TxDOT utilizes Traffic Management Centers (TMC) as one of the key tools to operate and manage its road network. 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; that said, 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 2.2.1.4. Further details on these programs and others can be found in the FNTOP State of the Practice Assessment Report and FNTOP Inventory of Existing Conditions Report.

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

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

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

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

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

<table>
<thead>
<tr>
<th>Identified Strategy</th>
<th>Recommendation</th>
</tr>
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<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 proposed FNTOP strategies could work together as an integrated statewide system. The framework helps illustrate the relationships between the FNTOP strategies and any overlapping opportunities that might allow for easier deployment. All strategies have the potential to be implemented together in functional groups or as stand-alone systems.

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

- Regional TMC(s)
  - ATMS
  - 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 Signage, and Data
- Smart Work Zone Information System
- Blocked Rail Crossing Traffic Management System
- Smart Freight Connector
- Safety Warning Detection System
- Truck Parking Availability System

- Real Time Traffic Data
- Notifications
- High-Resolution Freight Traveler Information System
- Partner Agencies
- Nav/Map/Traffic Services
- Other Stakeholders
- Media Outlets
- Gov Auth/ Emerg Serv
- Data Subscribers
- DriveTexas ATIS

Binational Traffic Operations Center
1.7  Purpose of the Concept of Operations Document

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

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

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

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

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

Exhibit 8: Systems Engineering V-Model

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

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2 Federal Highway Administration California Division and Caltrans, Systems Engineering Guidebook for ITS Version 3.0 Website
1.8 Blocked Rail Crossing Traffic Management System Overview

This ConOps is focused on a Blocked Rail Crossing Traffic Management System, which was one of the strategies identified in the FNTOP and recommended by stakeholders for advancement to the ConOps phase. At a high level, the Blocked Rail Crossing Traffic Management System would be a notification system that alerts truckers and other road users of situations when a highway-rail at-grade crossing has been occupied for an extended period of time. The goals of this system would be to help improve freight mobility by reducing queue delays due to extended blockages, as well as improve safety by reducing back-of-queue crashes and other consequential incidents.

Exhibit 9 provides an illustrative example of the Blocked Rail Crossing Traffic Management System strategy that was previously discussed in the FNTOP Strategies and Conceptual Framework Report.

**Exhibit 9: Illustrative Example of Blocked Rail Crossing Traffic Management System Strategy**

Key objectives—collected through stakeholder outreach and other FNTOP efforts—identified to frame what this system shall ultimately do include:
▪ Improve freight mobility in and around locations that are blocked by stopped or slow moving trains for an extended period of time;
▪ Reduce secondary incidents caused by queuing by providing alternatives to waiting in the queue;
▪ Provide real-time notifications of potential delays so that freight, emergency vehicles, and other road users can divert onto an alternative route;
▪ Improve interagency coordination and overall traffic management at the local level;
▪ Increase TMCs’ situational awareness as the events occur in the field; and
▪ Provide historical and real-time data (e.g. blocked crossing duration) for better traffic operations and management, as well as responding to citizen complaints regarding crossing blockages.

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 13623, 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 Blocked Rail Crossing Traffic Management System.** This section contains a description of the desired system and high-level requirements, how it will address the concerns outlined in Section 2, how it will operate, and how users will interface with the system.

▪ **Section 4 – Benefits, Impacts, and Alternatives of the Blocked Rail Crossing Traffic Management System.** This section describes the expected operational and organizational benefits and impacts of the essential features of the new system, the potential impacts during development, disadvantages and limitations of the proposed system, and alternatives and tradeoffs considered while developing the system concept.

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3 ANSI refers to the American National Standards Institute, AIAA refers to the American Institute of Aeronautics and Astronautics, and IEEE refers to the Institute of Electrical and Electronics Engineer. All three are standards-setting organizations.
- **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, including the existing systems currently in operation, and the deficiencies that are present. It later discusses the user classes that could apply to this ConOps document and the User Needs that support motivations to pursue a new Blocked Rail Crossing Traffic Management System.

2.1 Description of the Current Situation
With 10,539 track miles (all on the TMFN), Texas has more miles of rail and more railroad employees than any other state. Exhibit 10 shows all rail lines in Texas. 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’ ports, and many of the state’s rail-served industries.

The Federal Railroad Administration (FRA) maintains the national Highway-Rail Crossing Database. Railroad companies are required to provide data on train volumes and approximate speeds for each crossing. This resource is used by TxDOT to help identify problematic rail crossings. Updated monthly, the dataset contains information on rail crossings throughout the U.S. There are currently 16,213 active railroad crossings in Texas, as shown in Exhibit 11, operated by a variety of rail carriers. Approximately 9,500 of the crossings are public at-grade crossings. The remaining are private crossings where the roadway is owned by a private entity. Some of the railroads are larger, national operators, such as Union Pacific Railroad and BSNF Railway, and others are local freight or transit operators, such as Dart Trucking and Dallas, Garland & Northeastern Railroad (DGNO). Currently, 550 of the traffic signals managed by TxDOT receive railroad signal preemption (see Section 2.2.1.3 for more information).
Exhibit 10: State Railroad Map

Source: TxDOT, State Railroad Map 2016.
Exhibit 11: Texas Railroad Network and Active Railroad Crossings

The 2018 TFMP provides a comprehensive multimodal freight transportation plan for Texas, which is based on a decade of multimodal strategic planning and stakeholder collaboration at the statewide, regional, and local levels to facilitate continued economic growth and
goods movement throughout the state. The TFMP and its related recommendations supports
the USDOT National Multimodal Freight Policy and national freight goals, and includes state-
specific recommendations to explore technology options as part of policy and planning to
enhance freight transportation system safety, management, operations, and asset
preservation. Exhibit 12 summarizes how Texas’s freight mobility goals and associated
objectives relate to rail\(^4\). The following subsections highlight the key existing conditions
associated with Texas’ freight mobility goals regarding highway freight mobility near rail
crossings.

*Exhibit 12: Texas’ Freight Mobility Goals and Objectives Related to the Rail Mode*

<table>
<thead>
<tr>
<th>2018 TFMP Goals</th>
<th>Description</th>
<th>Objectives Related to the Rail Mode</th>
</tr>
</thead>
</table>
| Mobility & Reliability | Reduce congestion and improve system efficiency and performance | • Apply the most cost-effective methods to improve system capacity and reliability (including technology and operations).  
• Partner with U.S. and Mexican federal, state, regional, local, and private sector stakeholders to address Texas-Mexico border crossing challenges.  
• Support the development and deployment of integrated Texas-Mexico border crossing management through ITS.  
• Leverage technology to improve management and operations of the existing transportation system. |
| Safety | Improve multimodal transportation safety | • 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. |

### 2.1.1 Mobility & Reliability

Today, Texas’ rail system plays an essential freight transportation role throughout the state, nationally, and internationally. Texas’s location and position on principal national rail corridors provides rail access to every region of the U.S., as well as to Mexico and Canada.

\(^4\)Texas Department of Transportation, 2019 Texas Rail Plan, December 2019.
Texas provides the majority of U.S. rail access points to Mexico, connecting this market to the Mid-Atlantic, Northeast, and Midwest regions of the country. Ports located on the Gulf Coast and on inland waterways also position Texas to be among the most important freight and intermodal transportation states in the nation. The combination of rail and trucking support a major intermodal freight transportation system with approximately 20 intermodal transfer facilities throughout the state. In addition, major freight intermodal logistics facilities have been developed in Fort Worth and at the Port of San Antonio where the interchange of freight between rail, truck, and air modes have produced opportunities for logistics and distribution industries. Multimodal connections also exist between the state’s rail network and commuter or rail transit networks in large cities like Dallas, Fort Worth, and Austin and, in some cases, commuter rail services operate on shared-use corridors owned by freight railroads or public agencies.\(^5\)

At-grade highway and rail intersections present a natural conflict point between freight modes. Rail always has priority at all at-grade rail crossings and local and state agencies have no authority to enforce time limits on how long a railroad can block a crossing. Railroad companies want to increase their efficiency by increasing their 10,000-foot train lengths (two miles) up to 15,000 feet, which can increase the “gate down” time at crossings as well as increase the chance of blocked crossings, particularly as trains maneuver into terminals. Railroads naturally want to keep their trains moving, as their revenue comes from delivery of goods. Occasionally issues are encountered that require a train to stop on the tracks, sometimes at locations that obstruct a highway crossing. Trains block crossings for a variety of reasons. The most common reason is regular train service, which creates the shortest gate down time as the train moves by at speed. Longer delays occur when a train has unexpected mechanical problems with locomotives, train cars, or malfunctioning active warning devices that keep gates in the down position. In addition, in major industrial areas where trains are entering rail yards or port facilities, crossings may be blocked for extended periods of time as trains reduce speed and at times must repeatedly move back and forth through the crossing to access appropriate rail tracks and terminals as trains are built and/or broken up. By federal law, railroad employees cannot work more than 12 hours per day, so there are instances when a train must stop until a relieving crew can take over\(^6\).

Most train activity at crossings results in minimal disruption to highway traffic, but the longer stoppages can result in significant queuing and propagating travel delays for the highway users. While there is limited data captured in Texas regarding delays caused by trains, a 2013 study conducted by the Northwestern Indiana Regional Planning Commission revealed that the worst crossings in the region closed their crossing gates for approximately 1.5 to 7.5 minutes per closing\(^7\). In Chicago, it was reported that in 2011, 7,817 hours of delay

\(^5\)Texas Department of Transportation, 2019 Texas Rail Plan, December 2019.

\(^6\)Texas Department of Transportation, Rail Division, Rail Frequently Asked Questions.

\(^7\)Northwestern Indiana Regional Planning Commission, Rail Crossing Issues in NWI.
were experienced by 384,037 motorists spread across 1,468 rail crossings (only taking into account weekday delays)\(^8\).

While Positive Train Control (PTC)—discussed in Section 2.2.2.2—provides very accurate information on where the train is, freight railroads do not typically publish train schedules. While trains tend to operate on a schedule that can become predictable to local drivers, daily variances due to things like customer needs, mechanical issues, and weather disruptions makes it difficult for trucking companies to reliably plan ahead and avoid delays caused by blocked rail crossings. The unforeseen stoppages and the lack of schedules create many mobility and reliability challenges for truck drivers.

Certain rail crossings are equipped with automatic gates and will notify the local traffic management center when the gates are down (e.g., Interstate 35 (I-35) in Laredo) so that the TMC can notify the public via DMS when the gates are down for an extended period of time. TxDOT takes an active role in grade-separating highway and rail crossings with particularly high traffic volumes, but due to the high infrastructure cost, only one or two new grade separation projects can be completed per year. As a result, TxDOT must mitigate the impacts of blocked rail crossings using other tools.

2.1.2 Safety
Safety is the number one consideration for TxDOT. At-grade rail highway crossings create a major conflict point for train and vehicular traffic. Incidents often result in significant injury or death. Crossing proximity to intersections, lack of adequate warning devices, and poor behavior of drivers, pedestrians and cyclists exacerbate conflicts.

Intersections near highway-rail at-grade crossings have multiple types of traffic: vehicles, trains, pedestrians and cyclists, causing a natural conflict point between modes. When a highway-rail at-grade crossing is located near a signalized intersection, it is possible that queues from the intersection could extend over the at-grade crossing and potentially cause stopped vehicles to become trapped on the tracks. For vehicles stuck on railroad tracks, in most cases, automatic detection is not available-only an emergency call number is posted. Safety issues during lengthy disruptions occur beyond the rail crossings themselves. Statewide, nearly 600 people have reported stalled trains to TxDOT since 2018, with crossings in Houston responsible for more than 25 percent of those complaints. Residents have reported trains being stopped for as many as six hours, forcing school buses and ambulances to find alternate routes around blocked intersections. In addition, trains have been known to block certain intersections at least four times a week and sometimes more than once per day.

\(^8\) Chicago Metropolitan Agency for Planning, Crossing Delay.
When inattentive drivers stop too quickly at crossing gates or the queues building up behind a lowered crossing gate, vehicles behind them have less time to react (especially slow-moving heavy freight vehicles), potentially leading to rear-end incidents. Due to the high frequency of blocked crossings, drivers have also been known to disregard active grade crossing warning devices and maneuver around lowered gates or past flashing lights and enter a crossing to try and “beat the train”. Pedestrians may also exhibit unsafe behavior by cutting across railroad tracks as a shortcut to a destination on the opposite side of the railroad tracks.9

Passive crossings (crossings with no train-activated warning devices) also pose a risk to drivers. Drivers may fail to look both ways to ensure the track is clear before attempting to cross a passive crossing, or a passive crossing sight distance may be obstructed by vegetation or by buildings.10 Some cities have installed cameras on poles off ROW to determine when a crossing gate has been down for an extended period of time. In some towns, this information is automatically sent to their 911 center so that the 911 operators can better route emergency vehicles.

The FRA’s Office of Safety maintains nationwide rail crossing accident and inventory information, including highway and rail crossing incident trends. Highway users include, but are not limited to, automobiles, buses, trucks, motorcycles, bicycles, recreational vehicles, farm vehicles, construction vehicles, roadway maintenance vehicles, pedestrians, and any other mode of surface transportation motorized or un-motorized.

Exhibit 13 shows the number of incidents at Texas at-grade highway and rail intersections by location from January 2011 to April 2020. There has been a total of 2,194 incidents resulting in 191 fatalities and 937 injuries. The counties with the highest number of incidents are: Harris County (323), Bexar County (106), Dallas County (104), Tarrant County (100), Fort Bend County (60) and El Paso County (53). These counties are all located in more developed areas.

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Exhibit 13: Highway-Rail Incidents for Texas, January 2011 to April 2020

Exhibit 14 shows the annual incident rate at at-grade highway and rail intersections over the past 10 years in Texas. Starting in 2012, the trend shows a slight increase in the incident rate year after year, except for a spike in 2014. In the first four months of 2020 alone, there have already been 3.21 incidents per 1,000,000 train miles, the highest rate in the past 10 years.
2.2 Existing Systems

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

2.2.1 Roadway Traffic Management Programs

2.2.1.1 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 widespread and coordinated level. Seven TMCs currently operate in Texas, which tend to be strategically placed near the urban areas where traffic volumes are highest and road incidents are generally more frequent. These TMCs typically provide services to state-owned roads and often manage the ITS...
assets for an adjacent District that may not have a TMC. Exhibit 15 summarizes each of the TxDOT TMCs, and Exhibit 16 shows the location of each TMC.

### Exhibit 15: TxDOT Traffic Management Centers

<table>
<thead>
<tr>
<th>TxDOT Traffic Management Centers</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Austin Combined Transportation, Emergency &amp; Communications Center (CTECC)</strong></td>
<td>Austin CTECC serves as the TMC for the Austin area, and also supports 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><strong>Dallas DalTrans</strong></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><strong>El Paso TransVista</strong></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><strong>Fort Worth TransVision</strong></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><strong>Houston TranStar</strong></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><strong>Laredo South Texas Regional Advanced Transportation Information System (STRATIS)</strong></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><strong>San Antonio TransGuide</strong></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>
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 through a smaller workstation with client software to deal with special events or emergencies, as opposed to a real-time traffic management system.

Separate from TxDOT, several cities and counties within Texas operate their own TMCs to manage their traffic signals and other events. In many instances, they collaborate with the nearby TxDOT District TMC if one exists, even when that TMC is housed in a separate facility. Many of these are cities that use TMCs to manage events or coordinate emergency response.

2.2.1.2 TxDOT Real-Time Traffic Management

All TxDOT TMCs operate their ITS programs using Advanced Traffic Management System (ATMS) software, as summarized in Exhibit 17. The ATMS software integrates multiple ITS devices into one single platform for easy operator use and management within each TMC. Previously, the legacy ITS program 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 to work collaboratively at the single press of a button or entry of a specific event type.

TxDOT utilizes LoneStar for its TMCs, which is based on the ActiveITS system developed by the Southwest Research Institute (SWRI). ActiveITS is also used in other states under different names. An exception to LoneStar’s use is in the Houston TranStar facility, which utilizes the Regional Incident Management System (RIMS) ATMS Platform, developed by the Texas Transportation Institute (TTI). It is important to note that while the ATMS may encompass the majority of the ITS devices that are controlled by a TMC, there are often certain devices that are operated under a separate software platform at the same facility, which can lead to gaps in data visibility under a single platform.

Exhibit 17: 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>
2.2.1.3 Railroad Traffic Signal Preemption

Approximately 550 of the traffic signals managed by TxDOT are instrumented with Railroad Traffic Signal Preemption systems. Railroad Traffic Signal Preemption systems are devices that send preemption requests from a railroad crossing device to a traffic signal controller to preempt the signal phasing in a way that provides green times (e.g. green lights) to vehicles that need to get clear of a railroad crossing prior to an approaching train. These systems also provide preemption—subsequent to clearing out the approach with a conflict—to intersection movements that do not cause vehicles to get stuck at a crossing, which reduces the chance of queuing into an intersection. Typically, railroad traffic signal preemption systems give the green light to the road that runs parallel to the railroad tracks, which allows for traffic movements that do not conflict with the railroad movement for the duration of the train movement.

Traffic signals that are installed near highway-rail at-grade crossings may be candidates for preemption by the railroad equipment. As outlined in the TxDOT Traffic Signals Manual, the traffic signal controller is connected to railroad equipment that includes track sensors to alert of the presence of a train, either to permit “simultaneous” (i.e., at the same time the railroad lights flash) or “advance” (i.e., prior to the time when the railroad lights flash) preemption. Railroad traffic signal preemption is required, per the TxDOT Traffic Signal Manual and the TxDOT Rail-Highway Operations Manual, for all intersections within 200 feet of a highway-rail at-grade crossing, and should be considered at other intersections where traffic routinely spills back over the crossing due to the signals or other congestion. An agreement with the railroad and the equipment owner is required, and it supersedes any preemption request from an emergency vehicle or priority request from transit or trucks, as applicable.

In general, if a signalized intersection is within 250 feet of a highway-rail at-grade crossing (or sometimes up to 500 feet), it will be evaluated for preemption. The preemption system works locally at each equipped traffic signal controller. Preemptions are not managed by LoneStar for TxDOT traffic signals and rail preemption requests are not communicated to other parties whose priority request has been superseded.

2.2.1.4 ITS Field Devices

TxDOT operates an extensive network of ITS field devices as part of its traffic management programs. Most ITS deployments are located near major urban areas or along highly traveled routes, as the largest benefit to road users (passenger cars, freight, etc.) is often captured by focusing investments in these 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 certain areas.
Some of the ITS equipment is highlighted as an existing system that could benefit traffic management near railroad crossing locations, which includes:

- CCTV Cameras; and
- DMS.
- Detection
- Roadside units (RSU)

**CCTV Cameras**

CCTV cameras are roadside devices that provide visual coverage of locations along traveled 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. Video feeds are transmitted back to the TxDOT District for real-time viewing; where TMCs are present, operators may keep these video feeds on in the background for passive monitoring and early detection of non-routine congestion. During incidents, CCTV cameras provide a high degree of visual clarity of how the incident is progressing, which allows for better management of the event and accurate dissemination of information to the public. They also can provide visual clarity on areas that experience mobility challenges, such as locations with recurrent traffic queues, which can help operators make informed response decisions.

Exhibit 18 shows the deployment of CCTV cameras at a statewide level. Across the State, TxDOT operates over 2,700 CCTV cameras.
**DMS**

DMS are electronic roadside signs that can broadcast changeable messages to road users, which may include public safety, traveler information, incident, 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. Most DMS are the large electronic signs that appear over Texas highways, but smaller equivalents can be found on other routes. In the Austin District, there are a few DMS that are classified as Comparative Travel Time (CTT) signs, which are static sign panels with changeable matrix boards that update the travel times for fixed routes.

Exhibit 19 shows the deployment of DMS at a statewide level. Across the State, TxDOT operates over 980 DMS. While these signs were deployed for different reasons over the years, their messages can be repurposed depending on the applications that are in the area.
Exhibit 19: TxDOT ITS Inventory - Dynamic Message Signs

Source: Texas Department of Transportation, Traffic Safety Division
2.2.1.5 Traveler Information Services
TxDOT operates several public-facing data services that provide reported traffic, incident, and road construction information. These services can be used to help motorists make informed travel decisions, either prior to their trip or during. This section focuses on the data exchange services that are managed by TxDOT.

Drive Texas
DriveTexas serves as the online, public-facing database that provides real-time highway conditions throughout Texas. This data can include construction projects, road closures, and other delays, as well as real-time traffic and future construction projects. 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.

DriveTexas at a statewide level is shown in Exhibit 20.

Exhibit 20: DriveTexas Website (Statewide)

2.2.1.6 Social Media Channels – Twitter
TxDOT provides real-time updates through established Twitter accounts, which include a statewide account as well as separate feeds for each of the TxDOT Districts. The statewide account focuses on similar large-scale notices that would be found on the TxDOT media page or Facebook account, whereas the local District feeds focus on day-to-day alerts and notifications related to construction, incidents, and weather. Exhibit 21 shows an example of the statewide TxDOT Twitter Website.
2.2.2 Rail Traffic Management Programs

2.2.2.1 Traffic Control Devices
The two main levels of traffic control at highway and railroad at-grade crossings are passive and active control devices. Passive devices provide static messages of warning, guidance, or action required by the driver (e.g., signs and pavement markings). Active control devices are activated by a train tripping a detection circuit in the track and will give warning of the approach or presence of a train. One of the most predominant forms of active traffic control is the use of automatic gates, which physically block the travel lanes and are used in conjunction with flashing lights. Another example of active traffic control devices are railroad signal preemption systems which send preemption requests from a railroad crossing device to a traffic signal controller to preempt the signal phasing in a way that provides green times (e.g. green lights) to vehicles that need to get clear of a railroad crossing prior to an approaching train (described in more detail in Section 2.2.1.3). Active control devices are typically supplemented by the same signs and markings used at passive crossings.\(^{11}\) Examples of passive and active control devices are shown in Exhibit 22.

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\(^{11}\) Federal Highway Administration, Design Guidelines For At-Grade Intersections near Highway Railroad Grade Crossings, November 2000
2.2.2.2 Positive Train Control on Texas Railroads

In 2008, Congress passed legislation requiring that a technology called PTC be installed on tracks that carry passengers and certain hazardous materials. PTC is a highly advanced technology designed to automatically stop a train before certain human-error types of incidents occur. PTC aims to reduce or prevent four specific types of incidents:

▪ Train-to-train collisions;
▪ Derailments caused by excessive speed;
▪ Accidents that can occur if trains are routed down the incorrect track; and
▪ Unauthorized train movements on tracks undergoing maintenance.

A PTC system, shown in Exhibit 23, consists of the three elements integrated by a wireless data communication system. These elements must move massive amounts of information back and forth between the back-office servers, the trackside equipment, and computers on board locomotives in order to function. The three elements include:

▪ **Onboard or Locomotive System** – This element monitors a train’s position and speed and activates brakes as necessary to enforce speed restrictions and prevent unauthorized train movements;

▪ **Trackside (or “wayside”) System** – This element monitors railroad track signals, switches, and track to communicate data needed to permit the onboard system to authorize train movement; and

▪ **Back Office Server** – This element stores all information related to the rail network and trains operating across it (e.g., speed restrictions, train movement authorizations, train compositions, etc.) and transmits this information to enforcement systems onboard locomotives.
By the end of 2018, PTC hardware has been installed on all Class I freight railroads and on all required route miles across the U.S., with all required employees trained in PTC operations and maintenance. As of January 2020, 98.5 percent of the required Class I route miles are in operation and additional segments of track are continually coming online.\textsuperscript{12} While PTC aims to help railroads reach their goal of zero accidents, some types of rail incidents are not mitigated through a deployment of PTC (e.g., grade conflict collisions and derailment due to infrastructure failures). It is important to note that PTC is only required on the Class I freight rail network. Texas’s short line rail network may or may not be equipped with PTC. Integration with PTC systems is one method to identify when a train is approaching a rail crossing, enabling informed traffic routing and 911 service routing.

2.2.2.3 Freight Railroad Supply Chain Data
Two of Texas’ Class I railroads (BNSF Railway and Union Pacific Railroad) offer their customers real-time shipment tracking information.\textsuperscript{13} This data feed is offered as a paid service for their customers and is not available for public use. Union Pacific Railroad offers Application Programming Interfaces (APIs) for registered developers to access real-time supply chain data. Union Pacific Railroad customers can track, manage, and pay for shipments and receive shipment notifications. Integration with their Shipment API provides access to real-time information on customers’ shipment locations and estimated time of arrival.

\textsuperscript{12} Association of American Railroads, Freight Railroads & Positive Train Control (PTC).
\textsuperscript{13} Burlington Northern Santa Fe Railway and Union Pacific Railroad, Developer Center
2.2.3 Road-Rail Conflict Monitoring

2.2.3.1 Railroad Monitoring System in the City of Sugar Land
The City of Sugar Land currently operates a Railroad Monitoring System at nine at-grade rail crossings along the Union Pacific Railroad and US 90A corridor. The system uses doppler readings and guidance on whether the adjacent traffic signal is being actively pre-empted by the railroad to determine if the highway-rail at-grade crossing has been blocked. It has been reported that over 1,500 rail blockages have been recorded in a two-month span. This information is utilized by first responders when planning their routes to respond to emergency calls. The monitoring information is transmitted via Bluetooth devices through TranStar and published on the city’s ITS website for public viewing, which is shown in Exhibit 24. The railroad monitoring map provides the train’s location, speed, and the railroad crossings that received preemption calls.

Local residents can sign up for texts or email notifications on blocked rail crossings. They have the ability to set filters on the minimum duration of a blockage. The City of Sugar Land is exploring ways to make this platform more user-friendly, such as pushing notifications to mobile devices and partnering with Waze to display the notifications on a more widely used platform.14

Exhibit 24: City of Sugar Land ITS Website (with Rail Crossing Status Layer Shown)

Source: City of Sugar Land ITS Website. Green rail crossing symbols indicate the crossing is currently clear.

2.2.3.2 Real-Time Train Monitoring at Port of Beaumont (Planned Effort)
As part of the Freight Innovative Technology project undertaken in cooperation with TxDOT and Federal Highway Administration (FHWA), TTI has identified an opportunity to reduce

14 City of Sugarland, Railroad Monitoring Systems
freight congestion around Port Beaumont by installing a train monitoring system. At this location, freight trains often block the main entrance to the port when delivering freight at the Port. Due to the blockage, arriving trucks start queuing, causing disruptions on city streets. The train monitoring project proposes to install a train monitoring system near the port entrance and a dynamic message sign for trucks prior to a truck staging area. If installed, the system would monitor trains and alert truck drivers when the port entrance is blocked or about to be blocked by trains, allowing truck drivers to route to the staging area instead. In Exhibit 25, the red lines indicate the rail tracks, the yellow circle represents the potential staging area, and the purple lines indicate the alternate truck route leading directly to the staging area. When the entrance is cleared, truck drivers would receive an all-clear message to proceed to the gate. As currently scoped, this project would be a demonstration project that would go through 2022, and is not scoped to be integrated into LoneStar as part of the planned effort.

Exhibit 25: Truck Routes and Highway-Rail At-Grade Crossings Near the Port of Beaumont

Source: Assessment Of Innovative And Automated Freight Strategies And Technologies—Phase III Final Report
2.3 Deficiencies in the Current System
The FNTOP State of the Practice Assessment Report and input from FNTOP stakeholders identified several common deficiencies in the existing system.

2.3.1 Mobility & Reliability
Texas has an extensive multimodal freight transportation system, and the interchange between modes at rail terminals, airports, pipelines, and seaports is crucial for freight mobility. Freight trains that are either passing through or stopped can block at-grade rail crossings, which can result in long queues of vehicles. The queues of idling vehicles not only delay freight deliveries, they create pollution issues for the local communities.

Blocked intersections (sometimes several in a row) can cause delays to traffic at all approaches if there are no feasible alternate routes. Vehicles may search aimlessly for an alternate route if there are no signs indicating otherwise. If the intersections are located along high-volume freight routes, this can cause major delays to truckers, whose most important travel metric is travel time reliability. Such delays can impact the delivery time of their freight and decrease their mobility when they lose some of their hours-of-service (HOS) time waiting for the crossing to clear.

Blocked intersections can also hinder the mobility of emergency vehicles trying to reach an incident on the other side of the railroad tracks. While TxDOT has studied opportunities to improve freight operations using technology at at-grade rail crossings (e.g., real-time train monitoring at the Port of Beaumont), many of the proposed projects have yet to be implemented.

The traveling public may understand that freight train traffic cannot be avoided or limited to certain hours of the day, however, the lack of insight into freight train schedules can be particularly frustrating. Railroad companies do not publish this information publicly due to privacy policies. Some freight railroads may install detection equipment for their own use, but they do not typically share the data with TxDOT or other public agencies. This results in the inability to effectively predict when a crossing will be blocked or how long the blockage will last. Sometimes trains can close crossings for a significant period of time as part of local delivery challenges or mechanical issues.

In addition, freight-specific traveler information systems have been limited in scale of deployment and in participation by freight-related and transportation firms. This is often due to the priority historically given to the general motoring public, limited resources, and the often unique informational needs of the freight community. Though ATIS systems do provide information that can be used by trucking firms, often the aftermarket creates specialized applications leveraging use of such information to be even more useful to trucking. Recognizing the importance of freight, TxDOT is working to enhance its existing ATIS systems.
and adding capabilities tailored to the freight community, including rail crossing information such as sharing delays experienced due to trains at at-grade crossings.

### 2.3.2 Safety

When trains block at-grade highway rail crossings and there is no information provided regarding a safe alternate route, vehicles either remain in the queue until it clears, or tend to start driving through unfamiliar neighborhoods searching for a way around. This can cause additional traffic and potentially unsafe situations for local communities. Drivers also may engage in unsafe driving behaviors such as making illegal U-turns or speeding down other roads looking for an alternate route. Pedestrians, seeing a stopped train and lowered gates may still try to cross, not realizing that another train is approaching. Truckers who waste part of their HOS delayed at blocked crossings may end up parking somewhere illegally later in their trip because they were not able to reach their original destination. Blocked crossings with no public notification can also cause emergency vehicles to lose precious time responding to people in need.

### 2.4 Profiles of User Classes

The following contains a profile for users and stakeholders that would be involved with the Blocked Rail Crossing Traffic Management System.

#### 2.4.1 TxDOT Divisions

TxDOT Divisions handle a wide range of services for the agency. For various TxDOT initiatives, these Divisions coordinate internally to serve as stakeholders and—depending on the topic—lead the initiative.

Several Divisions would be relevant to this strategy. The TxDOT Rail Division is generally responsible for statewide rail planning, implementing rail-related policies, and administering state and federal funds, when available; they would be a key stakeholder that would help lead policy related to rail crossing management with other Divisions working on this strategy. The Traffic Safety Division would also be a key stakeholder, as this strategy would be an expansion of the existing ITS program for which they currently are responsible for establishing standards and practices in Texas. Lastly, the TxDOT Transportation Planning and Programming Division would be a key stakeholder, as implementation of this strategy would impact freight operations and require exploration for new alternative freight routes. Other Divisions would collaborate on this strategy, based on its relevance to their initiatives.

#### 2.4.2 TxDOT Districts

TxDOT operates 25 Districts to manage the state-owned highway system across all geographical areas of Texas. The Districts would be key stakeholders in identifying where freight-related issues due to blocked rail crossings exist, based on their local experience and outreach with their communities. The Districts would also be responsible for installing,
operating, and maintaining field devices deployed as part of this strategy to close gaps in data coverage.

2.4.3 Texas Department of Public Safety
The Texas Department of Public Safety (TxDPS) is responsible for statewide law enforcement and vehicle regulation. TxDPS would be a key stakeholder providing planning-level insight into areas with high incident rates that result from queuing, as well as provide insight on operations planning for law enforcement and emergency responders that have to operate in areas where train blockages are an issue.

2.4.4 Local Communities
Local communities and regional governments often deal with citizen complaints that arise from blocked rail crossings, excessive truck queues, and/or significant traffic reroutes in response to a large disruption. These communities and governments often fund their own rail improvement initiatives or support adjacent efforts being conducted by TxDOT. These groups monitor local rail transportation needs and, when necessary, initiate rail development projects by either working directly with the railroad or contacting TxDOT Rail Division staff for assistance and/or guidance. Additionally, local and regional governments serve as additional oversight for the implementation of improved safety measures for their highway-rail at-grade crossings. Through their efforts, recommended improvements to the local highway-rail at-grade crossings can be executed to enhance the quality of life in their area.\(^\text{15}\)

Local communities would be a key stakeholder for identifying high-profile truck routes with local blocked rail issues, as well as acceptable alternate routes.

2.4.5 Metropolitan Planning Organizations
Metropolitan Planning Organizations (MPOs) are federally mandated and funded transportation policy-making organizations comprised of local government and transportation officials for areas with populations of at least 50,000. In the context of this strategy, they would be key stakeholders that help identify where issues exist along urban freight routes. MPOs would also be a local resource for outreach with local communities for additional feedback on alternative truck routes.

2.4.6 Railroads
A total of 55 short line railroads and three Class I’s operate within the state. The two largest carriers, Union Pacific Railroad, and Fort Worth-based BNSF Railway, operate over almost 11,400 miles, or 78 percent of the total miles in Texas. The Kansas City Southern Railway Company, the third Class I railroad in the state, operates over 820 miles. Short line

\(^{15}\) Texas Department of Transportation, 2019 Texas Rail Plan, December 2019.
railroads, comprised of local railroads or switching/terminal railroads, comprise the remaining almost 2,300 miles of rail line operated in the state.\textsuperscript{16}

Railroads would be a key stakeholder for helping identify areas in their operation that are more prone to issues that could lead to blocked rail disruptions for highway crossings. While they would need to protect certain operational knowledge to maintain a competitive advantage in the marketplace, they would offer invaluable guidance on day-to-day issues.

\subsection*{2.4.7 Truckers}

Truckers would be the main end-users of this system and would use the blocked crossing notifications to make informed routing decisions. Signed alternative routes will help reduce the chance that they turn onto a route that is not approved for trucks, which will help reduce citizen complaints and risk of vehicle damage, such as striking a low bridge. Truckers may also benefit from information available on historical blockages to help make informed pre-trip routing decisions.

\subsection*{2.4.8 Trucking Companies/Dispatchers}

Trucking company dispatchers work with truckers to plan trips and assist with real-time route information. This group would be an end-user in the system and would utilize information on blocked rail crossings to help dispatch their trucks in a manner that avoids historically-blocked time periods, as well as offer advanced notification if a particular route is reported as blocked in real-time.

\subsection*{2.4.9 Emergency Responders}

When incidents occur along a route with an at-grade rail crossing, it is imperative that emergency response vehicles (police, fire trucks, ambulances, hazardous response teams, etc.) are able to reach the scene of the incident. If a train is blocking the intersection (or several intersections), the disruption could put lives at risk. While most emergency response plans strategically place their personnel to cover territory on opposite sides of the railroad to mitigate this issue, occasions do arise—such as multiple-alarm fires or major catastrophes—where personnel are called to a scene outside of their territory.

The Texas Highway Patrol (responsible for monitoring state roads, supporting local police efforts and public safety education), as well as local police, fire departments and ambulance services would be end-users in the system and would utilize real-time and historical crossing information to help dispatch their emergency vehicles in a manner that avoids blocked intersections.

\subsection*{2.4.10 Other Users}

Other road users have to deal with disruptions caused by stopped train traffic at crossings, which can include regular drivers, school bus operators, paratransit shuttles, bicyclists and

\textsuperscript{16} Texas Department of Transportation, 2019 Texas Rail Plan, December 2019.
pedestrians, and other groups. Additionally, certain groups may find added value in additional real-time information on whether a train is approaching a crossing, regardless if the lights and gates have started to go down. For example, school buses stop at all non-exempt railroad crossings to look and listen for an approaching train before determining if it is safe to cross; access to forecasted train arrival information would further assist a school bus driver in making an informed decision regarding a safe crossing. In addition, when people know how long the delay will be, it can help reduce stress and road rage.

These other users would also be considered end-users and could be notified of blockages due to stopped trains, historical blockages to make informed trip departure times, and estimated real-time arrival of trains to determine if it is safe to make a crossing.

2.5 User Needs
As part of the FNTOP, the User Needs Assessment developed a comprehensive list of User Needs identified through a gap analysis and stakeholder engagement. The specific needs and gaps from the FNTOP User Needs Assessment addressed by this strategy are summarized in Exhibit 26. The assessment prioritized these needs based on relevance, plausibility, and alignment with the 2018 TFMP goals and objectives. The User Needs were divided among seven high-level freight technology areas that were previously established in the FNTOP State of the Practice Assessment Report:

- (T)raffic Management;
- (A)dvanced Traveler Information Systems;
- (D)ynamic Route Guidance;
- (D)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 to which it belongs to. For example, in Exhibit 26, UN-T4 represents the fourth User Need for the (T)raffic Management freight technology area. Each User Need is associated with one or more goals from the TFMP and is prioritized as follows:

- **High** – The need is a “must-have” and should be considered essential to the development of the FNTOP.
- **Medium** – The need is a “should-have” or desirable capability for which there is considerable interest, but is not necessarily critical to TxDOT.
- **Low** – The need is a “nice-to-have” or not viable in the near-term.
More information about the FNTOP User Needs and how this strategy can address them is available in the FNTOP User Needs Assessment Report, as well as FNTOP Strategies and Conceptual Framework Report.

**Exhibit 26: Affiliated User Needs for Blocked Rail Crossing Traffic Management System**

<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>UN-T3</td>
<td>Need for more investment in congestion management strategies to address growing traffic.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-T4</td>
<td>Need to develop the Houston-Dallas-San Antonio triangle with new smart technologies to improve operations.</td>
<td>Safety, Economic Competitiveness, Asset Preservation and Utilization, Mobility and Reliability</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-T7</td>
<td>Need for rural ITS in high-traffic freight areas to help support operations.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Medium</td>
<td>Inventory of Existing Conditions, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-T13</td>
<td>Need for more urban arterial management to manage freight deliveries.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A3</td>
<td>Need for more Dynamic Message Signs (DMS) on primary freight corridors to relay traffic information.</td>
<td>Safety, Asset Preservation and Utilization, Mobility and Reliability</td>
<td>High</td>
<td>Inventory of Existing Conditions, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-A4</td>
<td>Need for more advanced notice of real-time traffic conditions</td>
<td>Safety, Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>State of the Practice,</td>
</tr>
<tr>
<td>ID</td>
<td>Preliminary User Needs</td>
<td>Texas Freight Mobility Plan 2018 Goals</td>
<td>Priority</td>
<td>Source</td>
</tr>
<tr>
<td>--------</td>
<td>----------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------</td>
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<td>-----------------------------</td>
</tr>
<tr>
<td>UN-A14</td>
<td>(delays, incidents, construction, weather conditions) to improve routing decisions.</td>
<td></td>
<td></td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td></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>

**Dynamic Route Guidance Freight Technology Area**

| UN-D3  | Need for information on alternative freight-specific routes to improve efficiency on Texas roadways. | Economic Competitiveness, Mobility and Reliability | Medium   | Stakeholder Interviews      |

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

<p>| UN-C1  | Need for more infrastructure improvements to support automated vehicles (roadway markings, signage). | Economic Competitiveness, Mobility and Reliability | High     | State of the Practice, Stakeholder Interviews |
| UN-C5  | Need for more smart infrastructure to support automated vehicles on the TMFN.                      | Economic Competitiveness, Mobility and Reliability | Medium   | Stakeholder Interviews      |</p>
<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>UN-I1</td>
<td>Need to further develop the Texas rail freight network and other multimodal technologies to decrease reliance on roadways.</td>
<td>Economic Competitiveness, Multimodal Connectivity</td>
<td>High</td>
<td>State of the Practice, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-I2</td>
<td>Need for more blocked rail crossing notification systems to improve safety and efficiency.</td>
<td>Safety, Mobility and Reliability, Multimodal Connectivity</td>
<td>High</td>
<td>State of the Practice, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-I4</td>
<td>Need for operational improvements along primary and secondary transport modes to support freight mobility as a whole.</td>
<td>Economic Competitiveness, Mobility and Reliability</td>
<td>High</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-I6</td>
<td>Need for more investment in technology and infrastructure to support ports in Texas and allow for growth in freight.</td>
<td>Economic Competitiveness, Asset Preservation and Utilization, Multimodal Connectivity</td>
<td>Medium</td>
<td>Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-I11</td>
<td>Need for technology improvements at highway-rail grade crossings to improve safety.</td>
<td>Safety, Multimodal Connectivity</td>
<td>Low</td>
<td>State of the Practice, Stakeholder Interviews</td>
</tr>
<tr>
<td>UN-I12</td>
<td>Need for more technology to improve freight transfer between modes to improve multimodal connectivity.</td>
<td>Mobility and Reliability, Multimodal Connectivity.</td>
<td>Low</td>
<td>Stakeholder Interviews</td>
</tr>
</tbody>
</table>
2.6 Assumptions and Challenges

Several key assumptions and challenges would apply to a system that manages traffic during a blocked rail crossing situation. These assumptions and challenges are identified in the following sections.

2.6.1 Assumptions

- **The system only applies to public, active, at-grade rail crossings** – Grade separated rail crossings do not present the modal conflicts experienced at at-grade rail crossings and therefore do not need to be considered for this strategy. Private crossings where the roadway is owned by a private entity are not subject to federal laws and regulations and are also not considered for this strategy.

- **Real-time train location tracking data from the railroads may not be available for use** – If freight rail schedules or real-time train location data cannot be obtained from rail companies themselves or third-party data sources, remote train detection equipment would be installed in the field to gather train activity data at spot locations.

- **ITS devices used for train detection would be deployed at high-priority locations based on screening criteria developed in collaboration with applicable stakeholders** – With 16,213 active railroad crossings in the State (approximately 9,500 of those are public at-grade crossings), TxDOT and stakeholders would need to provide input as to which ones would benefit the most from the deployment of train monitoring devices. High-priority locations may be based on high-traffic freight routes, frequent delays, and the availability of alternate routes.

- **Existing ITS field devices that are in the larger improvement area would be utilized, where possible** – If CCTV cameras already exist in the larger improvement area, they may be able to be utilized to monitor where queues are building up. Similarly, DMS in the general area may be utilized for notification of a blocked rail crossing, depending on the standard operating procedures of the owner agency. This could apply to TxDOT or non-TxDOT assets, depending on the participation of local agencies.

- **Blocked crossing notifications would not be limited to the freight community** – Blocked rail crossings can cause delays for both the freight community and the traveling public. Advanced notification would be shared with both the freight community and the traveling public via on-site DMS or web-based/mobile traveler information services.

- **Regional systems would share information with any TMC or ATIS that may be operating in that region** – In an effort to improve traffic management, notifications generated to indicate 1.) whether a train is imminent at an intersecting truck route, and 2.) whether a train has obstructed a crossing for an extended period of time, would be shared with any TMC or ATIS that may be operating in that region (including city and county TMCs/ATISs) by agencies who have deployed Blocked Rail Crossing Traffic Management Systems.
2.6.2 Challenges

▪ **Accessing ROW for ITS equipment installation** – The train detection sensors may encroach on ROW not owned by TxDOT, or require temporary easements to install and maintain those assets. Railroad tracks are private property of the railroad companies that operate on them, which requires special permission to access. However, a radar monitoring study conducted by TTI in San Antonio concluded that many spots exist where detectors can be deployed off the railroad on a TxDOT facility to monitor train presence, length, speed, and location.

▪ **TxDOT maintenance of ITS assets that are off the freeway network** – Existing TxDOT maintenance contracts may not be set up for staff to maintain ITS assets that are located off of the traditional freeway network where most ITS assets are currently located. This may require modifications to funding for personnel to service remote assets outside of a defined maintenance area.

▪ **Limited expertise with new system equipment** – The new system may require TxDOT to add equipment that may not be part of the current ITS program, which would require additional training.

▪ **Standalone versus Integrated implementation of the system** – Depending on how the ATMS is set up in the local region, the TxDOT Districts, cities, or counties may be limited to either a “central” or a “local” operation. Each operation has advantages and disadvantages. Central operations allow for a wider area of response, but can function improperly if communication channels are disrupted. Local operations tend to coordinate more properly in the field, but are limited in terms of the scope of their program due to issues like sight-line challenges for communications.

▪ **Isolated vs. Corridor deployment of the system** – Depending on stakeholder preferences, remote field equipment could be deployed along a corridor of rail crossings (i.e. “corridor” deployment) or at an “isolated” crossing. Corridor deployments provide more information, such as train arrival forecasting and location, but are more expensive and elaborate because of the number of sites. Isolated sites are simple and less costly, but only can report if the single crossing is blocked. This would need to be evaluated through screening criteria and benefit-cost analysis.

▪ **CV-equipped vehicle notifications** – Implementing CV applications at dedicated crossings to notify CV-equipped vehicles of an approaching train may be a cost-effective approach for strategy deployment, but may require adhering to ever-changing federal regulations over spectrum allocation for CV message distribution.

▪ **Data sharing concerns** – Freight railroads do not publish operational information (e.g., train schedules) due to security and other concerns. Such information is made available to their customers for shipment tracking purposes, but may not be provided as a service for public transportation agencies. Although receiving real-time data feeds from railroad companies would greatly simplify the implementation and scalability of this strategy, it is
unlikely that TxDOT would be able to obtain this type of data. If railroad companies do agree to provide real-time train locations, it would be imperative for TxDOT to prevent any proprietary data from being shared publicly so as to satisfy railroad companies’ data sharing policies.

- **Cost of ITS equipment needed to implement strategy** – Field equipment can be costly, depending on how many sites are deployed.

- **Data quality, reliability, and latency** – This strategy relies on monitoring devices deployed near rail crossings and analytics to determine whether a train is imminent at an intersecting truck route and whether a train has obstructed a crossing for an extended period of time. Agencies that deploy any field equipment must validate the data quality, reliability, and latency of the devices to ensure that the notifications generated are accurate and timely. In addition, the communications backhaul that provides service to the ITS devices may require wireless communications that have inherent delay.

- **Integration of strategy into existing traffic management platforms** – Each TxDOT District with a TMC has their own deployment of LoneStar (or RIMS at Houston TranStar) and more rural traffic management centers may still be using vendor-specific software to control their ITS devices. Since there is no consistent traffic management platform statewide, integration of any new systems may be straightforward for some and more difficult for others.
3.0 Concept for the Proposed Blocked Rail Crossing Traffic Management System

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

3.1 Objectives

The Blocked Rail Crossing Traffic Management System is intended to provide reliable, real-time information primarily to truckers so that they can make informed decisions regarding route choices during extensive network disruptions due to a stopped train.

At a high level, the Blocked Rail Crossing Traffic Management System would be a notification system that alerts truckers and other road users of instances when a highway-rail at-grade crossing has been occupied for an extended period of time. The goals of this system would be to help improve freight mobility by reducing queue delays due to extended blockages, as well as improve safety by reducing back-of-queue crashes and other consequential incidents. The system would monitor rail traffic and rail crossing use through ITS equipment at select sites, and would detect events (e.g., delays, congestion), inform TMC operators of the potential existence of disruptions, and generate and disseminate real-time notifications to road users to help them make informed route decisions. Information about the delays and recommended routes will further be broadcast to roadway users via DMS, and other advanced traveler information systems via standardized response plans automatically run when certain conditions are met. Additionally, historical information regarding recurrence of blockages at certain times of day would be provided to aid in pre-trip planning. Depending on the state of CV adoption, this train detection system would provide advanced notification of an approaching train (i.e., train at adjacent crossing) to a CV-equipped vehicle, such as emergency vehicles, freight vehicles, or school buses. CV RSUs located near railroad crossings would issue train arrival notifications to CV on-board units (OBUs) to aid motorists by letting them know if the rail crossing lights are about to activate.

Deployment of this strategy would be successful at locations where an alternate route exists, either via an unblocked/unoccupied crossing, a grade-separated crossing, or a staging area for trucks to wait for the blocked crossing to clear. A potential challenge will be identifying alternate truck routes, either because there is not one that provides a competitive option (e.g., increase in time and/or distance is too great), or because that alternate route requires leaving the state highway system. The use of a non-state route as the alternate route will require coordination and collaboration with local agencies to gain support for the use of these non-state roadways.
Exhibit 27 provides an illustrative example of the Blocked Rail Crossing Traffic Management System strategy that was previously discussed in the FNTOP Strategies and Conceptual Framework Report.

*Exhibit 27: Illustrative Example of Blocked Rail Crossing Traffic Management System Strategy*

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

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

The main features and functions of the Blocked Rail Crossing Traffic Management System are discussed in Exhibit 28.
## Exhibit 28: Blocked Rail Crossing Traffic Management System
### Features and Functions

<table>
<thead>
<tr>
<th>Features</th>
<th>Main Functions</th>
<th>User Need(s) Addressed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real-Time Blocked Rail Crossing Notifications</td>
<td>Truckers and roadway users would be informed of potential delays and options to take alternative action. This information may also include gate downtime. The information may be provided to the ATIS directly or via the ATMS. CVs would also receive real-time notifications.</td>
<td>UN-T3, UN-T4, UN-T7, UN-T13, UN-A3, UN-A4, UN-A14, UN-A16, UN-D3, UN-C1, UN-C5, UN-I1, UN-I2, UN-I4, UN-I11, UN-I12</td>
</tr>
<tr>
<td>Historical Blocked Rail Crossing Information</td>
<td>Transportation agencies would be able to respond to citizen complaints of excessive highway-rail at-grade crossing blockages with data-supported information.</td>
<td>UN-A14, UN-D3, UN-I1, UN-I2, UN-I6, UN-I11</td>
</tr>
<tr>
<td>Estimated Train Arrival Times</td>
<td>Roadway users would be able to receive notifications of when a train is expected to arrive at a highway-rail at-grade crossing, allowing them to make informed decisions regarding whether to cross or seek an alternate route. Having a prediction of train location based on speed and length would offer a proactive, dynamic map routing.</td>
<td>UN-T3, UN-T4, UN-T7, UN-A4, UN-A14, UN-A16, UN-D3, UN-C1, UN-C5, UN-I1, UN-I2, UN-I11, UN-I12</td>
</tr>
<tr>
<td>Historical Train Arrival Times</td>
<td>Trucking companies and truckers would be able to utilize historical information to make informed departure decisions as part of trip planning activities.</td>
<td>UN-A4, UN-A14, UN-D3, UN-I1, UN-I2, UN-I6, UN-I11</td>
</tr>
</tbody>
</table>

Since this system relies on technological processes, the general framework follows the requirements for a successful ITS program. At a high level, a successful ITS program requires 1.) a means to collect data, 2.) a means to process the data, and 3.) a means to distribute that data to the targeted user group. As long as this process is followed, this system will have the necessary building blocks to succeed.

![Information Flow Diagram]

Although the process is straightforward, the means and methods to implement these requirements can vary widely. Currently, Texas has a few initiatives underway to deploy...
Blocked Rail Crossing Traffic Management Systems, but they are isolated improvements and vary by owner. TxDOT also does not operate a statewide program that oversees the deployment of these systems at the current time, meaning there is not a standard approach to pursue this type of system if a District or local jurisdiction elected to pursue one. Furthermore, the current state of the practice lacks a standard approach for collecting, processing, and distributing information as well, requiring TxDOT and its affiliated stakeholders to determine their own template for implementing this system. The absence of a standard or template is not an issue, however, because this system can be created based on key objectives—collected through stakeholder outreach and other FNTOP efforts—that are identified to frame what this system shall ultimately do.

The following sections examine several key strategies to consider as part of the Blocked Rail Crossing Traffic Management System. 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 strategies are discussed in the following sections:

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

### 3.2.1 Data Collection

Data collection methods for this system aim to collect information regarding:

1. If an at-grade crossing is being actively used;
2. Where a train is located relative to an at-grade crossing; and
3. How long the gate has been down.

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

#### 3.2.1.1 Railroad Crossing Use Detector

This type of component would collect and report data to determine if a railroad crossing was in use or not in use. These detection units typically cover a single railroad crossing due to the distance between crossings, although there may be exceptions.

There are various detector devices that collect this information, such as microwave radar, lidar or video processing. These devices evaluate the railroad crossing to determine if a train is physically present at the site. This component may also be: 1.) an integrated unit tied into the railroad gate control system, which reads whether the gate control system is active due to a train presence; or 2.) an integrated unit in an adjacent traffic signal control cabinet near a railroad crossing that is wired for railroad signal pre-emption, which would read whether
the traffic signal controller is in its pre-emption state due to a reported train (e.g., Railroad Monitoring System in the City of Sugar Land described in Section 2.2.3.1). The preferred alternative for collecting this information would depend on the ability to integrate with the railroad gate control system, the presence of a traffic signal controller and signal preemption data, or available ROW, easements, and layout of the railroad crossing in case additional train detection sensors are required.

These detection devices—regardless of specific technology—could be installed at a single railroad crossing or at several sequential railroad crossings. Each unit would provide its own real-time report on whether a train was present at its specific rail crossing, but a group of detection units would allow the processor units (discussed in a later section) to have a better estimation of where trains might be located at any given time within the defined corridor.

3.2.1.2 Train Tracking System
This component would utilize data feeds from the railroads themselves regarding the real-time location of trains (e.g., PTC on Texas railroads as described in Section 2.2.2.2, or freight railroad supply chain data as described in Section 2.2.2.3). Availability of train location data would provide monitoring coverage that would far exceed the capabilities of the remote detector components, as a train could be tracked anywhere along its railroad. This would allow for a more comprehensive estimated arrival time at a specific crossing, as well as offer a more robust data set to identify historical trends.

As mentioned earlier in the document, some railroads in Texas offer real-time supply chain data to registered developers, but this information is not currently available to the public sector. It is unlikely that this data would be available in the near-term to support the Blocked Rail Crossing Traffic Management System, but opportunities may become available at a later time to better enhance the existing system.

3.2.2 Data Processing
Data processing methods for this system aim to process information to determine:

1. Whether a crossing is currently blocked/occupied;
2. Whether a crossing is currently blocked/occupied for an amount of time that exceeds a predetermined threshold and warrants notification;
3. The estimated location of a train;
4. The train’s estimated time of arrival at a specific crossing; and
5. Based on historical data what is the likelihood of a specific crossing being blocked/occupied at a certain time.

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 Field Processing Component
This component collects and processes raw traffic data from field devices. This processor would be locally programmed to initiate responses, such as activation of a sign with flashing beacons, without the need to get approval from a centralized location. Activation statuses and other information could be sent to a centralized processing system or to an ATMS for recordkeeping, but all decision-making would be done locally in the field.

3.2.2.2 Centralized Processing Component
This component collects and processes raw traffic data from field devices. The data may be used to build traffic management algorithms to monitor traffic conditions, such as rail crossing times, blocked crossings, etc. This component would activate alerts, such as turning on flashing beacons, through the communication network. Unlike the field processor, this component would require an operational communications network to work with the remote assets, but would be able to structure its decision-making based on more data than available to a remote field processing component. Activation statuses and other information could be sent to an ATMS for recordkeeping, but all decision-making would be done as part of the independent central system.

3.2.2.3 ATMS Processing Component
An ATMS software collects and processes raw traffic data in real-time delivered to the TMC, allowing operators to monitor, detect, and respond to planned and unplanned events. Information such as rail crossing times, blocked crossings, traffic conditions and other messages relevant to road users can be quickly disseminated allowing motorists to make informed travel decisions. Unlike the central system option, having the ATMS manage all processing and response efforts would keep all operations under one software platform, allowing operators an easier time to work with the system as well as allow for other ITS assets in the broader ITS program to be potentially utilized for blocked rail events. Existing TMCs are described in more detail in Section 2.2.1.1, while ATMS platforms used in various TxDOT Districts are summarized in Section 2.2.1.2.

3.2.3 Information Distribution
Information distribution methods for this system aim to distribute information regarding:
1. Whether a crossing is currently blocked/occupied;
2. Whether an alternative route is recommended in response to a blockage; and
3. Whether a crossing is forecasted to be blocked/occupied, based on historical data.

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

3.2.3.1 Roadside Sign with Activated Flashing Beacons
This component helps improve driver awareness by providing road users with a highly visual signal in advance of a change in conditions. Beacons would be activated only at certain
times using either a manual switch or wireless beacon controller, which would inform motorists of real-time rail crossing blockage issues.

3.2.3.2 DMS
DMS are typically used to display information about traffic conditions, detours, travel times, construction and road incidents. These signs would be located at decision points to alert road users of possible delays, and allow them to reroute if possible. In the context of this system, the DMS would activate when an issue was detected and show a pre-planned message to inform motorists of the blocked rail crossing issue. An inventory of existing DMS statewide is included in Section 2.2.1.4.

3.2.3.3 CV Roadside Unit
This component provides wireless communications from roadside infrastructure to vehicle OBUs. Roadside units engage with the OBUs of vehicles to issue alerts regarding traffic information and other relevant travel data. In the context of this system, CV roadside units near railroad crossings could issue train arrival notifications to aid motorists by letting them know if the rail crossing lights are about to activate.

3.2.3.4 ATIS
This component disseminates real-time information including traffic, transit, weather, and work zone events. In the context of this system, the ATIS would issue the notification of a blocked rail crossing to the broader public (e.g. via DriveTexas, further described in Section 2.2.1.5, the ITS websites for the TxDOT Districts, or via social media channels such as Twitter for large-scale blockages as described in Section 2.2.1.6).

3.3 Conceptual High-Level System Architecture
This section discusses the vision for the high-level system architecture. Recognizing some of the details will be determined as part of the procurement effort, this ConOps presents the design of the generalized concept of operation.

Exhibit 29 presents the high-level concept for the Blocked Rail Crossing Traffic Management System architecture. The diagram illustrates the high-level systems diagram alongside the data flows among components and will be used to guide the development of the system.
Exhibit 29: Systems Diagram

This recommended high-level architecture utilizes available communications networks to facilitate the movement of information from the field to server/cloud site and vice versa. Although these data flows can be accommodated through third-party communications infrastructure, it is more advantageous for Texas to keep their ITS program mostly within their network over the long term, where possible. The Blocked Rail Crossing Traffic Management System is shown illustratively in this architecture, which leaves options open to either integrate it into the ATMS or operate it as a separate standalone system that might feed alarms to the ATMS. A standalone system may be present on or off premises at TxDOT, depending on how the specifications are written at the time of procurement, and could be hosted as part of a cloud server. As the data are processed, the notifications are sent out to the field, to TMC operators, and to the ATIS (DriveTexas or others) to notify of an event. Many of these processes could be automated, depending on the final design.

This architecture does not intend to prescribe the exact equipment that is to be utilized. In particular, the detection equipment can vary widely in terms of how data is collected, but
ultimately the end goal is to have a system that provides a high level of reliability and accuracy when pairing all of the components together.

3.4 Integration Options
Two options are envisioned for the integration of this strategy. Each TxDOT District and/or local community will have the ability to decide which approach works better for their specific environment:

1. Full integration into the regional ATMS; or
2. Standalone system (locally operated or centrally operated).

3.4.1.1 Option 1 – Full Integration with the Regional ATMS
In Option 1, the ATMS platform would be the central component to the overall transportation management system. It would monitor, control, and manage the Blocked Rail Crossing Traffic Management System including: receiving real-time data from detection systems, CV RSUs and CCTV camera feeds; controlling notification signs and other related devices; and obtaining operational statuses on specific devices. These devices would be deployed near rail crossings in and around critical freight routes to help identify incidents that operators would track until they are resolved and traffic flow is back to normal. The ATMS would use all the collected information, including railroad train location data if available, to disseminate messages to the ATIS, remote notification signs, and CVs along the affected routes.

Some of the main advantages of a full ATMS integration include:

1. All systems and subsystems would be housed in a single platform.
2. The existing platform already has configurable rules, logical responses, and controls that provide coordination with field devices, databases, and interfaces to internal and external systems.
3. The ATMS Graphical User Interface (GUI) is already vetted by TxDOT and it is familiar to operators.
4. Existing ATMS platform can be modified to adopt new requirements of this system.

With a full integration, each District would need to identify if software enhancements are needed, such as new interfaces to field devices, GUI improvements, etc.

Exhibit 30 illustrates the high-level view of a Blocked Rail Crossing Traffic Management System that is fully integrated into the ATMS platform (Option 1).

3.4.1.2 Option 2 – Standalone System
In Option 2, the Blocked Rail Crossing Traffic Management System would be a standalone system running on its own processing unit and not directly integrated with the ATMS platform. The system would receive the detection data from field sensors at the rail crossing;
the data would be processed; the system would acknowledge a blockage, activate the beacons and send a preset message to the DMS, as applicable. This operation could be done locally in the field on a closed-loop system or through a centralized operation using the communications network.

The ATMS would only receive information in the form of alarms and notifications, which would typically show on the operator’s ATMS console. Alternatively, the system could bypass the ATMS and send notifications and alarms directly to the ATIS. In both instances, it may be necessary to modify or develop software interfaces for the newly added system and the external systems (ATMS and ATIS).

Exhibit 31 illustrates the high-level view of the standalone Blocked Rail Crossing Traffic Management System (Option 2).
Exhibit 30: Option 1 – Full Integration Approach

Users
- TxDOT
- Traveling Public
- Truckers
- TMC Operators
- Emergency Responders

Field Devices
- CCTV
- DMS
- Detection Systems (Sensors)
- Gates & Barriers
- Signals
- Static Signs with Beacons
- CV RSIU

Data Sources
- Video Streams, Snapshots & Status
- DMS Operational Status
- Vehicle Detection Data and Status
- Operational Status
- Operational Status
- Operational Status
- Operational Status

System Concept / ATMS Integration
- Camera Control
- DMS Control
- Device Configuration
- Device Control
- Device Control
- Device Control
- Device Control

Dissemination Methods
- Advanced Traveler Information System
  - Website
  - Mobile App
  - DMS
  - Connected Vehicles

Railway Providers: Location Data
Exhibit 31: Option 2 – Standalone Approach

<table>
<thead>
<tr>
<th>Users</th>
<th>Field Devices</th>
<th>Data Sources</th>
<th>System Concept / Standalone</th>
<th>Dissemination Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>TxDOT</td>
<td>CCTV</td>
<td>Snapshots &amp; Status, Send Command</td>
<td>Alarms, Notifications &amp; Snapshots</td>
<td>ATMS</td>
</tr>
<tr>
<td>Traveling Public</td>
<td>DMS</td>
<td>DMS Operational Status, Send Command</td>
<td>Alarms and Notifications</td>
<td></td>
</tr>
<tr>
<td>Truckers</td>
<td>Detection Systems</td>
<td>Vehicle Detection Data and Status, Status Request</td>
<td>Alarms</td>
<td></td>
</tr>
<tr>
<td>TMC Operators</td>
<td>(Sensors)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency</td>
<td>Gates &amp; Barriers</td>
<td>Operational Status, Status Request</td>
<td>Alarms</td>
<td></td>
</tr>
<tr>
<td>Responders</td>
<td>Signals</td>
<td>Operational Status, Status Request</td>
<td>Alarms</td>
<td></td>
</tr>
<tr>
<td>Static Signs</td>
<td>Static Signs with</td>
<td>Operational Status, Status Request</td>
<td>Alarms</td>
<td></td>
</tr>
<tr>
<td>with Beacons</td>
<td>Beacons</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CV RSU</td>
<td>CV RSU</td>
<td>Operational Status, Send Command</td>
<td>Alarms and Notifications</td>
<td></td>
</tr>
</tbody>
</table>

Advanced Traveler Information System
- Website
- Mobile App
- DMS
- Connected Vehicles
3.5 **Support Environment**
This section discusses the major components of the environment supporting the Blocked Rail Crossing Traffic Management System operations. Key elements include:

1. Supporting Subsystems.
2. Supporting Personnel.

### 3.5.1 Supporting Subsystems
There are various subsystems that form part of the supporting services for the Blocked Rail Crossing Traffic Management System. The structure, functionality and design of each subsystem directly impacts the design of the overall system. Key subsystems to consider are identified in Exhibit 32.

**Exhibit 32: Supporting Subsystems**

<table>
<thead>
<tr>
<th>Supporting Subsystem</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Information Collection Subsystem</td>
<td>This subsystem collects real-time information from detector stations installed near rail crossings. The subsystem interprets data gathered about rail crossing use (blockages, delays) and transmits it to an ATMS or standalone system. This data may be used to alert truckers and other road users of the conditions along these facilities.</td>
</tr>
<tr>
<td>CCTV Monitoring Subsystem</td>
<td>This subsystem helps monitor current traffic conditions. CCTV images/video provide TMC operators with visual confirmation and further perspective on blockages, delays, and congestion. Within an ATMS system, TMC operators have the ability to control CCTV video and view images. The images can be used to confirm data gathered by detection systems. Within a standalone system, it also provides snapshots of conditions at the rail crossing.</td>
</tr>
<tr>
<td>Information Dissemination Subsystems</td>
<td>This subsystem encompasses the ATIS, DMS, roadside signs with flashing beacons, and CV notifications and alerts. Its role is to report blockages, delays, traffic conditions, suggested routes to truckers and other road 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</td>
</tr>
</tbody>
</table>
### Supporting Subsystem

<table>
<thead>
<tr>
<th>Supporting Subsystem</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Supporting Subsystem</strong></td>
<td>provides alerts to help facilitate the required maintenance and does not need to be integrated with a maintenance management system.</td>
</tr>
<tr>
<td><strong>Communication Subsystem</strong></td>
<td>This subsystem provides network communications between the field elements and the regional TMC or the centralized processing system. Traffic data is provided in real-time. Center-to-Center communications between agencies is also possible to facilitate inter-agency coordination and communication.</td>
</tr>
</tbody>
</table>

### 3.5.2 Supporting Personnel

TxDOT TMC staff, maintenance staff, system administrators, and system developers are the key personnel necessary to support the system. If maintenance is supplied by the regional agencies, it is important to have an inter-agency agreement in place to ensure that roles and responsibilities are clearly defined and understood. Key personnel to consider are identified in Exhibit 33.

**Exhibit 33: Supporting Personnel**

<table>
<thead>
<tr>
<th>User Group</th>
<th>Primary Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TMC Operators</strong></td>
<td>Operate the ATMS, monitor roadways, monitor operational status of ITS devices.</td>
</tr>
<tr>
<td><strong>System Administrators</strong></td>
<td>Monitor ATMS performance, configure ITS devices in the ATMS, oversee ITS asset management, monitor ITS devices not integrated with the ATMS.</td>
</tr>
<tr>
<td><strong>System Developers</strong></td>
<td>Manage new and existing ATMS applications.</td>
</tr>
<tr>
<td><strong>Maintenance Staff</strong></td>
<td>Support and maintain ITS device functionality, and troubleshoot devices as necessary.</td>
</tr>
</tbody>
</table>

### 3.5.3 Supporting Processes

The following are processes needed to support the Blocked Rail Crossing Traffic Management System:

- **Software Support and Update**: Processes are needed to ensure that all the required software are available and up-to-date for the Blocked Rail Crossing Traffic Management System and the ATMS platform.
4.0 Benefits, Impacts, and Alternatives of the Blocked Rail Crossing Traffic Management System

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

4.1 Benefits

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

- **Increased Mobility** - The system would provide real-time at-grade crossing status information to truckers and road users enabling them to make rerouting decisions in order to avoid blockages and delays at these locations. This would help reduce queues, mitigate congestion and improve traffic flow.

- **Increased Traffic Throughput** – The system would notify truckers and other road users of delays giving them the opportunity to take an alternate route, if available, or to make changes to their schedule to accommodate the delay (e.g. take a break, fill up their tank, etc.). This strategy would promote a more effective use of the available road network leading to lessening traffic congestion at railroad crossings.

- **Increased Safety** – The system would provide at-grade crossing status information to truckers and road users through visual signage (e.g. DMS, flashing beacons) helping increase their situational awareness. Informed drivers have the ability to scan their surroundings and adjust their behavior to adjust to the changing roadway conditions such as long queues, congestion, sudden braking by other drivers, etc. In turn, this can help reduce the number of incidents at rail crossings helping reduce injuries and save lives.

- **Reduced impact of traffic incidents** – The system would provide truckers and other road users with delay notifications and route recommendations designed to help them reduce the impacts of incidents on their drive time.

- **Increased Reliability on Traffic Data Collection** – For the system to function properly, a reliable detection system is needed along critical freight routes that experience frequent delays. The detection system would monitor railroad operations and trigger the system when it detects obstructions or delays. These parameters are used by the system in order to notify road users, help manage traffic to reduce congestion at crossings, and improve safety by reducing the likelihood of queueing and drivers taking unfamiliar alternative routes.

- **Increased TMC operator efficiency** – The system would expand the amount of tools a TMC operator could use. For fully automated systems, the operators would have minimal responsibility on the day-to-day operation of the system.
Improvement to overall traveler experience – The system will improve travel time and minimize delays along key freight corridors with railroad at-grade crossings during incidents. The system will also provide truckers and road users with the ability to make more informed travel decision choices, which would allow them to be more successful with their day-to-day operations and boost their satisfaction with the system.

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

4.2.1 Policies
The following summarizes some of the key operational and institutional policies for system development:

- **Traffic Management** – The system shall be consistent with TxDOT Standard Operating Procedure (SOPs) for TMC activities and tasks. The system must not interfere with the operations of the TMC, and operator involvement must be minimal, such as to infrequently confirm that the components are all online.

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

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

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

- **Compliance with Design Standards** – The system must utilize infrastructure that is designed in compliance with the Texas Manual on Uniform Traffic Control Devices (TMUTCD), applicable TxDOT design guides, and other design standards or guides where applicable, including the American Association of State Highway and Transportation Officials (AASHTO) A Policy on Geometric Design of Highways and Streets, and AASHTO Roadside Design Guide.

- **Driver Distraction Laws** – Any applications will be designed in a fashion that prevents potential safety hazards from distracted driving. For instance, any roadside signs will follow design standards established in the TMUTCD.
4.2.2 Constraints
The following list summarizes some of the key operational constraints for system development:

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

- **Data Quality** – Due to the monetary and physical constraints, detection infrastructure may not be as thorough as desirable. Depending on the degree, system robustness may not be as optimal as it potentially could be if these constraints did not exist.

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

- **Network Communications** – Field-to-center network communications may be necessary in order to have a comprehensive system, but for sites in remote locations, the most cost-effective solution may involve wireless communication options.

- **Limitations on Alternative Freight Routes** – Coordination and collaboration with local agencies is necessary to confirm the availability of alternate routes and that there is community support and agreed upon benefits to rerouting around blocked crossings. Some communities may have no options, or may be politically opposed to routing freight into other areas.

- **ATMS Integration** – Sensors, cameras, and related applications will depend on the capabilities of each regional ATMS. Software development may be required to integrate new subsystems and update the user interfaces. For an integrated operations approach, TMC operators will be required to monitor and manage the system components and view system alarms/notifications.

- **Limited ROW** – This strategy may involve the placement of monitoring equipment at locations that are outside of TxDOT ROW.

- **Limited Train Location Data** – Due to concerns over proprietary data, railroads do not typically share data on train schedules. There are no specific FRA guidelines that prevent railroads from publicly announcing their train schedules, but most freight railroads choose not to do it.

4.2.3 Operational Impacts
From an operational perspective, the implementation of the High-Resolution Freight Traveler Information System strategy would have the following impacts:

- **Increased Need for Monitoring and Verification** – Delays and obstructions may require additional verification by operators, depending on the type of detection systems
implemented at each site and the operational policies used by the local transportation agency. Verification could be executed with field personnel or via CCTV cameras.

- **Increased Demand for Real-Time Network Communications** – Network communications occur in real-time from field device to field device, field device to TMC, and/or TMC to TMC. Efficient and reliable communications would be needed to collect and monitor traffic data, view CCTV video images, provide delay information to drivers while in route, and disseminate this information via traveler information systems and CV-enabled technology.

- **New Training Requirements** – Maintenance personnel may require additional training in order to support new detection systems. TMC operators may require additional training to manage new detection systems.

### 4.2.4 Organizational Impacts

From an organizational perspective, the implementation of the Blocked Rail Crossing Traffic Management System would potentially impact both the public and the private sector.

#### 4.2.4.1 Public Sector

The successful implementation of the Blocked Rail Crossing Traffic Management System would require close collaboration and interaction between TxDOT and regional agencies. Collaboration should begin prior to the implementation of new detection systems and identification of alternate freight routes.

Installation and operation of static signs with beacons or DMS at decision points would also require close collaboration between TxDOT Districts, Divisions, and local agencies, including coordinating the permitting application for sign construction in non-TxDOT ROW.

SOPs should be provided on how to monitor and operate the system, and should also include blocked rail crossing parameters. Agreements should be made regarding responsibilities for operating and maintaining the DMS, including procedures for approving posted message content.

#### 4.2.4.2 Private Sector

In regard to the private sector, if railroads are willing to participate in the deployment of this strategy, collaboration with railroad stakeholders is needed if the installation of new detection systems is required on private railroad property, including coordinating permit applications on their private land. Data sharing agreements between the railroad and TxDOT would need to be in place to obtain train schedule information. In addition, data sharing between the railroad and TxDOT would also require standardized data formatting for the Blocked Rail Crossing Traffic Management System to function. If railroads would prefer not to share their ROW or access to their data, this strategy would not impact the private sector.
TxDOT would instead install detectors on public ROW to collect the data needed to determine where rail crossings are blocked.

4.2.5 Impacts During Development

The impacts during development could vary depending on the implementation approach chosen by each District. For a Blocked Rail Crossing Traffic Management System deployed as part of an existing ATMS platform, the software would communicate with and exchange information with new ITS devices. Some ATMS software development would be needed to integrate the new devices into the existing platform. Additionally, the GUI would need modifications to allow operators to manage and control the new field devices. This development work may be done concurrently and should not affect day-to-day operations.

For a standalone system, there would be information exchange with various external systems. At a minimum, the standalone system would transmit current traffic information, device status, notifications, and alarms to the ATMS. Alternatively, the system may bypass the ATMS and report directly to the ATIS. In either scenario, interface development for the systems to connect may be done in parallel, and it is not foreseen to affect day-to-day operations.

4.2.6 Impacts to Stakeholders

Relevant stakeholders for the Blocked Rail Crossing Traffic Management System strategy are listed in Exhibit 34. Stakeholders are denoted by roles of owner, key stakeholder, and/or end-user. This strategy envisions TxDOT Districts as the owners that would own, operate, and maintain the systems installed on state-owned routes. The affiliated Districts, their TMCs, and other public sector agencies would be key stakeholders in identifying where needs exist, based on queuing issues and availability of alternative freight routes that do not disrupt the local community. End-users would primarily be the private sector truckers and other road users who would benefit from system notifications in real-time. The impacts listed in Exhibit 34 assume that the approach taken is Option 1 – Full Integration with Regional ATMS (described in detail in Section 3.4.1.1), unless otherwise stated.

Exhibit 34: Relevant Stakeholders for the Blocked Rail Crossing Traffic Management System strategy

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Role</th>
<th>Strategy Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>TxDOT Divisions</td>
<td>Owner / Key Stakeholder</td>
<td>- Will oversee the implementation of the strategy and provide support.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Will prioritize implementation locations with input from other stakeholder groups.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Will implement data-sharing agreements with each regional TMC.</td>
</tr>
<tr>
<td>Stakeholder</td>
<td>Role</td>
<td>Strategy Impact</td>
</tr>
<tr>
<td>----------------------</td>
<td>---------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Will offer technical recommendations in each respective area of expertise to support TxDOT’s various user groups.</td>
</tr>
</tbody>
</table>
| TxDOT Districts      | Owner / Key Stakeholder   | • Will own, operate, and maintain the systems installed.  
                               • Will manage their own ATMS system, including any new ITS devices for the new system that are integrated into the ATMS.  
                               • Will monitor ITS devices not integrated with the ATMS (standalone system).  
                               • Will provide day-to-day oversight of the new system.  
                               • Will monitor device operability.  
                               • Will monitor the new system’s performance.  
                               • Will report on system performance.  
                               • Will communicate real-time conditions and incident information related to railroad crossings through DriveTexas.  
                               • Will encourage close coordination between TxDOT and Districts to provide for seamless real-time traffic information across the region. |
| TxDPS                | Key Stakeholder           | • Information will be shared with State Patrols in and around rail crossings equipped with detection systems.  
                               • Historical data will be used to assist with planning exercises for emergency responders whose coverage area must cross railroad tracks.  
                               • State patrols will provide assistance on scene at these locations during secondary incidents caused by queues and during major congestion events. |
| Local Communities    | Key Stakeholder           | • Will help inform TxDOT of known local issues due to blocked rail crossings.  
                               • Will help identify acceptable alternative routes in the local community. |
<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Role</th>
<th>Strategy Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPOs</td>
<td>Key Stakeholder</td>
<td>• Will plan for the Blocked Rail Crossing Traffic Management System to be part of the long-range MTP.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Will help identify high priority implementation locations.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Will help identify regional grant opportunities to fund large-scale implementation of this system to improve regional mobility.</td>
</tr>
<tr>
<td>Railroads</td>
<td>Key Stakeholder</td>
<td>• May possibly share train schedule information with TxDOT and local agencies.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• May possibly share PTC information or expanded sharing of preemption data.</td>
</tr>
<tr>
<td>Truckers</td>
<td>End-User</td>
<td>• Will be informed of incidents and congestion 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>• Dispatchers will receive alerts via the ATIS System. In this case, information will be pushed from the ATMS to the ATIS.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Will utilize travel information disseminated from the ATIS system to help truck drivers avoid congested areas and make travel route decisions.</td>
</tr>
<tr>
<td>Emergency Responders</td>
<td>End-User</td>
<td>• Dispatch will receive notifications via the ATIS System. This would allow them to make informed routing decisions for emergency vehicles on route to an incident.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Will be informed of incidents and congestion via DMS, the ATIS website, mobile device apps, social media, and information rebroadcasted by the media and third-party providers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• CV-equipped emergency vehicles may receive notifications on whether a train may be approaching the crossing.</td>
</tr>
<tr>
<td>Stakeholder</td>
<td>Role</td>
<td>Strategy Impact</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>------------</td>
<td>----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Other Roadway Users</td>
<td>End-User</td>
<td>• Will be informed of incidents and congestion via DMS, the ATIS website, mobile device apps, social media, and information rebroadcasted by the media and third-party providers.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• External partners will access the ATIS system to obtain traveler information.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Road users with CV-equipped vehicles can receive notifications of a train approaching at a certain crossing.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Road users can utilize alternate routes when a blocked rail event is occurring.</td>
</tr>
</tbody>
</table>

### 4.3 Alternatives To This Strategy

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

#### 4.3.1 Disadvantages and Limitations

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

- **System Monitoring and Maintenance** – Additional equipment would need to be operated by the TMC and maintained regularly, which increases overall ITS programmatic operations and maintenance (O&M) costs.

- **Routing Recommendation Compliance** – The effectiveness of the system is limited by the ability to divert freight traffic to the alternate route(s) recommended during delays. Drivers are expected to read and follow the recommendations disseminated on DMS, roadside signing, or ATIS systems, which may not always be intuitive to an unfamiliar driver.

- **Data Processing** – The system is limited by the technology currently available. There may be a need to develop software and modify the network architecture to implement the concept. Software development can be a costly expense.
Agency/Regional Policies – The system may be limited by internal agency administrative policies that do not allow inter-agency coordination and cooperation, which could limit the full capabilities of the system.

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

4.3.2.1 Alternative 1: “Do Nothing” Approach
This alternative would maintain the current situation, which would require no changes to the existing program, no increases in costs, and no additional staff. TxDOT’s existing traffic operations program would continue to provide the same types of service, with no improvements in managing blocked rail events. If this alternative is pursued, TxDOT would expect to maintain the status quo, capturing none of the benefits outlined in Section 4.1.

4.3.2.2 Alternative 2: Require railroads to issue location data to support crossing use forecasting and blockage notifications
This alternative would instead require railroads to publicly publish schedules for truckers to utilize as part of their operations. This alternative would substantially reduce TxDOT’s role and simply make train locations, arrival times, and schedules directly available from the railroads to all road users. It is likely that TxDOT would utilize this traffic data stream to publish forecasted rail crossing blockages on DriveTexas, but the need to install field equipment for train detection would be negated.

It is unlikely that this alternative would occur successfully. No specific FRA guidelines prevent railroads from publicly announcing their train schedules, but due to a variety of competitive considerations (e.g., liability, security, confidentiality), railroads do not typically share this information with the public. Train schedules tend to be dynamic and frequently adjusted to meet customers’ needs, so a perception exists that publishing inaccurate schedules may put truckers and the traveling public in danger giving them a false sense of confidence that a train is not expected to arrive at a specific time, resulting in safety concerns and possible incidents. It would take regulation to make this information be widely available, which would face fierce opposition from groups who do not want to share their location information. With these challenges, this alternative is not recommended.

4.3.2.3 Alternative 3: Invest in grade separation
This alternative would avoid use of technology and simply separate the highway-rail grade at locations that handle large volumes of traffic while also experiencing frequent rail
blockages. Grade separation would completely resolve the blockage issue and allow for traffic to operate freely through this intersection, reducing delays and safety issues. That said, grade separation is an extremely costly undertaking and requires a number of conditions to be met to satisfy justification for grade separation. The American Association of State Highway and Transportation Officials (AASHTO) edition of Policy on Geometric Design of Highways and Streets manual describes six conditions that need to be considered when determining if a grade separation or interchange is needed: roadway type, reduction of bottlenecks, reduction of crash frequency and severity, site topography, road-user benefits and traffic volume. Assuming these conditions are favorable, project costs are significant and depend on the type of grade separation being built. For example, the costs for a two-level interchange (refers to congestion occurring primarily on one cross street) may be in the range of $10-30 million, while a three-level interchange (refers to congestion occurring on all approaches) may cost more than $100 million. In many cases, these high project costs make grade-separated crossings cost prohibitive.

While TxDOT is exploring opportunities to implement grade separation, considering it as an alternative here is not recommended on a widespread level.

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17 Texas A&M University, Grade Separation.
5.0 Operational Scenarios

This section presents six operational scenarios that describe situations in which the Blocked Rail Crossing Traffic Management System 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 Blocked Rail Crossing Traffic Management System 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 35: summarizes the operational scenarios presented in this section.

Exhibit 35: Summary of Operational Scenarios

<table>
<thead>
<tr>
<th>#</th>
<th>Scenario</th>
<th>Stakeholder Perspective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Rail crossing is blocked and trucker is notified of blockage and an alternate route is identified.</td>
<td>Truckers</td>
</tr>
<tr>
<td>2</td>
<td>Rail crossing is blocked and, upon notification, trucker pulls over to wait for the crossing to open because no alternate route is available.</td>
<td>Truckers</td>
</tr>
<tr>
<td>3</td>
<td>Truck at a port receives advanced notice of a train arrival and leaves a few minutes early to avoid getting stuck at a blocked rail crossing.</td>
<td>Truckers</td>
</tr>
<tr>
<td>4</td>
<td>School bus driver is notified in advance of an arriving train and takes an alternate route to avoid delay.</td>
<td>Other User</td>
</tr>
<tr>
<td>5</td>
<td>Emergency response vehicle is notified of an arriving train and takes an alternate route to avoid delay.</td>
<td>Emergency Responders</td>
</tr>
<tr>
<td>6</td>
<td>TxDOT District looks at historical blocked rail crossing data to make informed planning decisions.</td>
<td>TxDOT District</td>
</tr>
</tbody>
</table>

5.1 Occupied Highway-Rail Crossing – Truck Takes Alternate Route

On a Wednesday morning at 12 p.m., Charlie has just picked up a large shipment from a distribution center near Alliance Airport in Fort Worth. He is a short haul commercial truck driver with more than 15 years of experience, operating mostly within the Dallas-Fort Worth area.

Charlie is traveling south on I-35 West to deliver his shipment to a large store north of downtown Fort Worth. He’s on-time and his in-cab navigation shows an estimated time of arrival (ETA) of 12:35 p.m. Charlie’s navigation system instructs him to exit I-35 West and
take an arterial road for several miles to his destination. He has taken this route before and knows that trains sometimes block the at-grade crossings due to congestion in a nearby switching yard. In the past, he has found himself stuck in a line of trucks waiting to cross, with delays sometimes lasting 30 minutes or more.

A few minutes later, Charlie notices a roadside sign that reads “Rail Crossing Ahead In Use. Use Alternate Route when Flashing”. Atop the sign are two beacons that are flashing rapidly. On other occasions where Charlie has passed the sign, the beacons were not active and he was able to cross the railroad tracks in one-mile without an issue. Realizing that they have been activated for a reason, he follows the instructions and turns onto the signed alternate route, noting that other trucks around him are also doing the same.

He proceeds north for about a mile and follows the signed alternate route. The alternate route leads to an overpass across the railroad tracks. As he travels over the railroad tracks, he sees a large freight train traveling slowly along. Judging by the number of train cars, Charlie speculates that he could have lost more than 15 minutes had he not taken the alternate route. He is relieved that he avoided a potential delay and that his navigation system has only added an additional two minutes to his ETA. Charlie still makes his delivery on time.

5.2 Occupied Highway-Rail Crossing – Truck Waits

It’s 8 a.m. on a Tuesday and Molly is starting a busy day. She is a professional frac sand hauler with over 20 years of experience. Throughout the years, she has worked in the Permian Basin and, today, is on route to deliver a large load of frac sand to an oil well outside of Odessa.

With so many years of experience, she has become familiar with the region. Still, she uses her in-cab navigation system to avoid unexpected congestion and incidents, as those events still occur. Today, her navigation system is showing that her route is clear and she will arrive early at the delivery location.

A few minutes later, as Molly continues traveling on the rural route to her destination, she notices a roadside sign that reads “Railroad Crossing Ahead In Use When Flashing. Watch for Stopped Traffic.” Two beacons on the sign are flashing rapidly. Molly knows the railroad crossing is about three miles ahead of her and, having driven this route many times, she knows there are no freight-approved alternate routes to bypass the railroad tracks. With railroad delays sometimes lasting over a half hour, she decides to pull into the nearest truck stop, about a quarter mile ahead and long before the queued traffic that frequently builds up at the railroad crossing.

Molly parks her truck at the private truck stop down the road. She has time to go inside, use the bathroom, and grab a refreshing drink. Now back at her truck, she checks the
DriveTexas website for information on the status of the railroad crossing. DriveTexas shows the crossing as “red” to indicate that it is still blocked, so she decides to check back in a few minutes.

About thirty minutes later, she checks DriveTexas again and sees that the crossing is now “green” to show that it has opened up. She immediately gets back on the road and heads toward her destination. She drives through the rail crossing with no delay. Her navigation system has added 10 minutes to her ETA, but luckily, Molly left early anticipating any setbacks. She is happy that she was able to reduce her driving time and fuel consumption by making the stop, rather than sitting idly at the railroad crossing.

5.3 Incoming Train – Port Application
It’s 9 a.m. on a Monday morning and Susan has just arrived at the Port of Houston. She’s picking up a shipment from one of the port’s docks. This is a routine day for her. As a short haul truck driver, her day generally consists of her picking up loads at the Port of Houston or Galveston and delivering them to large facilities throughout the Houston area. With many years of experience, she is used to the region’s recurring congestion and knows that, given the number of freight trains operating in the area, sometimes delays occur at railroad crossings.

By 9:15 a.m., she has followed signs for the correct dock, picked up the load, and is ready to leave the port to make the delivery. She does not have to leave the port until 9:30 a.m. in order to be on time, so she is in no hurry to get back on the road. Susan enjoys a quick snack and checks DriveTexas to see if there are any major incidents she should be worried about. To her surprise, DriveTexas shows a notification related to a rail crossing nearby. The railroad crossing directly outside the port’s gates is noted as having a potential train arriving there in about 10 minutes. This data is based on sensor reports of a train passing at other highway at-grade crossings upstream of the crossing. It’s now 9:25 a.m. Susan realizes that if she leaves at 9:30 a.m., as she had originally planned, she might be delayed when the train comes through, as trains near the port sometimes stop due to rail traffic attempting to leave first.

Not wanting to be potentially late for her delivery, she immediately begins driving the posted speed limit to avoid getting stuck at the rail crossing and is able to exit the port without any delay. A few minutes later, as she is stopped at a traffic light outside the port, she notices the train approaching and the crossing gates lowering behind her. Seeing that it is a large freight train, she is relieved that she avoided a massive delay. Susan continues towards her destination, on schedule to arrive a few minutes early. She’s now determined to check DriveTexas more often before planning her entries and exits to the port terminals around Houston.
5.4  **Incoming Train – School Bus Application**

Jose has been a bus driver for 25 years. He works for a middle school in Denton, Texas, a city north of Dallas. Today is a busy day for Jose. It’s a Friday afternoon at 4 p.m. He has a bus full of kids anxious to get home for the weekend and the afternoon rush hour is building up around him.

Jose has always been very passionate about his job. Throughout his career, he has brought kids to and from school with no safety issues. However, one aspect of the job that makes him anxious are the rail crossings. The City of Denton has numerous railroad crossings, with both freight and transit trains passing through them. Jose has seen drivers make foolish decisions near the crossings, such as speeding up to try to beat the gates and he wishes that people had a better idea of when trains were actually approaching.

As Jose continues on his route today, he’s not worried about the rail crossings. He will eventually need to cross the tracks, but there are multiple parallel streets he can take to cross them. Jose is approaching his usual crossing when he receives a notification on his bus’s connected vehicle on-board unit. It alerts him that a train is approaching in three minutes, even though the crossing lights and gates have not yet activated. Despite getting this alert, Jose feels more comfortable as he stops at the tracks with greater awareness of the train’s location than he would be if the lights suddenly came on. The train is still nowhere in sight and he elects to drive the school bus safely across the tracks.

He remembers that his supervisor had mentioned that TxDOT would be installing a new Blocked Rail Crossing Traffic Management System throughout Denton. Through a newly-installed connected vehicle on-board unit on his bus, Jose now receives notifications of forecasted train arrivals directly to his dashboard. Having been the first notification Jose received, he is extremely happy with the results. He was able to know ahead of time when the crossing would be in use, avoiding any potential safety issues or delays. The rest of his afternoon runs smoothly and he brings all the kids home on time.

5.5  **Incoming Train - Emergency Response Vehicle Application**

Nick works as an ambulance driver for the Lyndon B. Johnson Hospital in Northeast Houston. He has over 10 years of experience transporting patients to the hospital. It’s 3 p.m. on a Thursday afternoon and it has been a seemingly slow day for Nick. He has only received two calls, the most recent being a patient with minor injuries who did not need to be transported to the hospital. Currently, he is on his way back to the hospital.

For Nick, his favorite aspect of the job is that it has allowed him to memorize the streets around Northeast Houston. Driving for almost the entirety of his eight-hour shifts, he has become extremely familiar with the roads, creating a mental map of the most efficient routes to and from the hospital. The only frustration he experiences is at the numerous rail crossings that surround the hospital. Although he knows exactly where each one is, trains...
can sometimes stop on the tracks and block the crossings for long periods of time. In this case, Nick has to quickly make a U-turn and find an alternate route that has clearance over the railroad tracks, wasting crucial time as his patient is waiting. Most ambulance services set up their territories to minimize the need to cross tracks, but in this geographic area, it is unavoidable.

About a week ago, Nick’s supervisor informed him that Lyndon B. Johnson Hospital was partnering with the TxDOT Houston District in a connected vehicle program that works with a newly implemented Blocked Rail Crossing Traffic Management System. Equipped with an on-board unit, Nick’s ambulance would receive notifications about nearby blocked rail crossings. These notifications would be published to his on-board unit to inform him of any railroad crossings that were currently in use by a train, as well as any railroad crossings that might be in use in the near future as the train moved along.

As Nick is returning to the hospital, he receives a call regarding an individual potentially suffering a stroke. Although it is outside his normal operations area, many other emergencies have tied up the other ambulance services, leaving his as the closest. He receives the address and immediately begins to drive towards it. About two minutes later, Nick receives an alert on his ambulance’s navigation system, warning him of a blocked rail crossing ahead. At the same time, he notices that his navigation system reroutes him to an alternate route, an overpass about a half mile north of the blocked crossing.

Nick follows the suggested route. As he drives on the overpass, he notices a large freight train stopped on the tracks. He continues to his destination, already feeling relieved that he avoided a significant delay. At the address, he picks up the patient and brings him to the hospital as quickly as possible. On the way back, he receives the same blocked rail crossing notification and takes the same route from earlier, finding that the train has stopped and has blocked all of the at-grade crossings. Nick is extremely happy with the results of this new feature and how quickly it was able to alert him. As response time is extremely important in his job, he believes that this new safety feature could potentially save the lives of many patients.

5.6 Performance Reporting
A TxDOT District in central Texas has implemented a Blocked Rail Crossing Traffic Management System to cover a large number of at-grade crossings in its District. Through extensive stakeholder outreach, the District identified strategic railroad crossings on roads with high freight volumes. They focused on high-volume urban and rural corridors, as well as rail crossings that interfere with port operations.

After the first year of operations, they decide to analyze the data collected for future planning work. Since its implementation, the Blocked Rail Crossing Traffic Management System has collected detailed data on all occurrences, storing the historical data in a
database. District engineers are able to access data on the number of times each rail crossing was blocked, as well as when the blockage started and ended.

Several communities have expressed complaints with blocked rail crossings in the past. With access to this extremely detailed data, the TxDOT District is able to ease concerns over long crossing blockages, backed up by the data to show that, on average, crossings were not blocked for long periods of time. In cases where concerns were justified by the data, the District worked with the community and other stakeholders to explore opportunities for grade separation.

After visualizing the dataset, the District outlined a specific plan on how to move forward with the information they had collected. They isolated the rail crossings with the longest delays and plan to explore opportunities to implement grade separation at these locations, engaging local stakeholders and the major rail carriers that operate on them. In an attempt to address queuing-related crashes, the District looked at crash reporting data at the locations before and after the Blocked Rail Crossing Traffic Management System was installed and can already note a reduction in back-of-queue incidents. With the success of this program, the District decides to engage local stakeholders in an effort to expand the system to other key rail crossings.
6.0 Next Steps
This Blocked Rail Crossing Traffic Management System ConOps is one of six ConOps documents to be 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 36).

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

Exhibit 36: Next Step in the Texas FNTOP
7.0 References

The following is a list of relevant documents, standards, and references used in preparing this document:


▪ Federal Railroad Administration, Highway–Rail Crossing Database.


