Chapter 2: I-10 Today

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

AADT .... Annual average daily traffic
ADOT .... Arizona Department of Transportation
ANSI .... American National Standards Institute
ATA .... American Trucking Associations
ATRI .... American Transportation Research Institute
BOE .... Bureau of Equality
CACC .... Cooperative adaptive cruise control
Caltrans .... California Department of Transportation
CAN .... Controller area network
C-ITS .... Cooperative intelligent transportation system
CMV .... Commercial motor vehicle
ConOps .... Concept of Operations
COTS .... Commercial off-the-shelf
CPA .... Comptroller of Public Accounts
C-TIP .... Cross-Town Improvement Project
CV .... Connected vehicle
CV/AV .... Connected vehicle/automated vehicle
CVRIA .... Connected Vehicle Reference Implementation Architecture
CVSA .... Commercial Vehicle Safety Alliance
D-CS .... Detection-Control System
DMS .... Dynamic message sign
DMV .... Department of Motor Vehicles
DOT .... Department of transportation
EDI .... Electronic Data Interchange
FAF .... Freight Analysis Framework
FAST .... Fixing America's Surface Transportation Act
FASTLANE .... Fostering Advancements in Shipping and Transportation for the Long-Term Achievement of National Efficiencies
FHWA .... Federal Highway Administration
FMCSA .... Federal Motor Carrier Safety Administration
FPM .... Freight performance measure
FRATIS .... Freight Advanced Traveler Information System
GDP .... Gross domestic product
GIS .... Geographic information system
GPS .... Global positioning system
HAZMAT ...... Hazardous material
HPMS .... Highway Performance Monitoring System
HURF .... Highway User Revenue Fund
ICM .... Integrated corridor management
ITS .... Intelligent transportation system
MAASTO ...... Mid America Association of State Transportation Officials
MAP-21 .... Moving Ahead for Progress for the 21st Century
MARAD .... Maritime Administration
MDOT .... Michigan Department of Transportation
MVD .... Motor Vehicle Division
NATSO .... National Association of Truck Stop Operators

N-CAST .... National Corridors Analysis and Speed Tool
NHS............. National Highway System
NMDOT .... New Mexico Department of Transportation
NTSB........... National Transportation Safety Board
OBD-II.......... Onboard diagnostics II
OOIDA .... Owner-Operator Independent Drivers' Association
POE............. Port of entry
RFTA .... Revenue and Fuel Tax Administration
SCMS .... Security Credentialing and Monitoring System
SHA............. State Highway Administration (Maryland)
SHF .... State Highway Fund
SRF.............. State Road Fund
SRI .... Smart Roadside Initiative
TCP/IP.......... Transmission control protocol/Internet protocol
TERP .... Texas Emission Reduction Plan
TIGER........... Transportation Investment Generating Economic Recovery
TMC............ Transportation management center
TMF .... Texas Mobility Fund
TPAS .... Truck Parking Availability System
TPIMS .... Truck Parking Information Management Systems
TSPS............ Truck Smart Parking Services
TTI............... Texas A&M Transportation Institute
TxDOT.......... Texas Department of Transportation
USDOT .... United States Department of Transportation
USGS........... US Geological Survey
V2I .... Vehicle-to-infrastructure
VMT............ Vehicle miles traveled
VWS............ Virtual weigh station
WIM .... Weigh in motion
WRI............. Wireless roadside inspection

INTRODUCTION

This chapter describes both the characteristics and the assets of the I-10 corridor but also surveys a range of freight technologies and operational improvements that might be considered for implementation in the corridor. Its title, "I-10 Today," conveys the current state of the interstate highway corridor and the current state of freight applications and improvements that could improve freight operations within the corridor in the future. The information in the chapter provides a foundation for the remainder of the Concept of Operations (ConOps) documentation and will be a valuable survey to share with stakeholders as their views and inputs are applied to the ConOps development process in the next chapter. This chapter has two major components (related to the corridor ConOps study process): an inventory of the corridor's condition and capabilities and a survey of available information regarding freight technologies and operational improvements that might be applied in the corridor.

CORRIDOR INVENTORY

This section presents an assessment of the I-10 western connected freight corridor across a broad spectrum of elements that are essential to efficient freight mobility. The purpose of this section is to characterize the corridor in terms of its freight handling/transport capabilities and deficiencies through cataloging and assessing transportation facilities along the corridor; documenting existing operational conditions and characteristics; cataloging network transportation management and intelligent transportation system (ITS) assets; detailing corridor institutional characteristics; and documenting any other essential assets and/or elements that may contribute to freight mobility.

This section is divided into three main subsections. The first part describes the corridor inventory and corridor inventory database. The second part describes the economic importance of the corridor and how public freight investments are funded. Finally, the third part discusses the public- and private-sector corridor stakeholders identified in each of the four states and included in the stakeholder electronic contact list.

Freight Corridor Inventory

An inventory was conducted on the I-10 corridor with a focus on documenting its freight-related infrastructure, transportation management assets, and operational conditions. This information was compiled into a geographic information system (GIS) database inventory with geolocation features and summarized in an inventory log. Additionally, the inventory identified the funding sources and arrangements in place in each state along the I-10 western connected freight corridor (i.e., California, Arizona, New Mexico, and Texas) to help develop and sustain its ability to contribute to freight mobility, as well as studies that have documented the economic impact that freight has along the corridor across all four states. The information documented in this inventory was collected from government and private-sector online resources and consultations with stakeholder agencies.

This section begins with a description of the GIS database and the state-by-state structure of the information compiled in it. The second part of this section discusses the funding of freight infrastructure and the regional economic impact of freight along the corridor, summarizing current freight-related tax and revenue streams and identifying studies that document the economic impact of freight mobility.

Geographic Information System Inventory Database

The information in the inventory was documented on a state-by-state basis and is described in detail in a separate technical memo for the project. This information was compiled into a simple inventory database that contains geolocation features that map all transportation facilities along the corridor and that is consistent with Arizona Department of Transportation (ADOT) GIS database structures. The information included in the database covers six inventory categories: (a) general physical inventory; (b) operational conditions and characteristics; (c) ITS elements; (d) freight facilities; (e) communications systems in use along the corridor; and (f) compliance and enforcement facilities and systems.

Organization of the Database

The GIS database consists of several geospatial data layers that describe the attributes that define the six inventory categories listed above. Geospatial data layers are databases geographically referenced. In other words, geospatial data layers relate data items with their special location. Figure 1 presents how the database is organized. The six inventory categories are defined by a set of attributes for each of the four states along the I-10 western connected freight corridor (i.e., California, Arizona, New Mexico, and Texas). Geospatial data layers provide information related to each attribute within each state. Inside these geospatial data layers, the information is contained in data items, which are the smallest data entity in the database.

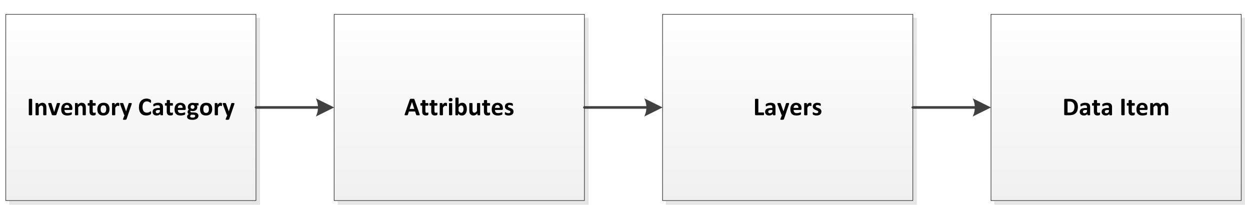


Figure 1. Database Organization

Table 1 explains how the database is structured. Specifically, the inventory log lists each of the six inventory categories and relates them with the 17 attributes. It also provides the name of the geospatial data layers that describe each attribute contained in the six inventory categories. Finally, the inventory log lists the data items contained in these geospatial data layers. The sections that follow provide a detailed description of the inventory categories along with the attributes, layers, and data items associated with them. Finally, the database is presented in a GIS shapefile format compatible with ADOT databases.

Table 1. I-10 Corridor GIS Database Structure and Sources

Inventory Category	Attribute	Sources
General Physical	Bridge and tunnel locations	National Bridge Inventory
	Number of lanes	HPMS
	Interchanges	HPMS and FAF
	Urban areas	Bureau of the Census Urbanized Area Boundaries
Operational Conditions and Characteristics	Managed lanes	HPMS
	Traffic volumes	HPMS
	Integrated corridor management	Federal Highway Administration ICM website and DOT websites
	Areas of recurring congestion	Google Maps
	High accident locations	ADOT safety corridors for Arizona, Safe Transportation Research & Education Center data from 2013 to 2015 for California, NMDOT safety corridors for New Mexico, and TxDOT crash data for Texas from 2014 to 2016
ITS Elements	Weigh in motion and PrePass	PrePass, Caltrans, and TxDOT
	Communications systems in use	Federal Communications Commission
Freight Facilities	Commercial airport location	National Transportation Atlas Database
	Intermodal facility location	National Transportation Atlas Database
	Seaport location	National Transportation Atlas Database
	Truck stop location and services	Trucker forum and gas station websites
	POE location	National Transportation Atlas Database
Compliance and Enforcement	Inspection facility information and location	ADOT, Caltrans, NM Motor Transportation Police, and TTI
	EMS and law enforcement agency location	USGS National Structures Dataset

Note: HPMS = Highway Performance Monitoring System; FAF = Freight Analysis Framework; ICM = integrated corridor management; DOT = department of transportation; NMDOT = New Mexico Department of Transportation; TxDOT = Texas Department of Transportation; POE = port of entry; Caltrans = California Department of Transportation; TTI = Texas A&M Transportation Institute; USGS = US Geological Survey.

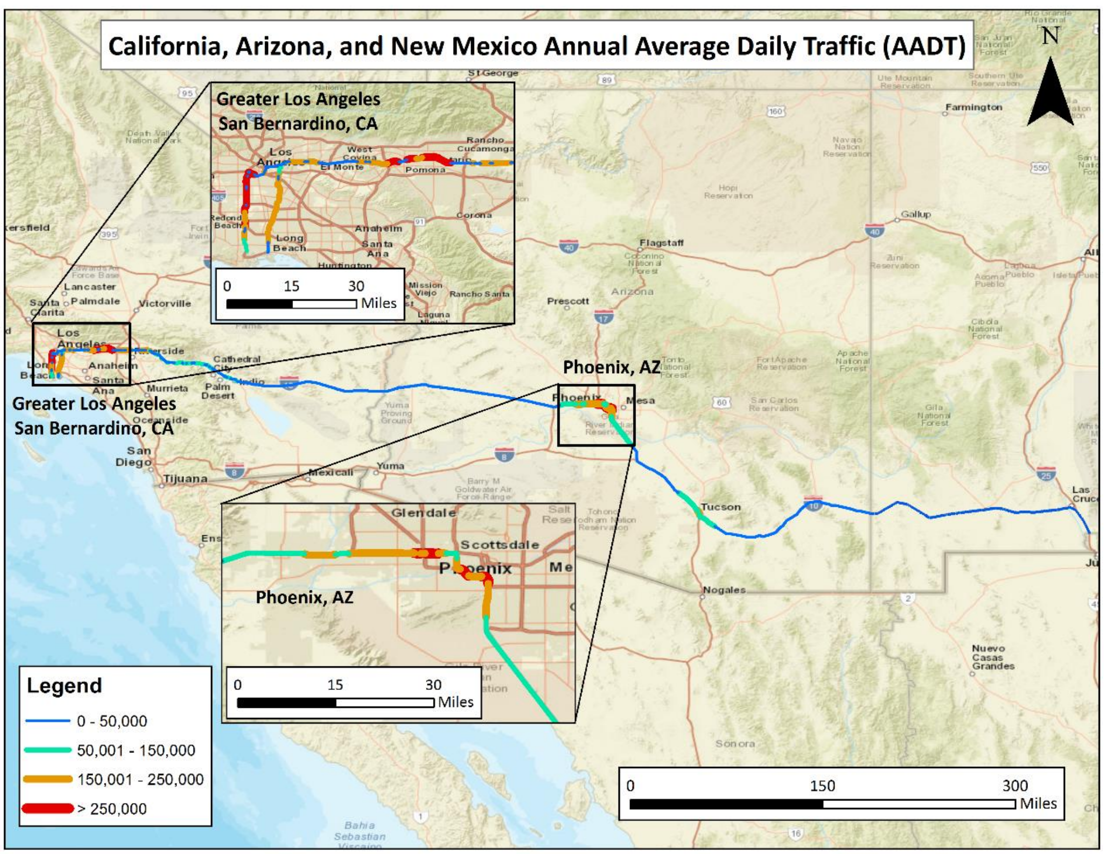
Corridor Inventory Analysis

This section identifies some of the issues that can be examined using the GIS database, including:

- How the I-10 corridor functions for its users in terms of traffic, congestion, and safety
- How the I-10 corridor connects multimodal freight generators such as seaports, cargo airports, truck terminals, and international ports of entry
- How assets along the I-10 corridor interact with freight travelers, including truck parking and safety enforcement facilities

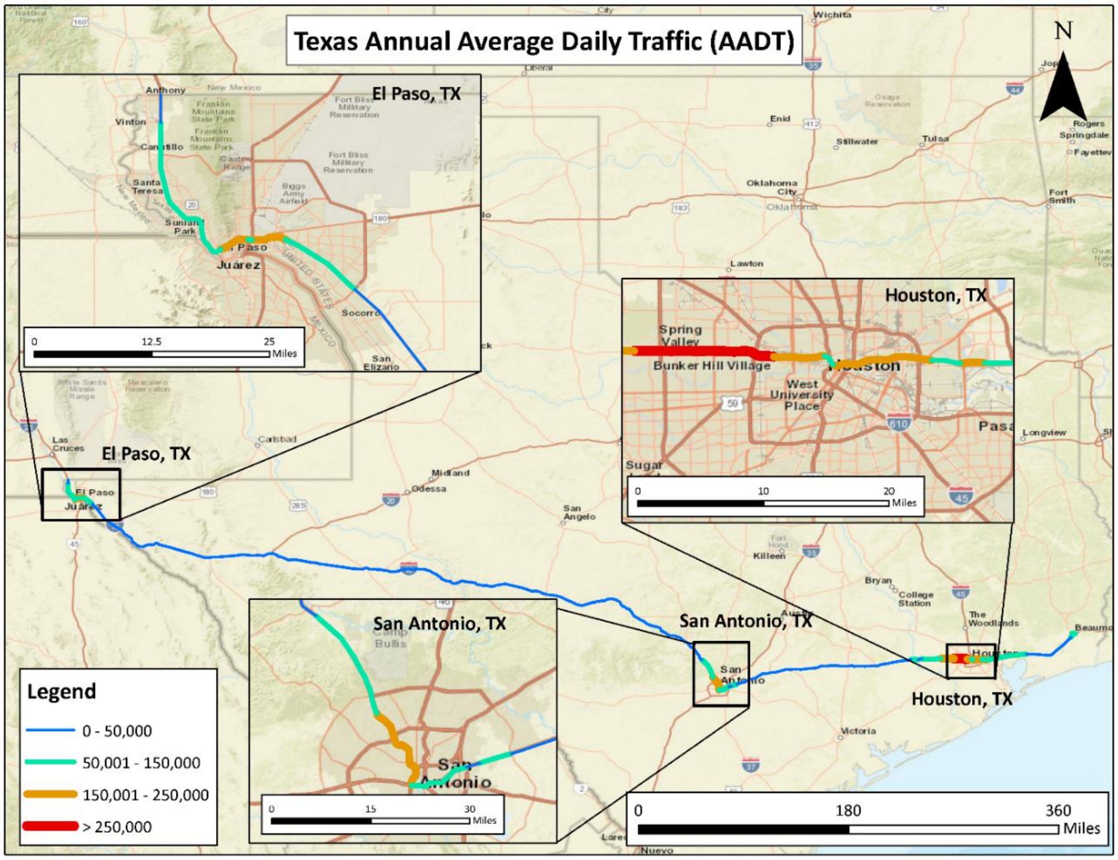
Corridor User Functionality

Figure 2 and Figure 3 illustrate levels of overall vehicle traffic along the I-10 corridor, as measured by annual average daily traffic, measured in numbers of vehicles per year. For much of its distance, I-10 experiences modest traffic levels, but in urban areas, total traffic increases with urban commuting and regional freight traffic.



Source: GIS Database Mapped by Project Team

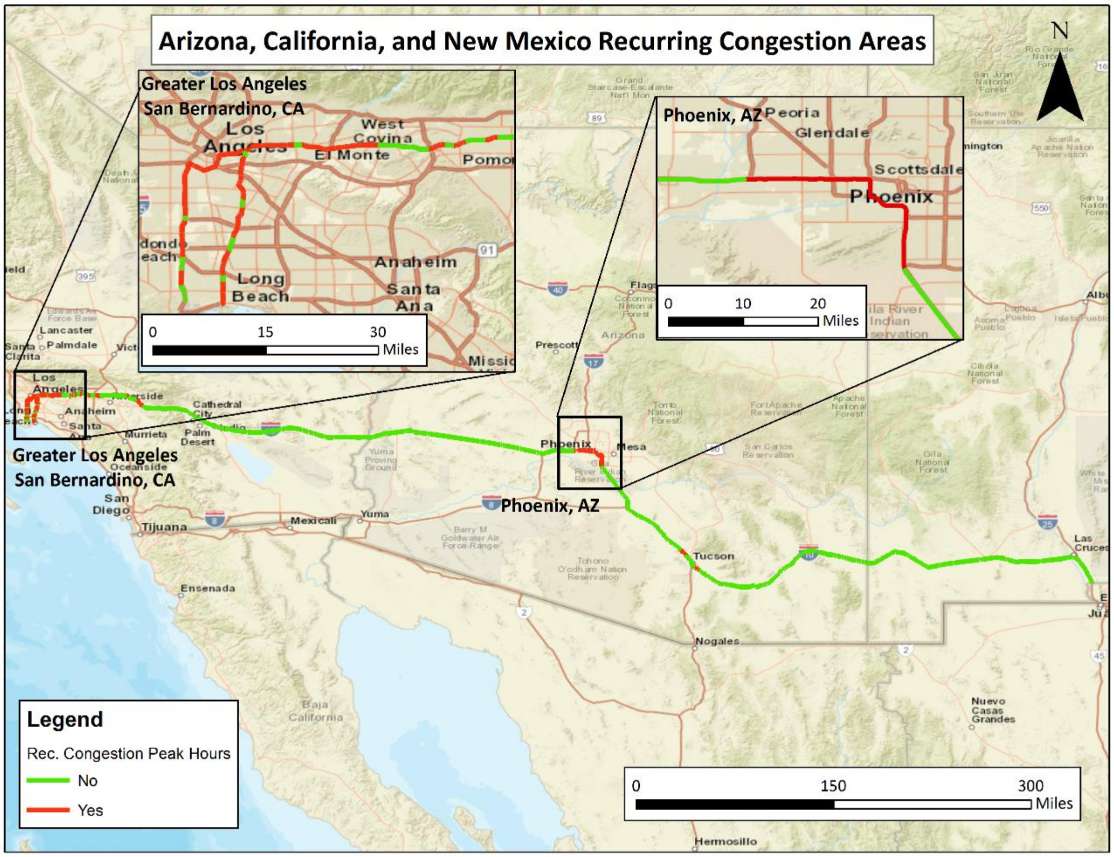
Figure 2. Annual Average Daily Traffic Along I-10 in California, Arizona, and New Mexico



Source: GIS Database Mapped by Project Team

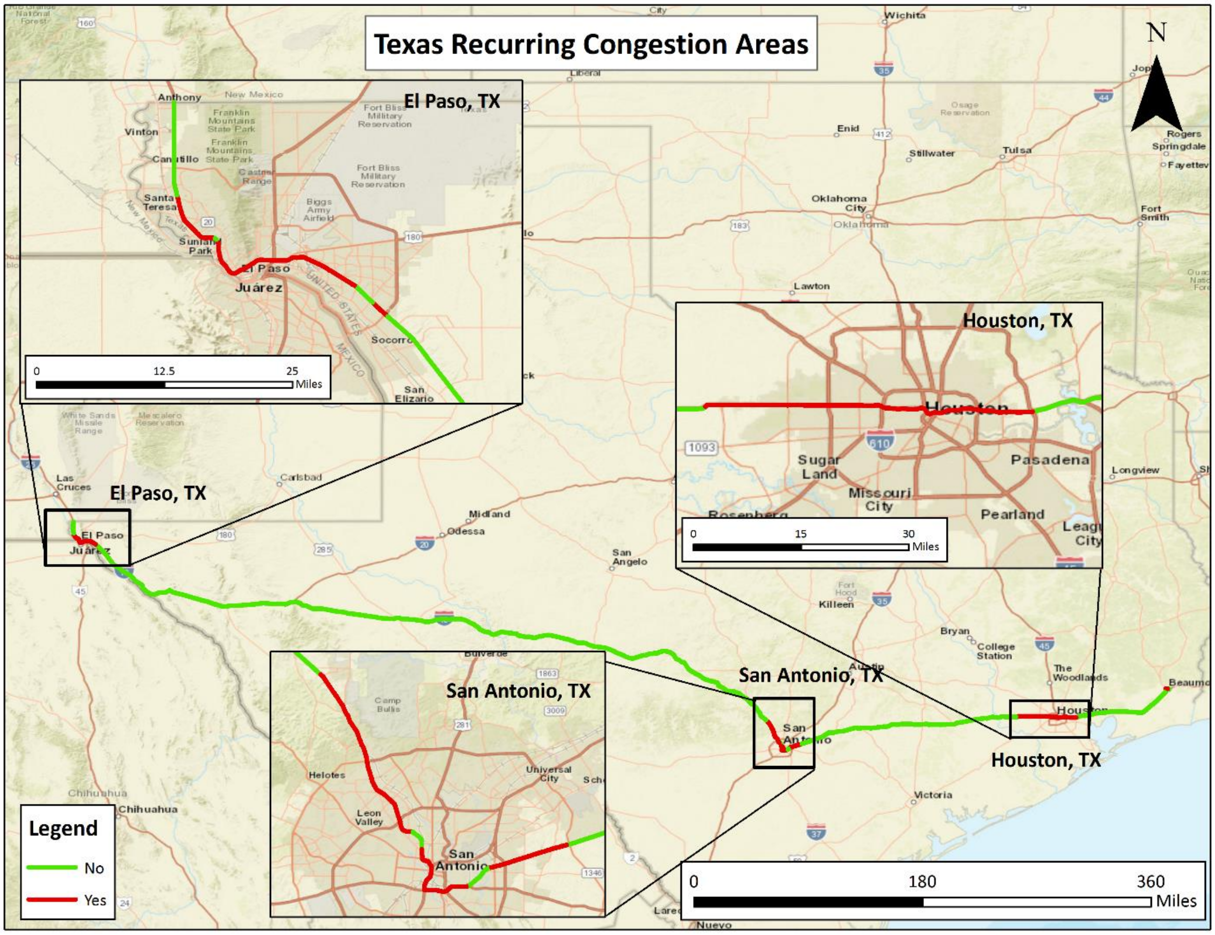
Figure 3. Annual Average Daily Traffic Along I-10 in Texas

Figure 4 and Figure 5 offer a similar view of this phenomenon, illustrating locations of recurring congestion, as defined by records of average travel speeds of all vehicles along highway segments in peak hours (7:00 a.m. to 10:00 a.m., 4:00 p.m. to 7:00 p.m.). Again, overall congestion increases within urban areas, where more freight vehicles will be entering and exiting the highway and competing with other local traffic.



Source: GIS Database Mapped by Project Team

Figure 4. I-10 Corridor Congestion in California, Arizona, and New Mexico



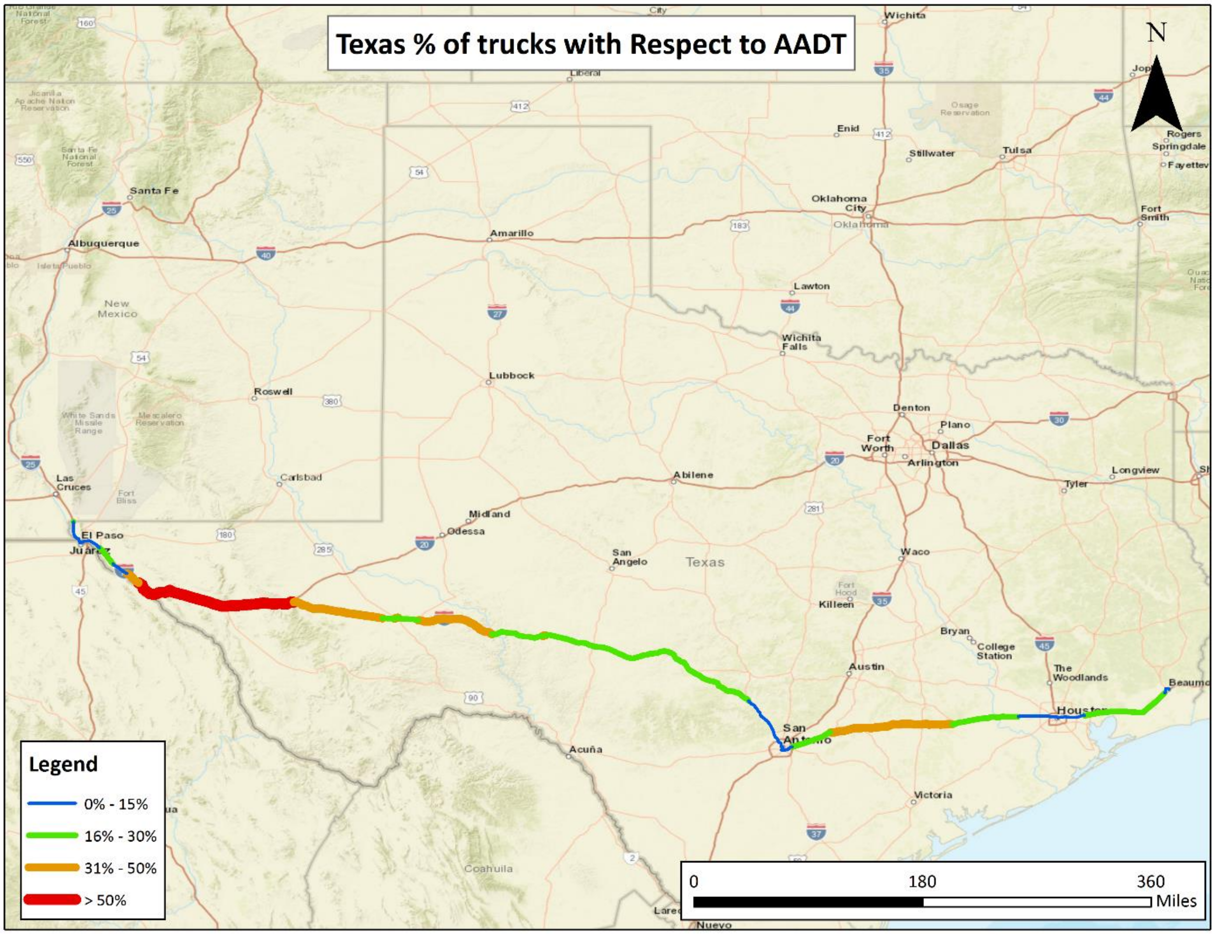
Source: GIS Database Mapped by Project Team

Figure 5. I-10 Corridor Congestion in Texas

While the maps above indicate relatively lower traffic and congestion in rural segments of I-10, a larger proportion of that traffic is comprised of trucks. Figure 6 and Figure 7 show the ratio of trucks to overall annual average daily traffic. I-10 is an important route for intercity freight traffic.

Source: GIS Database Mapped by Project Team

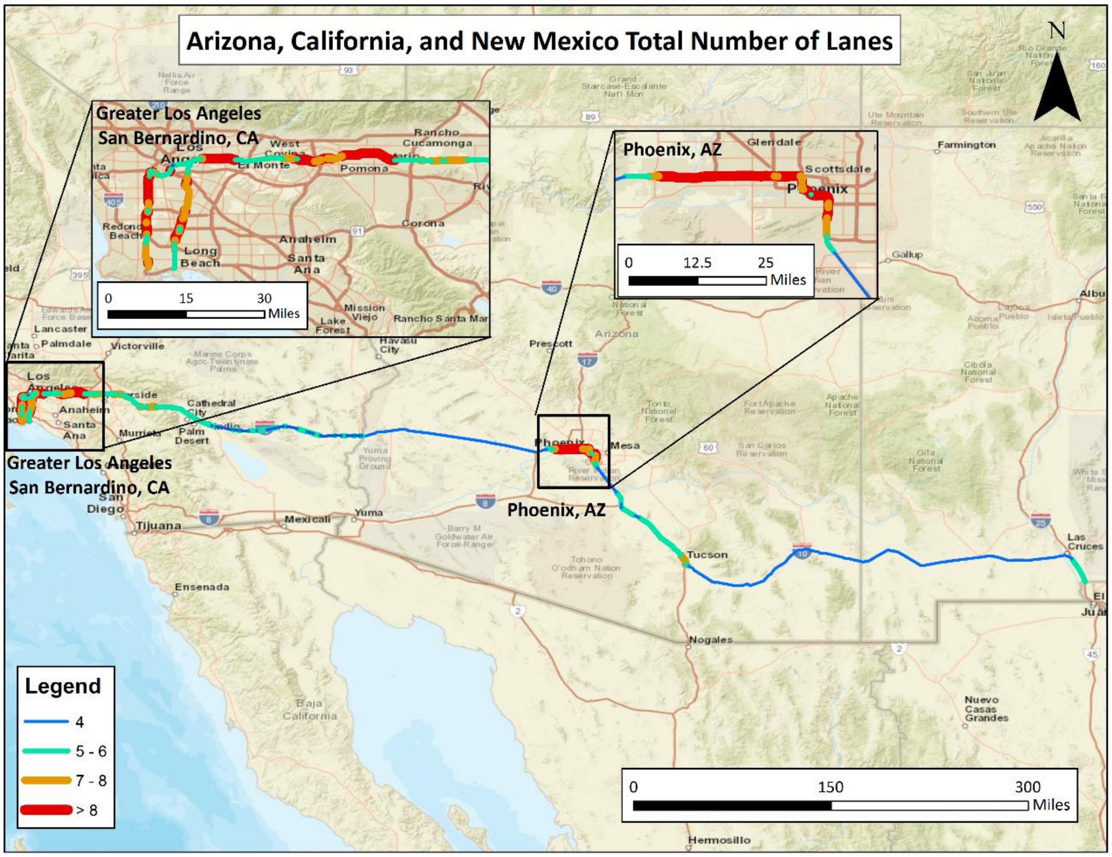
Figure 6. Truck Percentage of Overall AADT on I-10 in California, Arizona, and New Mexico



Source: GIS Database Mapped by Project Team

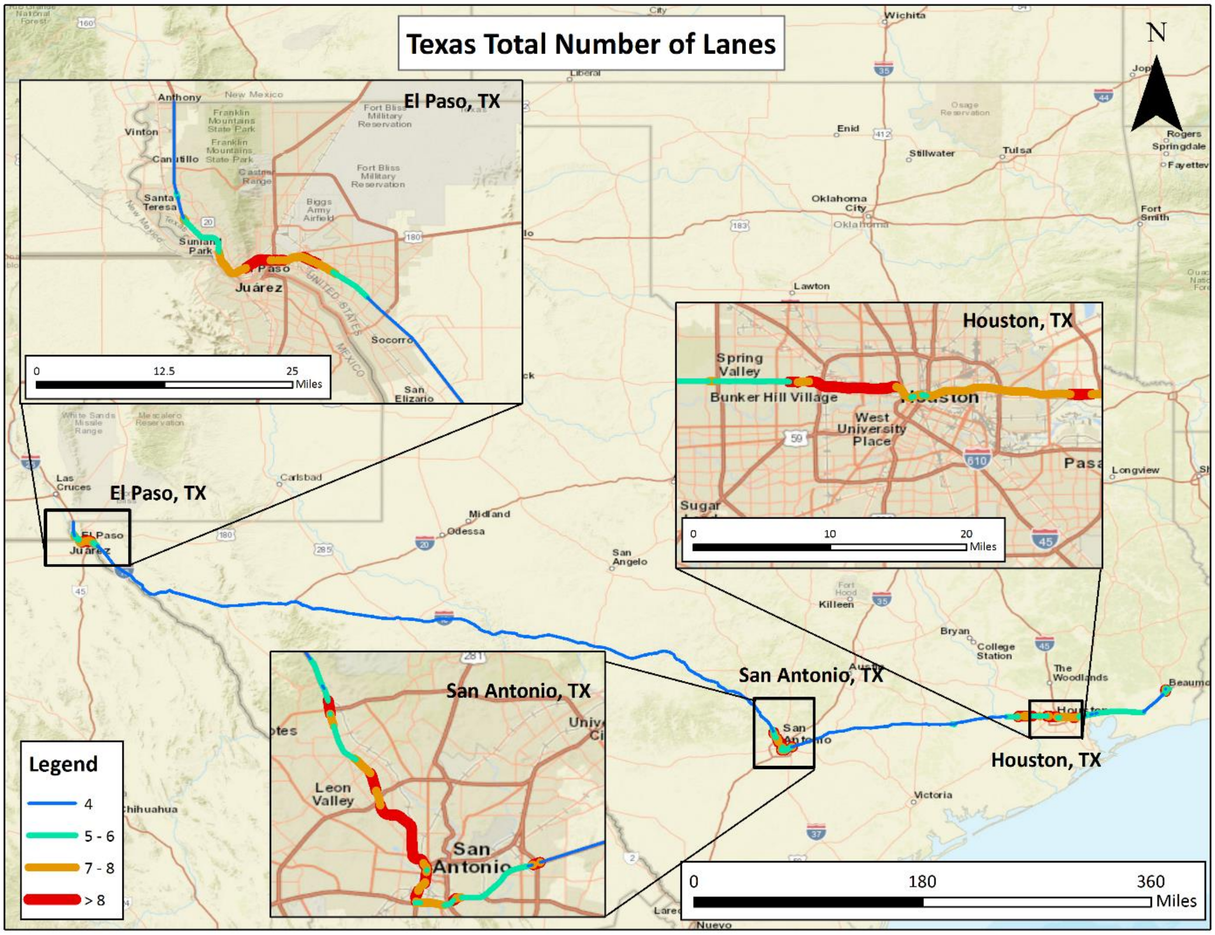
Figure 7. Truck Percentage of Overall AADT on I-10 in Texas

Figure 8 and Figure 9 illustrate overall highway capacity in the 1-10 corridor, expressed by the number of lanes in each highway segment, not including frontage roads. Overall capacity of I-10 matches general regions of increased traffic, although lane constraints (from six to four) are scattered throughout rural California between Southern California and the Arizona border, in Central Arizona between Phoenix and Tucson, and at the New Mexico–Texas border.



Source: GIS Database Mapped by Project Team

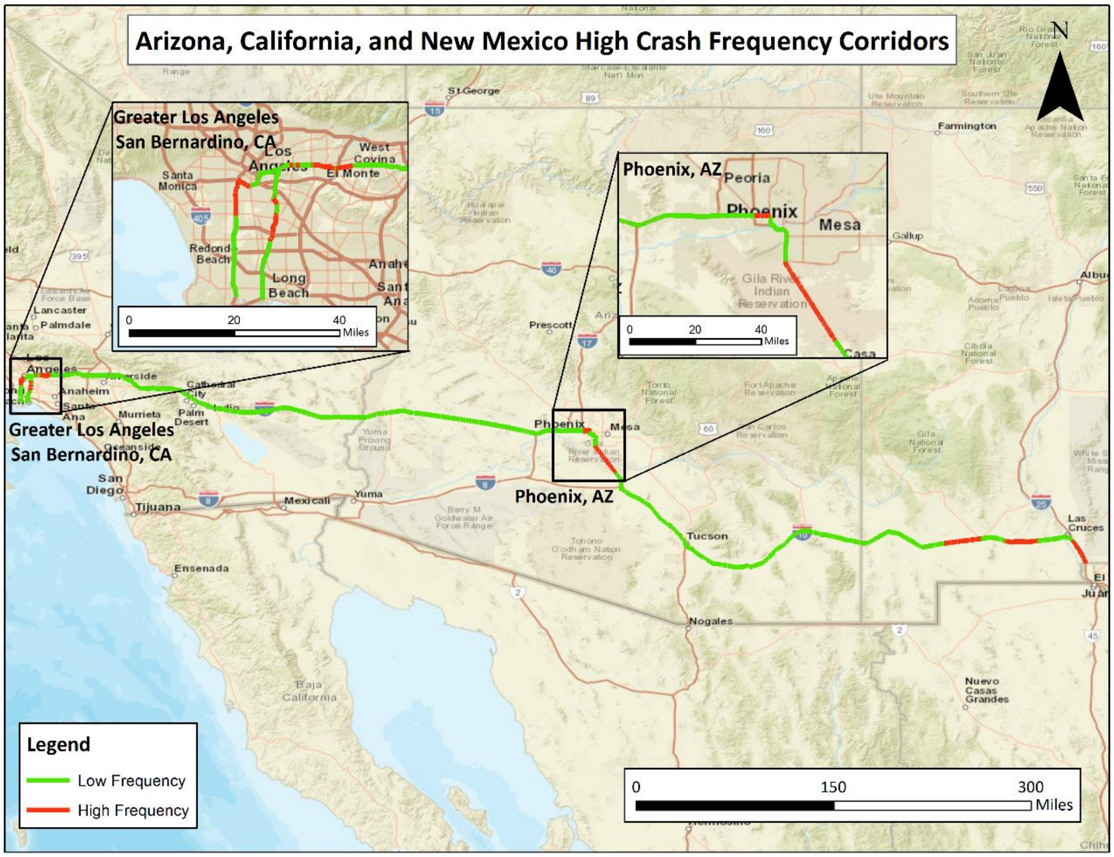
Figure 8. Number of Lanes on I-10 in California, Arizona, and New Mexico



Source: GIS Database Mapped by Project Team

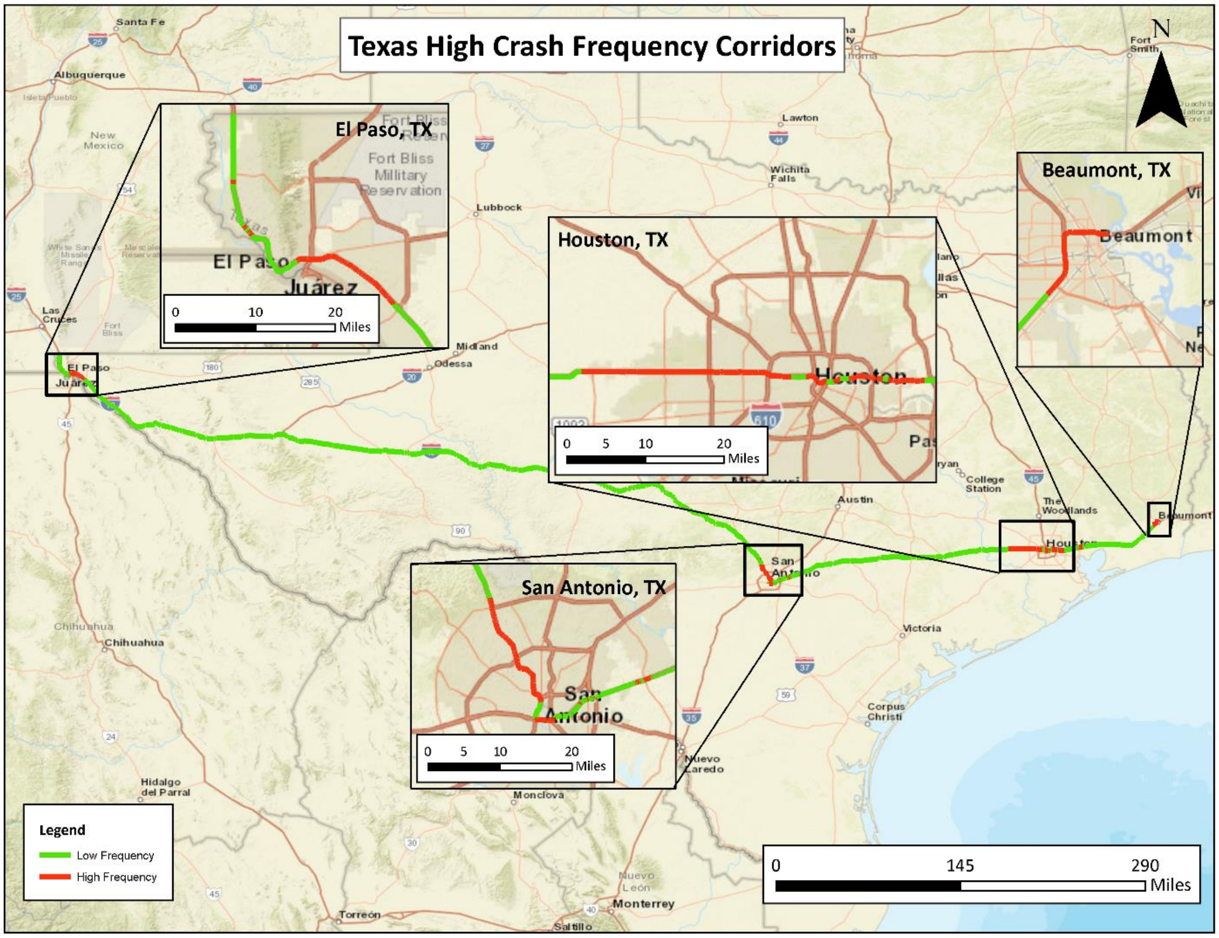
Figure 9. Number of Lanes on I-10 in Texas

Figure 10 and Figure 11 show overall vehicle safety issues along the I-10 corridor. In California and Texas, geographic hot spots were identified using GIS accident data, while in Arizona and New Mexico, safety corridors designated by the DOTs are indicated.



Source: GIS Database Mapped by Project Team

Figure 10. I-10 High Crash Frequency Corridors in California, Arizona, and New Mexico



Source: GIS Database Mapped by Project Team

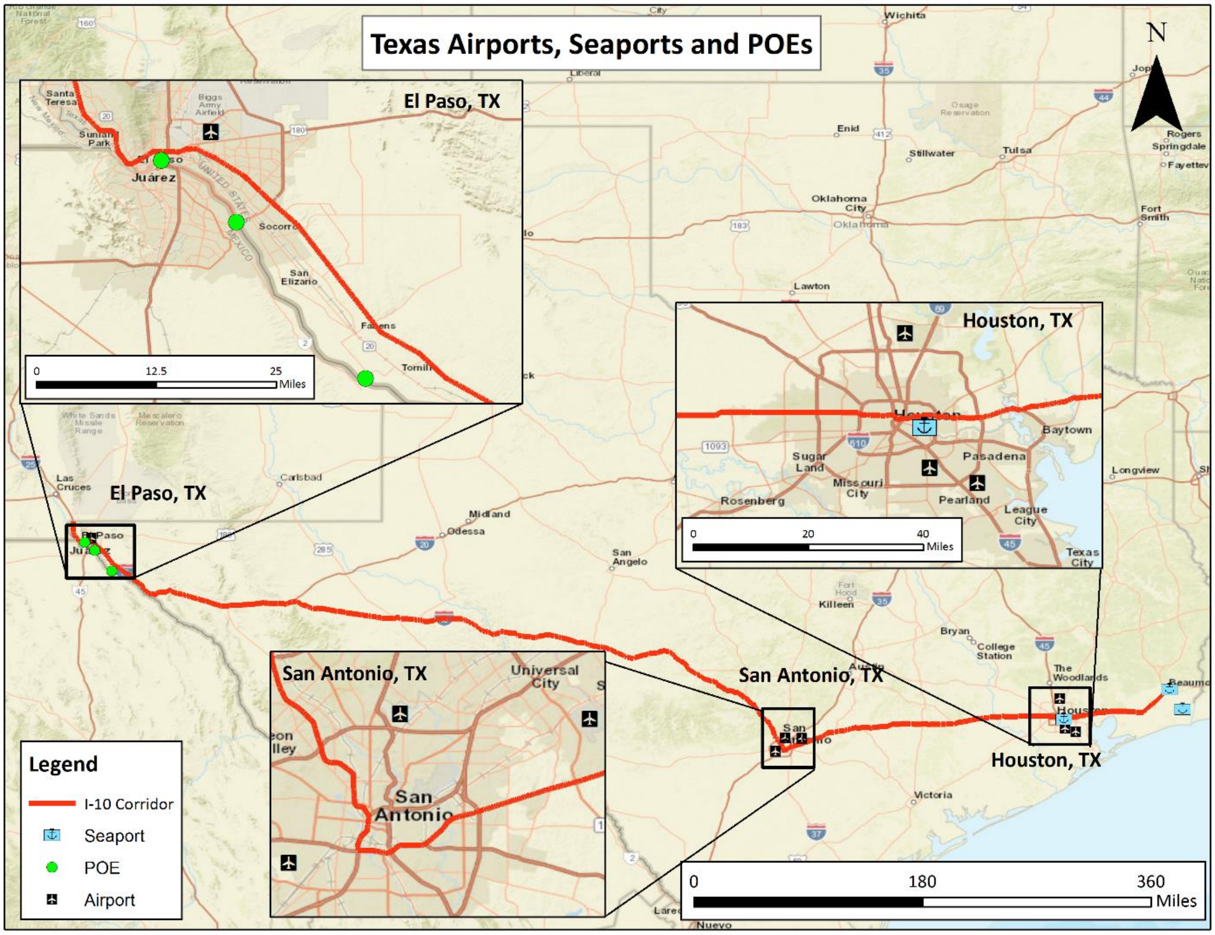
Figure 11. I-10 High Crash Frequency Corridors in Texas

Multimodal Freight Generators

Figure 12 and Figure 13 indicate major seaports, cargo airports, and POEs along the I-10 corridor. International commercial airports within the urban areas along the corridor are included, as are national and regional airports within 10 mi of the highway. Major seaports near the corridor are identified in Texas and California; the two San Pedro Bay ports of Los Angeles and Long Beach are included even though they are not located along I-10 because container traffic from the ports travels along I-10 to distribution centers and warehouses in the Inland Empire of San Bernardino and Riverside Counties, as well as to warehouses in metropolitan Phoenix. International ports of entry within 110 mi were selected since these ports are likely to generate traffic that travels along I-10 to other destinations.

Source: GIS Database Mapped by Project Team

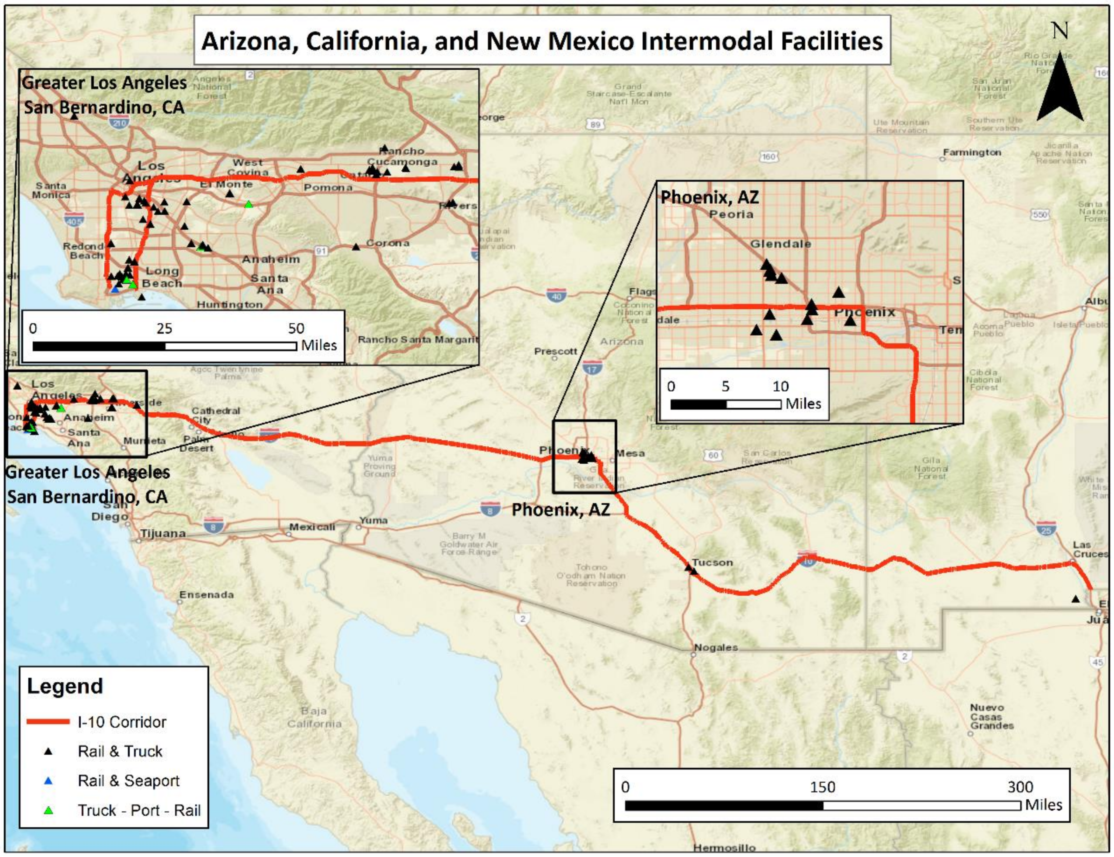
Figure 12. Airports, Seaports, and POEs near I-10 in California, Arizona, and New Mexico



Source: GIS Database Mapped by Project Team

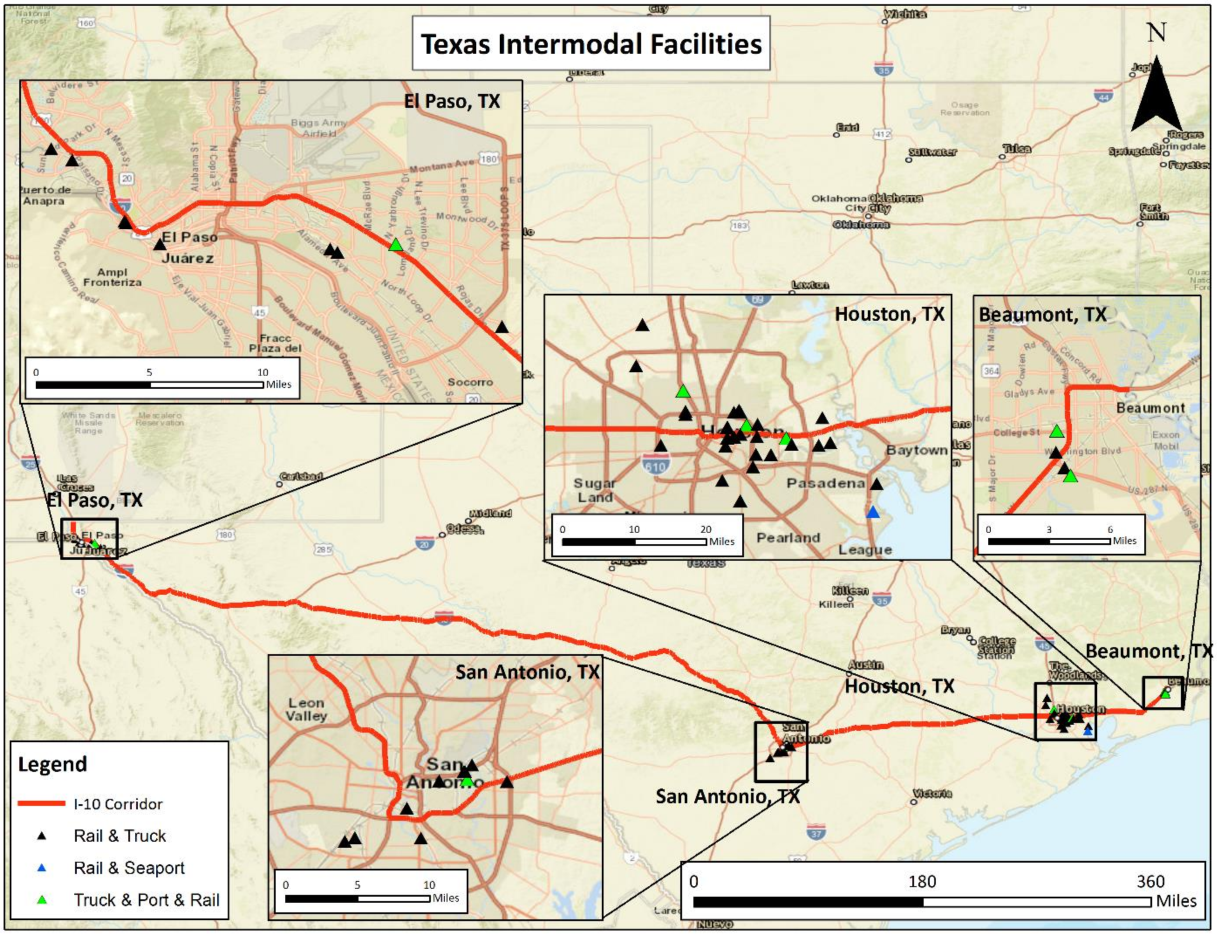
Figure 13. Airports, Seaports, and POEs near I-10 in Texas

Figure 14 and Figure 15 show a portion of intermodal facilities marked within the National Transportation Atlas Database as locations where freight can be transferred from one mode to another, including long-distance trucking to local deliveries. The facilities in the database within 10 mi of I-10 are included. Although this is a federal database, it does not include all intermodal facilities, thus creating a gap in the GIS database.



Source: GIS Database Mapped by Project Team

Figure 14. Intermodal Facilities Along I-10 in California, Arizona, and New Mexico

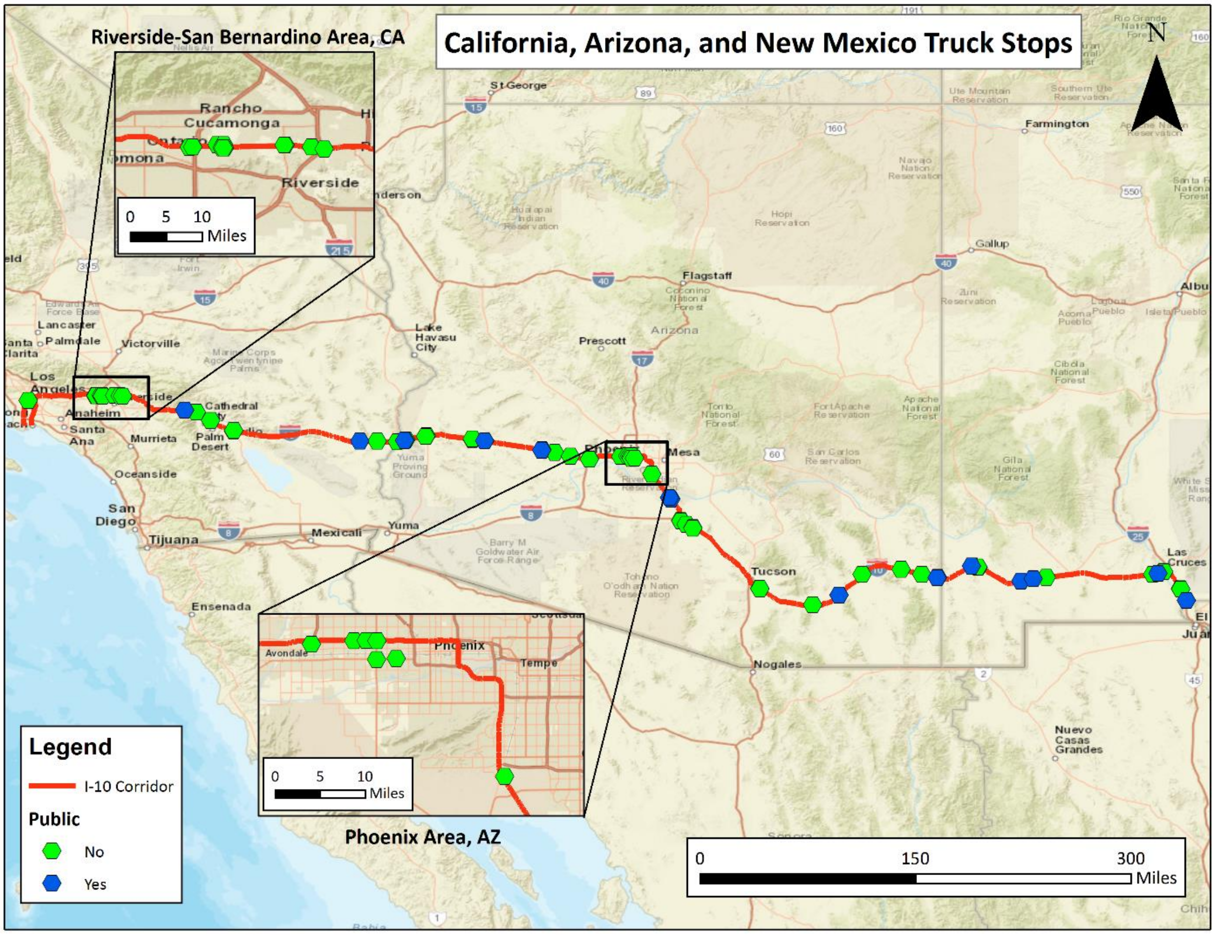


Source: GIS Database Mapped by Project Team

Figure 15. Intermodal Facilities Along I-10 in Texas

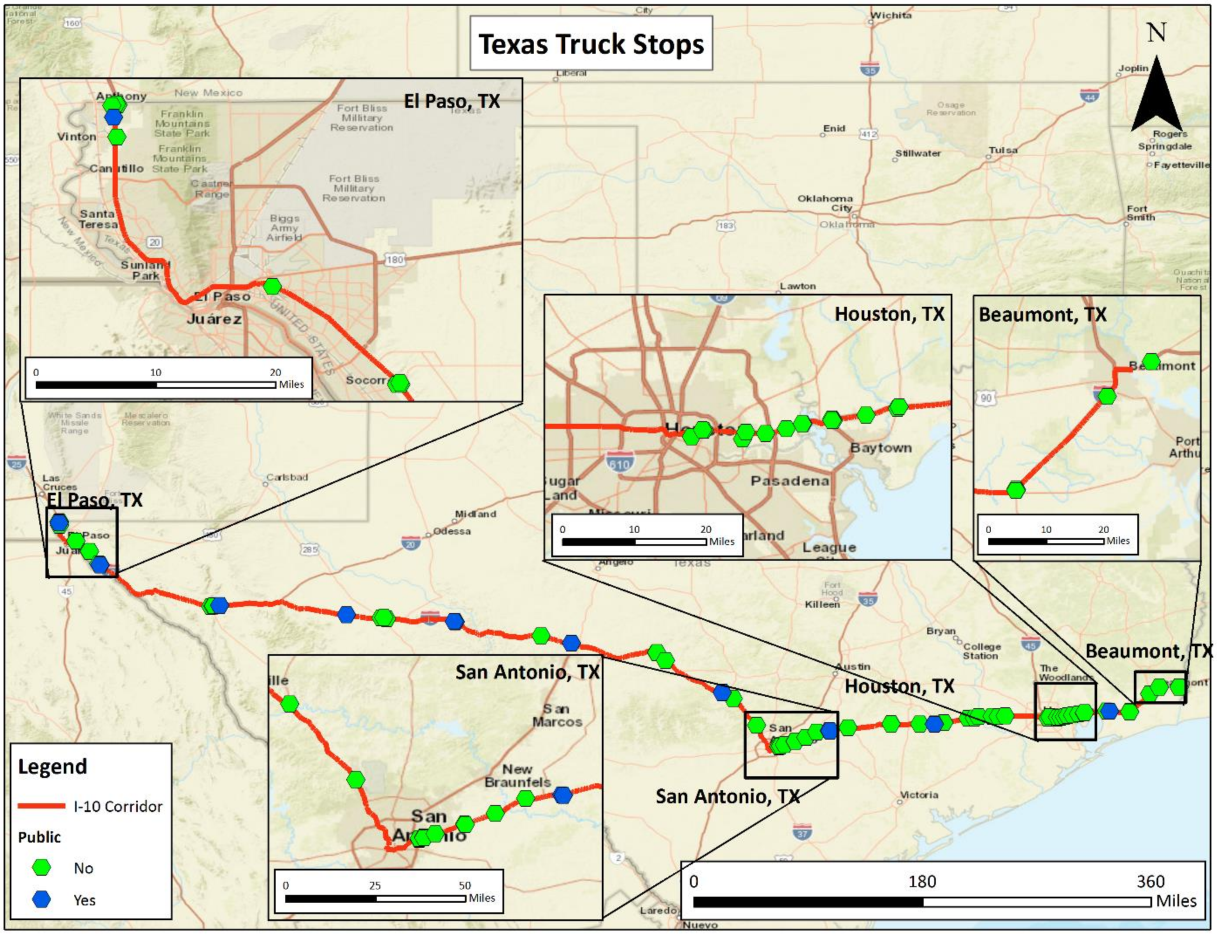
Truck Freight Interaction

Figure 16 and Figure 17 show the locations of public and private truck stops and rest areas along I-10. Truck parking is an important issue for motor carriers and shippers (discussed later in this chapter), and this map illustrates the distribution of truck parking along I-10. Public and private parking is scattered in West Texas, plentiful between San Antonio and the Texas-Louisiana border, well distributed in New Mexico and Arizona, but sparse in the desert region between Indio and the California-Arizona border.



Source: GIS Database Mapped by Project Team

Figure 16. Truck Stops and Public Rest Areas Along I-10 in California, Arizona, and New Mexico



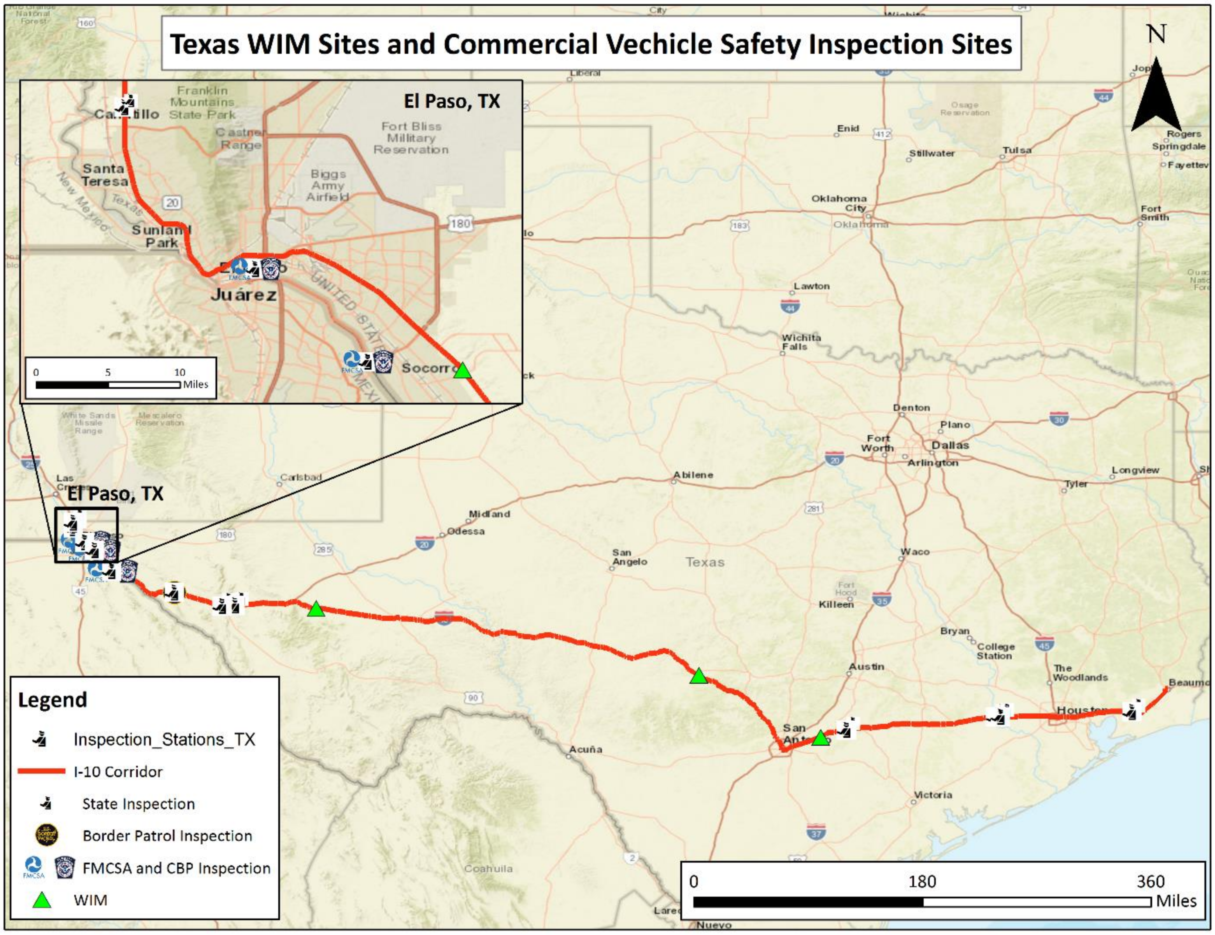
Source: GIS Database Mapped by Project Team

Figure 17. Truck Stops and Public Rest Areas Along I-10 in Texas

Figure 18 and Figure 19 shows the distribution of roadside safety enforcement through weigh-in-motion scales and vehicle inspection facilities (discussed later in this chapter) as well as border-related enforcement sites along or near the I-10 corridor in Texas.

Source: GIS Database Mapped by Project Team

Figure 18. Commercial Motor Vehicle Safety Facilities Along I-10 in California, Arizona, and New Mexico



Source: GIS Database Mapped by Project Team

Figure 19. Commercial Motor Vehicle Safety Facilities Along I-10 in Texas

I-10 Corridor Freight Infrastructure Funding, Financing, and Economic Impact

The I-10 corridor directly impacts economic prosperity in the southern region and indirectly impacts the national economy by serving as one of the country's most important gateways to international trade from Asia and Europe by sea, and from Mexico by land. Sustaining these impacts long term requires reliable funding sources to maintain operations and expand capacity when needed. The following paragraphs present freight- and trade-related economic indicators for the corridor, discuss existing arrangements for funding of freight infrastructure along the corridor, and identify recent analyses or studies that have documented the economic impact of freight mobility along the corridor.

Key Freight and Trade Economic Indicators Along the I-10 Corridor. The I-10 corridor connects major metropolitan areas that serve as transportation and logistics hubs, as measured by employment. Census data from 2012 and 2013 show that these I-10 corridor cities are among the US metropolitan areas with the largest transportation and logistics employment (trucking, rail, marine, and warehousing), as shown in Table 2.

Table 2. I-10 Corridor Metropolitan Area Transportation and Logistics Employment, 2012–2013

Metropolitan Area	Transportation/Logistics Employment (Thousands)	Rank Among US Metro Areas
Los Angeles, CA	77	4
Riverside–San Bernardino, CA	60	5
Houston, TX	58	6
Phoenix, AZ	34	11

Source: (CPCS Transcom, 2015)

The I-10 corridor also captures three of the top 25 most valuable national intercity trade corridors among major metropolitan areas, in terms of the corridor's total freight shipment value, as shown in Table 3.

Table 3. I-10 Corridor Intercity Trade Corridor Freight Value, 2010

Metro Area Rank	Trade Corridors Connecting Metropolitan Area Pairs		2010 Total Value (Millions of Dollars)
	Metro Area	Metro Area	
2	Los Angeles–Long Beach–Santa Ana, CA	Riverside–San Bernardino–Ontario, CA	50,971
15	Beaumont–Port Arthur, TX	Houston–Sugar Land–Baytown, TX	22,035
17	Los Angeles–Long Beach–Santa Ana, CA	Phoenix-Mesa-Glendale, AZ	20,420

Source: (Tomer and Kane 2014)

A Brookings study on urban trade conducted a statistical analysis of the overall value of freight originating or terminating in a metropolitan area with the number of intercity trade corridors connecting to that same metro area (Tomer and Kane 2014). This statistical analysis revealed that the metropolitan area with the highest weighted measures of trade value and trade corridor nodes was the Chicago-Joliet-Naperville area in Illinois, Indiana, and Wisconsin. By comparing the value/corridor measures for all other metro areas as a percentage of Chicago's, this research created a relative measure referred to as "trade centrality." This performance metric compares the scale and intensity of trade activity among metro areas. Table 4 shows that the metro areas along this I-10 study area involve substantial intercity trade relative to other areas in the nation.

Table 4. I-10 Corridor Metropolitan Area Goods Trade Centrality

Metro Area National Rank	Metropolitan Area	2010 Total Trade Volume (Millions of Dollars)	Relative Trade Centrality
3	Los Angeles–Long Beach–Santa Ana, CA	699,322	97.7%
5	Houston–Sugar Land–Baytown, TX	511,898	90.7%
7	Riverside–San Bernardino–Ontario, CA	163,103	87.1%
9	Phoenix-Mesa-Glendale, AZ	146,966	86.0%

Note: Trade centrality is defined as a region's relative position in the national trade network, with a higher number of trade connections and greater trade volume leading to higher scores. The percentages reflect a metro area's trade centrality relative to Chicago, the region with the highest centrality measure.
Source: (Tomer and Kane 2014)

The I-10 corridor connects some of the nation's busiest seaports, as measured by total freight volume, container shipments, and overall maritime trade value, as shown in Table 5.

Table 5. Statistics for Ports Along the I-10 Corridor

Port	Total Short Tons Trade, 2015	Containers (Twenty-Foot Equivalent Units), 2015	Waterborne Foreign Trade Value by Customs District (Millions of Dollars), 2015
Los Angeles, CA	60,187,840	8,160,458	370,834
Long Beach, CA	78,164,597	7,192,066	*
Houston, TX	240,933,410	2,130,544	178,157
Beaumont, TX	87,169,875	NA	25,392

* The Port of Long Beach is included in the Los Angeles Customs District.
Source: American Association of Port Authorities (2016)

These statistics demonstrate the economic importance of the connections provided by I-10. This importance is also revealed in I-10's inclusion in the National Highway Freight Network, defined by the Federal Highway Administration (FHWA) as the most critical highway portions of the US freight transportation system determined by measurable and objective national data as required in Section 167, Title 23, US Code.

Freight Tax and Revenue Streams Along the I-10 Corridor. Throughout the interstate system, one of the main revenue sources is the fuel excise tax (both federal and state). An increase in traffic volume on I-10 leads to an increase in gas consumption, thereby increasing fuel tax revenue. Although a driver pays for fuel and its tax at a pump, the public entity collects the fuel tax from the refinery or trading companies. The fuel tax revenue is collected in an aggregate form from the entire region of a state, making it difficult to accurately presume the generated revenue from each corridor. Therefore, the following paragraphs discuss the freight tax and revenue streams that exist in each of the four states and identify the agencies that oversee revenue collections.

California. Caltrans is responsible for planning, designing, constructing, and maintaining the I-10 corridor throughout the state (Caltrans 2014). Its funding comes from user fees, property-related charges, and subsidies. Table 6 presents the fund accounts related to freight mobility along I-10.

Table 6. Caltrans Fund Structure Associated with Commercial Trucks

Tax Collection	Account Name	Tax Rate	Expenditure
Federal	Highway Trust Fund	$0.244/gal diesel	85% to Highway Projects and 15% to Transit Projects
State BOE	State Diesel Excise Tax	$0.11/gal diesel	Highway and Local Road Projects
	State Diesel Sales Tax	9.25%	Public Transit
State DMV	State Truck Weight Fees	varies	Debt Repayment Sources
	State Vehicle Registration Fees	varies	State Highway Patrol and DMV Support
County	Sales Tax	0.5%	Public Transit, Local Road, and Highway

Note: BOE = Bureau of Equality; DMV = Department of Motor Vehicles.

The Highway Trust Fund managed by the federal government disburses 91.4 percent of the revenue collected from California into the state (US Government Accountability Office 2011). That money is the main resource of the State Highway Account (SHA), which is used for interstate highway improvement and maintenance. The state BOE collects the diesel excise tax and diesel sales tax discretionarily. The fund from the diesel excise tax is used for local roads and highway projects, and the fund from the diesel sales tax is for public transit. In addition, local sales tax, which is an additional sales tax imposed by the county, funds public transit, local roads, and SHA projects. The state DMV collects vehicle registration fees and truck weight fees, and these sources are used for debt repayment, state highway patrol, and DMV administration.

Arizona. ADOT manages the Arizona segment of I-10. Its revenues mainly come from the Highway Trust Fund managed by the federal government and from the Highway User Revenue Fund (HURF) managed by ADOT. The state source is an aggregated fund structure derived from a variety of revenue streams. The details of these funding sources are presented in Table 7.

In the case of the Highway Trust Fund, Arizona receives 91.3 percent of its contribution to the fund (US Government Accountability Office 2011). About 85 percent of the received fund flows to highway projects, and the remaining balance flows to transit projects. In addition to the federal source, Arizona raises statewide money for highway construction and maintenance. ADOT's Revenue and Fuel Tax Administration (RFTA) manages the fuel revenue and is responsible for the bookkeeping of the HURF.

The diesel excise tax revenue accounts for 14.24 percent of the HURF (ADOT n.d.). The vehicle registration fee and the motor vehicle operator license fees and miscellaneous fees account for 3 percent and 4 percent, respectively. The Motor Vehicle Division (MVD) imposes a motor carrier tax on commercial shipping vehicles. The fee is calculated based on the weight of the truck and the mileage within the state. The motor vehicle license tax accounts for 29 percent of the HURF. It assesses the vehicle's residual value and charges an ownership tax. In 2016, about 25 percent of the HURF was distributed to the operating budget for the state highway systems.

Table 7. ADOT Fund Structure Associated with Commercial Trucks

Tax Collection	Account Name	Tax Rate	Remark
Federal	Highway Trust Fund	$0.244/gal diesel	85% to Highway Projects and 15% to Transit Projects
State RFTA	State Diesel Excise Tax	$0.26/gal diesel	—
State MVD	Motor Vehicle Registration Fee	$8/year car	—
	Motor Carrier Tax	Varies	Calculated by combination between weight and freight distance
	Motor Vehicle Operator License Fees and Misc. Fees	Varies	—
	Motor Vehicle License Tax	Varies	Annually assessed regarding the residual value of asset

New Mexico. The I-10 segment in New Mexico is mainly managed by NMDOT. Its funding sources, shown in Table 8, include the federal Highway Trust Fund and the State Road Fund (SRF). Federal funds are mainly spent on new construction along the highway system, and the SRF is primarily used for the maintenance of the preexisting transportation assets (New Mexico Legislative Finance Committee 2015).

In the case of the Highway Trust Fund, the State of New Mexico receives 7.5 percent more than it transfers (US Government Accountability Office 2011). About 85 percent of the federal fund flows to highway projects, and the rest is assigned to transit projects. The state raises the SRF from a fuel tax and weight-distance tax. A diesel excise fuel tax is charged at a rate of $0.21/gal. The weight-distance tax is assessed based on the weight of trucks and the miles traveled on New Mexico highways. Because the freight traffic volume is highly correlated with the economic condition, the revenue stream is less stable than other funding sources. For the SRF, the gasoline fuel tax, diesel fuel tax, weight-distance tax, vehicle registration fee, and minor fees account for 30 percent, 25 percent, 20 percent, 20 percent, and 5 percent, respectively.

Table 8. NMDOT Fund Structure Associated with Commercial Trucks

Tax Collection	Account Name	Tax Rate	Remark
Federal	Highway Trust Fund	$0.244/gal diesel	85% to Highway Projects and 15% to Transit Projects
State Taxation and Revenue	State Diesel Excise Tax	$0.21/gal diesel	—
State MVD	Weight-Distance Tax	Varies	Calculated by combination between weight and freight distance
	Vehicle Registration Fee	Varies	—

Texas. TxDOT manages the I-10 corridor in Texas (Texas Legislative Budget Board Staff 2011). In Texas, both the federal Highway Trust Fund and the state's own funding sources are used for maintenance and construction projects on the state highway systems, as summarized in Table 9. The state's main funding sources associated with freight transportation include:

- State Highway Fund (SHF): Backed by the Highway Trust Fund, state diesel excise tax, motor vehicle registration fee, motor vehicle registration fees for special vehicles, sales tax on lubricants, and motor vehicle title certificates. These revenues are mainly generated by economic activities.
- Texas Mobility Fund (TMF): Backed by the motor vehicle inspection fees, driver's license point surcharges, driver's license fees, driver record information fees, and court fines. These revenues are mainly collected during the legal administration process.

The SHF is dedicated to state highway system construction and maintenance and support of TxDOT functions. The TMF can be used more generally than the SHF. It funds state highway projects and can be utilized as a collateral for debt financing and as a source for public transportation development. The following paragraphs discuss the structure of the SHF because of its direct relevance to interstate highway projects.

In the case of the Highway Trust Fund, Texas receives 91.3 percent of its contribution to the fund (US Government Accountability Office 2011). About 85 percent of the received fund flows to highway projects, and the remaining balance flows to transit projects. The state Comptroller of Public Accounts (CPA) collects a state diesel excise tax ($0.20/gal diesel) from the oil businesses and distributes the collection to the school fund (25 percent), SHF (50 percent), and county and road district highway fund (25 percent) (Texas Administrative Code 1992; Texas Comptroller of Public Accounts n.d.; Texas Legislative Budget Board Staff 2011). In addition, the state CPA estimates the annual revenue of motor vehicle registration and special motor vehicle registration fees, and the county tax assessor-collectors collect them. The collected tax from motor vehicle registration fees is distributed to the county road and bridge fund and SHF, each at 50 percent. The revenue from the special motor vehicle registration fees is mostly transferred to the SHF and general revenue fund. The state CPA imposes a motor lubricants sales tax (6.25 percent), and the raised money is deposited into the SHF. The revenue from the motor vehicle title certificates managed by the state DMV is deposited to the SHF, TMF, and Texas Emission Reduction Plan (TERP).

In addition to these two funds, the Texas State Legislature introduced an innovative funding mechanism named transportation reinvestment zones in 2007. This mechanism enables local governments to collateralize future property tax revenue increments resulting from a transportation infrastructure investment. The money raised through this mechanism can be used as a contribution to the local match required for federally funded projects.

Table 9. Texas State Highway Fund Structure Associated with Commercial Trucks

Tax Collection	Account Name	Tax Rate	Remark
Federal	Highway Trust Fund	\$0.244/gal diesel	85% to highway projects and 15% to transit projects
State CPA	State Diesel Excise Tax	\$0.20/gal diesel	25% to the available school fund, 50% to SHF, and 25% to county and road district highway fund
	Motor Lubricants Sales Tax	6.25%	Mostly to SHF
State DMV	Motor Vehicle Title Certificates	\$28 or \$33 depending on registration location	To SHF, TMF, and TERP
County Tax Assessor-Collectors	Motor Vehicle Registration Fees	Varies	50% to county road and bridge fund, 50% to SHF
County Tax Assessor-Collectors	Motor Vehicle Registration Fees for Special Vehicle	Varies	Mostly to SHF and General Revenue Fund

Economic Impact of Freight Transport in the I-10 Corridor. An efficient freight transportation system is a key driver of regional and national economic growth and competitiveness. Reaping the benefits of such a system involves a significant and continuous investment of resources not only in its day-to-day operation but also in the expansion of its infrastructure capacity and technological capabilities. The paragraphs that follow summarize key findings of past studies that attempted to document the general costs, benefits, and economic impact of freight transport in the I-10 corridor.

The most comprehensive study that specifically examined the costs, benefits, and overall economic impact of trade and freight along I-10 is the National I-10 Freight Corridor Study, concluded in 2003 (Wilbur Smith Associates 2003). This study was a joint effort by the DOTs of the eight states along the corridor: California, Arizona, New Mexico, Texas, Louisiana, Mississippi, Alabama, and Florida. One study objective was to assess the importance of freight moving on I-10 to the economy of the corridor states and to the rest of the nation. This study estimated the economic value from freight transported along the I-10 corridor to be $1.38 trillion in the year 2000. The study also estimated that from this amount, $339.4 billion would be paid to about 10.4 million workers along the corridor, for an average earnings amount of approximately $32,500 per job. The study examined the role that highways play in the efficiency of other modes in the freight transportation system (i.e., ports, inland waterways, and railroads) and the importance of multimodal and intermodal integration in the planning of corridor investments to guarantee the optimal distribution of freight across all modes. This study also estimated the investment needed on corridor capacity to meet travel demand and maintain an acceptable level of service along the corridor between the years 2000 and 2025. The study found that by 2025, an additional 5064 lane miles would be needed to meet projected demand along the corridor, and that the cost of delivering this additional capacity would be $21.3 billion. Based on the anticipated corridor expenditures at that time, the study estimated the funding shortfall at $12.6 billion (Wilbur Smith Associates 2003).

Although other studies have looked at various economic impacts of freight on specific isolated locations along the I-10 corridor, the literature review did not reveal any comprehensive updates to the National I-10 Freight Corridor Study performed since its completion. One study sponsored by the El Paso Metropolitan Planning Organization looked at the economic costs of critical infrastructure failure on a major international border crossing, the Bridge of the Americas (Vadali et al. 2015). This crossing is located at the southernmost end of I-110, and less than 2 mi away from the I-10/I-110 intersection. The study estimated the overall direct economic impact of an unexpected failure or disruption of the infrastructure on freight users in the broader El Paso–Ciudad Juarez road network (including freight traffic on I-10). These direct economic impacts were evaluated by estimating truck operating costs, time delay costs, fuel costs, and shipment- and inventory-related costs for shippers. The study estimated that the direct costs associated with the delays caused by such a disruption of this link could reach up to $315 million/per day until mobility in the link was restored. This study and others highlight the impact that freight mobility on a corridor as important as the I-10 corridor has on the regional economies.

Corridor Asset and Data Gap Analysis

This section analyzes the gaps among the assets inventoried and the data collected in this task. At this point, no gaps have been found in capabilities, features or functions, policies, or regulations. However, the research team expects that gaps will be identified in the tasks that follow. The gaps found in Task 2 are mainly data inventory gaps and asset coverage gaps.

Regarding data inventory gaps, the version of the National Transportation Atlas Database used was released in 2015. Consequently, alternative data sources may be required. In this regard, the team observed that some of the main intermodal facilities in the state of New Mexico and the state of Texas are not present in this database even though they were already operating before 2015. Thus, an alternative data source to identify intermodal facilities is needed. Similarly, the HPMS version was also released in 2015, and the 2016 version will be available to the public later this year (FHWA 2015a). Therefore, the inventory may require an update as soon as the 2016 HPMS version is available. Finally, the team was not able to collect operations and maintenance costs at the corridor level. Costs identified were mainly capital costs associated with improvement projects in the corridor.

Concerning asset coverage gaps, the State of Texas does not participate in the PrePass initiative. Additionally, New Mexico has only one weigh-in-motion (WIM) and PrePass facility located at the New Mexico–Texas border, while there is no WIM and PrePass facility located at the New Mexico–Arizona border. The team also found that the deployment of HAR devices is very limited in Arizona and California. Finally, the States of Arizona and Texas do not have a mobile app to access traffic information via smartphones or tablets.

Freight Corridor Stakeholders

A number of I-10 corridor freight public- and private-sector stakeholders were identified in each of the four states during the course of the inventory. Public-sector stakeholders include federal agencies, state DOTs and motor vehicle safety agencies, and regional/local transportation planning and operations agencies. Private-sector stakeholders include local and state trucking associations, inland port and intermodal operators, and state and metropolitan freight advisory committees (where applicable). These stakeholders were compiled into an electronic contact list that includes organization, primary contact and title, secondary contact and title, and contact information, as detailed in a separate technical memo as part of this project.

INFORMATION SEARCH AND SYNTHESIS

In order to understand the current technologies and operational improvements possible within the I-10 corridor, this report was developed using databases and resources available through academic university libraries and Internet resources, including the National Transportation Library maintained by the US Department of Transportation (USDOT) Office of the Assistant Secretary for Research and Technology. Other information is also based on input from stakeholders and ConOps Study Technical Advisory Committee members.

This information search reviewed published sources for the latest technologies, innovations, and successful practices in developing common system requirements and interoperable systems across jurisdictional boundaries (e.g., local, regional, state, and interstate) for commercial vehicle credentialing and truck traveler information systems. The review included the latest advances in the realm of connected vehicle/automated vehicle (CV/AV) initiatives related specifically to commercial vehicles. Example key words and concepts included regional harmonization, corridor freight operational efficiency, shared-use facilities, data-sharing agreements, commercial motor vehicle (CMV) parking, SmartPark, intermodal linkages, the Freight Advanced Traveler Information System (FRATIS), multijurisdictional revenue streams, the Smart Roadside Initiative, truck platooning, longer combination vehicles, virtual weigh stations, enforcement preclearance, and connected freight corridors.

SMART ROADSIDE INITIATIVE

Introduction

The Smart Roadside Initiative (SRI) is a joint modal initiative between FHWA and the Federal Motor Carrier Safety Administration (FMCSA) envisioned as an advanced system using technology to be deployed along CMV routes to improve the safety, mobility, and efficiency of truck operations. The program, which began in 2008, is a component of the vehicle-to-infrastructure (V2I) element of USDOT's CV research initiative and encompasses technology and information-sharing research efforts with CMV roadside elements that are crucial to the missions of USDOT. Therefore, information collected for one purpose can be shared where authorized to serve multiple stakeholders and uses.

The vision for the SRI is that commercial vehicles, enforcement agencies, highway and intermodal facility owners, toll facility operators, and other modal agencies and companies on the transportation system collect data for their own purposes and share the data with all involved components. If achieved, this data sharing will improve motor carrier safety, operational efficiency, and freight mobility.

The primary SRI focus areas are in various stages of operation and deployment (ITS Joint Program Office n.d.):

- Electronic screening (e-screening)—automatic identification and safety assessment of a commercial vehicle in motion, allowing enforcement resources to focus on unsafe vehicles and carriers
- Virtual weigh stations (VWSs)/electronic permitting—roadside technologies that can be used to improve truck size and weight enforcement
- Wireless roadside inspection (WRI) program—technologies that can transmit safety data directly from the vehicle to the roadside and from a carrier system to a government system
- Truck parking research and ITS-based project deployments—commercial vehicle parking information that allows commercial drivers to make advanced route planning decisions based on hours-of-service constraints, location and supply of parking, travel conditions, and loading/unloading considerations

While truck parking systems were initially developed as safety-related ITS programs under the SRI program, this application is discussed in a separate section in this chapter. First, the programs are moving beyond concept design and demonstration into widespread implementation. Second, while truck parking systems were initially developed as a truck safety measure (pursuant to the National Transportation Safety Board recommendations in 2000), unlike the other SRI measures, which are designed to enhance and augment public CMV safety agency activities, the truck parking measures are more focused on motor carrier drivers and fleets.

Electronic Screening

Overview

E-screening provides a means of identifying CMVs that appear to need additional attention based on weight or credential checks, usually as the vehicle approaches an enforcement site. Components of an e-screening system could include a WIM scale, in-vehicle transponders, a roadside transponder reader, and various communication links (transponders are devices that combine functions of transmitters and responders; in CMV applications for safety or toll collection, the device is activated by a signal transmitted by a roadside or overhead antenna, and the device transmits vehicle-specific information that when received by the antenna, connects to stored electronic files about that particular vehicle).

Commercial services have been developed to register CMVs and collect safety information about a truck, its owners, and its drivers so that these known travelers can be precleared for faster movement through or bypass of weigh stations and vehicle inspection facilities. Some firms use transponders and associated roadside communication equipment, while others operate on a portable smart device or telematics devices (e.g., electronic log) operated inside the CMV cab. In 2013, FMCSA announced that Commercial Mobile Radio Services network devices (defined by FMCSA as smartphones, tablets, fleet management systems, global positioning system [GPS] navigational units, and onboard telematics devices) could be used as transponders for weigh station bypass services (DriveWyze 2016). Triggering the app requires use of stored latitude/longitude coordinates of geo-fences (GPS-defined areas) positioned strategically upstream of the weigh stations. The smart device relies on cellular service to communicate with a database where credential data are stored. After passing the WIM system, the app or transponder system queries the cloud for appropriate carrier credentials and merges the WIM result with carrier credential information to determine bypass status.

E-screening allows enforcement personnel to check weights and credentials of participating CMVs at highway speeds upstream of the decision point to allow apparently safe and legally loaded vehicles to bypass a weigh station. Enforcement personnel are then able to focus limited resources on more problematic vehicles and reduce congestion at these sites.

These e-screening benefits were tested and evaluated through a research study that developed a simulation model to describe e-screening operations at weigh stations and evaluated weigh station operations by varying factors such as transponder penetration rates and WIM thresholds.

The simulation process was applied to a small weigh station with a short queuing area and high truck demand, often leading to truck overflows. Results showed that properly adjusted WIM thresholds can result in significant improvement in travel time for legal trucks and reduced numbers of false green lights (bypass allowed for illegal CMVs). According to study findings, the transponder penetration rate was the principal factor affecting overall e-screening performance. With a transponder penetration rate greater than 20 percent, e-screening benefits were significant (Lee and Chow 2011), reducing the number of legally loaded trucks to be weighed statically.

E-screening Sites Along I-10

As the corridor inventory in this chapter reports, among the I-10 Corridor Coalition states, only Texas and New Mexico are equipped for DriveWyze bypass (the private third-party e-screening firm using smartphones); Arizona and California are not. Texas has two sites on I-10 (one eastbound and one westbound) near Seguin, Texas, both at Mile Marker 616. New Mexico has sites at Lordsburg at Mile Marker 24 (eastbound and westbound) and at Anthony (westbound only) at Mile Marker 160.

For PrePass (the private third-party e-screening firm using transponders), California has three sites by direction, one at Blythe (westbound only) and two at Desert Hills (both eastbound and westbound). Arizona has two PrePass sites, one at Ehrenberg (eastbound only) and another at San Simon (westbound only). New Mexico has only one site at Anthony (westbound only). Texas does not have any PrePass sites on I-10.

In summary, all four states are equipped for either DriveWyze or PrePass but not both.

Virtual Weigh Stations

VWSs are roadside enforcement facilities that can include WIM installations, cameras, and wireless communications, intended to expand the number of locations where CMVs are checked for size and weight compliance. Fixed weigh stations are expensive to construct and operate and can cause CMVs to bypass these sites by using alternate routes. Bypassing trucks are thought to represent a subset of the truck population that is more likely to be size and weight offenders.

Roadside safety inspections are the second half of the enforcement equation at fixed facilities, with even fewer trucks being inspected annually compared to the number of vehicles weighed. USDOT reports about 177 million CMV weight inspections/measurements conducted annually compared to only 3 million CMV safety inspections. Of the 3 million safety inspections, 73 percent result in violations, whereas only 0.29 percent of weight inspections result in violations (Cambridge Systematics 2009).

To address these and other issues, states are deploying VWSs, which mimic the operation of a weigh station but do not require constant human staffing. Their lower cost compared to full weigh stations also makes them an attractive option. At least 14 jurisdictions received FMCSA Innovative Technology Deployment grants in fiscal years 2006 to 2008 to deploy VWSs. As to what constitutes a VWS, no one-size-fits-all exists at the present time, but as time goes on, it may become more important for a more common footprint to be developed (Cambridge Systematics 2009).

States have investigated VWSs to determine their usefulness in deterring illegal CMV operations. The Maryland SHA installed its first VWS in Dayton, Maryland, in April 2009. A short-term evaluation used five sample CMVs selected by SHA and 85 random CMVs using the VWS as a prescreening tool for a downstream weigh station. Some pertinent results are as follows (FMCSA 2016):

- Selection of CMVs for pull-in based on WIM was 62 percent effective in detecting weight violations compared to the traditional random process, which only resulted in 1.6 percent.
- Selection of CMVs for safety inspections based on sensor measurements resulted in 1.5 times better inspection effectiveness than random selection.
- In this relatively small sample, weight violations were not correlated with out-of-service conditions, but these findings suggest the need for more research.
- Weight sensors achieved an accuracy level sufficient for prescreening purposes.

Some states are deferring deployment of VWSs until additional functionality can be demonstrated, particularly to link VWS weight measurements on each CMV with other information on the vehicle’s fleet safety experience, background information on the truck driver, and links to any registration and special permits associated with the CMV.

VWS systems face limitations inherent in the difficulties in machine-readable/automated identification of currently available identifiers for CMVs (e.g., license plates, vehicle identification number, and USDOT numbers). Even as VWS systems create information on size and weight compliance, any enforcement of those laws still requires human interaction (e.g., issuing citations), so VWSs can augment but not supplant other forms of size and weight enforcement.

Wireless Roadside Inspections

WRI research was undertaken to improve safety and operational efficiency of CMVs (trucks and buses) operating on the nation's highways by developing and testing a wireless inspection system that could conduct electronic inspections at highway speeds. This project was also considered an important asset to be used by the Commercial Vehicle Safety Alliance (CVSA; organization of state CMV safety enforcement agencies).

The WRI research project was to be implemented in three phases (Cherry et al. 2012):

- Phase I—Proof of Concept Test: This involved testing commercially available off-the-shelf (COTS) or near-COTS technology to validate the concept.
- Phase II—Pilot Test: This involved a demonstration of the selected technology capabilities and back-office components.
- Phase III—Field Operational Test: This was a complete end-to-end system test on multiple vehicles along a multistate corridor.

Phase I was completed in August 2007. In Phase II tests, a research team conducted a demonstration of the feasibility and benefits of electronically collecting safety data messages from in-service commercial vehicles and using them to conduct WRIs using three different communication systems. The conclusion was that WRIs can result in significant improvements in CMV safety without increasing the burden on enforcement personnel. Even though the technologies hold promise for improving inspection rates and generating inspection reports automatically, the system design needed improvement before being fully implemented (Flanagan and Capps n.d.).

By the end of Phase II, it became clear that more work would be needed prior to initiating a field operational test (Phase III). Therefore, FMCSA decided to conduct additional end-to-end full-system testing before proceeding to a field operational test (Flanagan and Capps n.d.). As plans for Phase III were developed, CVSA agencies were unconvinced that the new system would be sufficiently improved to supplant their investments in roadside e-screening systems. Motor carriers and drivers were concerned about privacy concerns regarding the data that would be collected directly from each truck's onboard computer system (Grisolano 2016).

In the congressional appropriations bill for the 2015 fiscal year, Congress directed USDOT to report to specific committees of Congress that the WRI program would not conflict with existing non-federal electronic screening systems and that the WRI program would not require additional statutory authority to incorporate generated inspection data into safety determinations (Dills 2015).

Fixing America's Surface Transportation (FAST) Act Section 5513 mandates that FMCSA submit to the congressional committees on transportation a report that includes a determination of whether federal WRI systems (FMCSA 2016):

- Conflict with existing electronic screening systems
- Require additional statutory authority to incorporate generated inspection data into the current inspection system
- Provide appropriate restrictions to address the privacy concerns of affected motor carriers

The WRI field operational test purpose is to develop and test a system that can determine potential issues related to vehicle registration, hours of service, and licensing compliance or safety violations. The system would send a wireless inspection report to inspectors to enhance their ability to identify noncompliant CMVs (Arnold 2016). If Congress is satisfied with the USDOT reports generated regarding the WRI program, then I-10 Corridor Coalition states could consider whether added enforcement generated by extracting data from truck onboard computer systems would be worth considering.

SRI Evaluation Studies

USDOT undertook a gap analysis to:

- Document the available and emerging roadside technologies that apply to commercial vehicles
- Analyze and document the SRI functionality as currently being developed
- Identify gaps that might hinder the SRI's intended functionality

This project resulted in a report that maps the current CV development efforts to SRI programs. The intent was to determine how much of the developing CV system design could be used to support SRI applications (e-screening, VWSs, and commercial vehicle parking) (Sumner et al. 2015).

The study found that SRI functionality (e.g., VWSs and commercial vehicle parking) can function within the CV environment. The study reported that it should be feasible to conduct an SRI roadside screening in a CV/dedicated short-range communications standards environment within a 10-sec window, provided essential and timely connectivity to credentialing systems exists.

Other Safety and Enforcement Technologies

Onboard Safety Inspection

Onboard safety inspection (through onboard diagnostics or similar technology) and transmittal to roadside devices with confirmation back to the driver/owner could report data elements from the onboard diagnostics II (OBD-II) parameter IDs that are emissions and/or safety related to alert regulatory, enforcement, or vehicle owner entities remotely of issues. Data elements of interest could include ("On-Board Safety and Security Monitoring" n.d.):

- Distance traveled with the malfunction indicator lamp on
- Time run with the malfunction indicator lamp on
- Fuel type
- Fuel status

- Oxygen sensor faults
- Vehicle identification number

Safety-related messages of potential interest, some of which are manufacturer specific, include the following:

- Power steering pressure malfunction
- Traction control data indicators
- Anti-lock braking systems/brake system indicators
- Air suspension status indicators
- Windshield wiper data indicators
- Turn signal indicator data

To test the concept would require a wireless dongle plugged into the OBD-II port (or taped directly to the applicable cabling) with cellular-based real-time communications to the vehicle. In addition, potential OBD-II/CAN (controller area network) bus security issues would have to be researched and mitigated as part of the test—specifically dealing with mitigation of possible hacking of the communications pathway into the vehicle. The study's security portion could be applicable to any future technology (e.g., CV/AV) that passes vehicle information and potentially could be used by bad actors to access the vehicle controls.

HAZMAT Route Preclearance and En-Route Monitoring

Hazardous material (HAZMAT) cargo that becomes involved in a crash and release can cause significant damage to any state department of transportation infrastructure and potentially threaten the public's life and health. Designated HAZMAT routes are important to limit the possible scope and locations of HAZMAT incidents, and departures from these routes can have significant (and unintended) consequences. HAZMAT route preclearance and en-route monitoring would provide assurance to the owner/operator and to public operating and enforcement agencies that routes were being followed. This information can then be used to ("Hazardous Material Security and Incident Response" n.d.):

- Inform law enforcement and the vehicle owner in real time of a possible violation and/or enforcement action
- Assess the owner/driver/carrier's adherence (or lack thereof) to official guidance and/or local permit status
- Potentially assign penalties for nonadherence to permitted routes

TRUCK PARKING

Background

Truck parking shortages have become a national transportation safety concern. An inadequate supply of truck parking can result in tired truck drivers continuing to drive because they have difficulty finding a place to park for rest or because they choose to park at unsafe locations, such as on the roadway shoulder or exit ramps. Section 1401 of Public Law 112-141 (Moving Ahead for Progress in the 21st Century Act [MAP-21]), commonly referred to as Jason's Law (named after Jason Rivenburg, a truck driver killed in 2009 in his parked truck), established eligibility for facilities to provide truck parking to serve the National Highway System (NHS).

The FHWA *Jason's Law Truck Parking Survey Results and Comparative Analysis* (FHWA 2015b), completed in August 2015, cited numerous other studies identifying a severe truck parking shortage in some regions, a lack of adequate information for truck drivers about parking capacity at existing facilities, and the challenges associated with routing and delivery requirements and accommodation of rest periods.

Table 10 summarizes parking deficiencies reported by state DOTs among the four I-10 states, although the information does not include data on individual corridors such as I-10. Even though this information is limited, it at least acknowledges specific areas or categories within each state that are deficient.

Analysis of statewide parking availability along the NHS using key indicators of truck vehicle miles traveled (VMT) and state gross domestic product (GDP) is more instructive than just the number of truck parking spaces alone. The VMT and GDP are indicators of truck activity in a particular state or area. Major corridors with significant truck traffic need more truck parking spaces than those with less traffic.

Table 10. Truck Parking Survey Data for I-10 States

Category	State			
	Arizona	California	New Mexico	Texas
Shortages at designated pullouts or vistas	Y	N	Y	Y
Shortages at private truck stops	N	Y	N	Y
Shortages at public rest areas	Y	Y	Y	Y
Trucks parking along freeway shoulders	Y	Y	Y	N
Trucks parked at freeway interchanges	Y	Y	Y	N
Trucks parked at weigh stations	N	Y	N	N
Trucks parked in local commercial areas	N	Y	N	N
Trucks parked on conventional highway roadsides	Y	Y	Y	Y
Trucks parked on local streets near freeways	N	Y	N	N

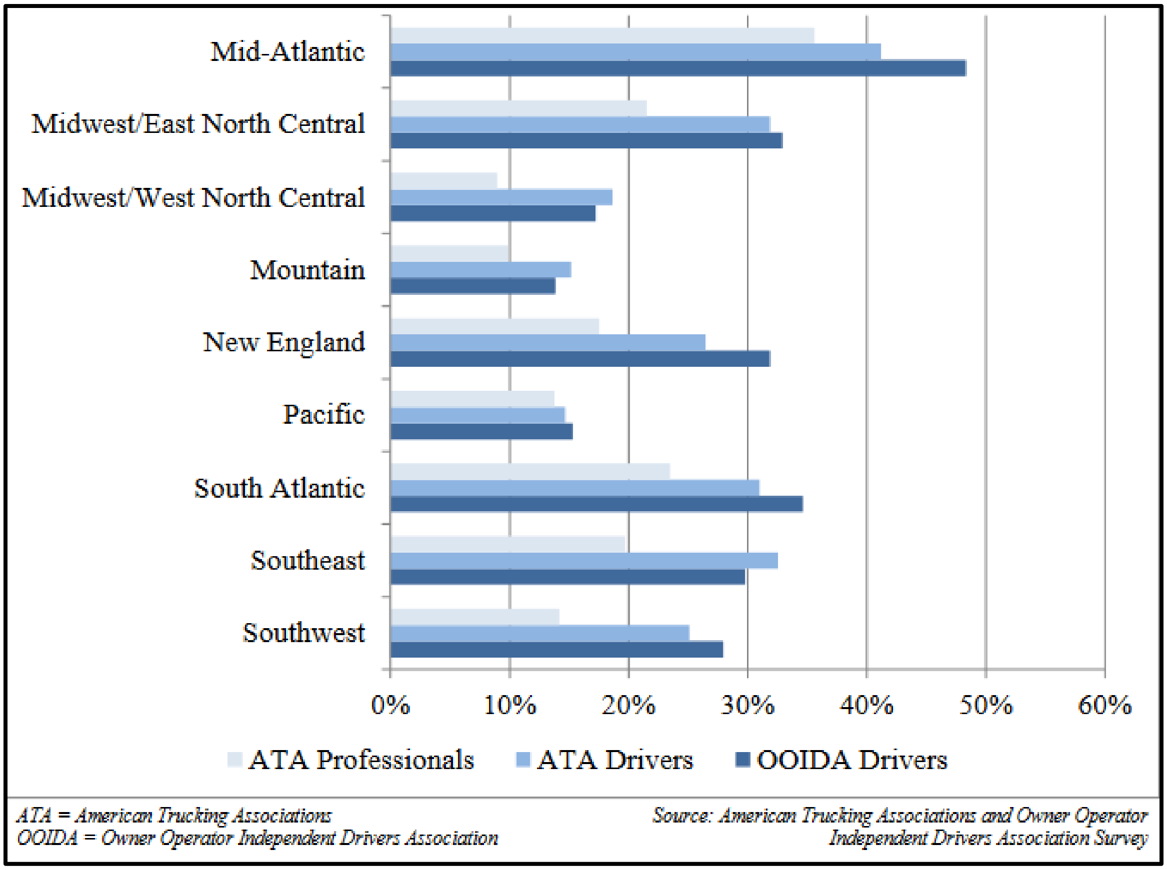
Source: TTI Summary of FHWA (2015b), State DOT Survey Information, Figures 10–18

Texas and California reported high levels of parking but still had shortages at private truck stops. Both states reported fewer spaces along the NHS relative to VMT, but Texas is in the top 25 percent of states with spaces relative to GDP. The states with the lowest ratio of spaces to NHS miles include Texas and adjacent states (including New Mexico for this study).

FHWA is encouraging states to include truck parking considerations in their state freight plans and solicit input from truck drivers and truck stop operators through their state freight advisory committees. States have the flexibility to use a number of formula programs for truck parking. They can also apply for grant opportunities to fund significant truck parking projects. Grant opportunities are available to states through two ongoing programs: Fostering Advancements in Shipping and Transportation for the Long-Term Achievement of National Efficiencies (FASTLANE) grants, and Transportation Investment Generating Economic Recovery (TIGER) grants (MAASTO n.d.).

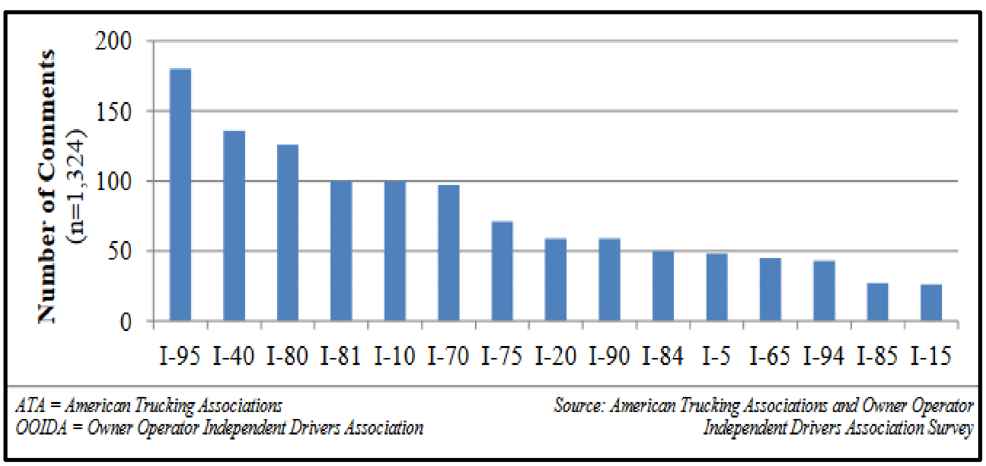
Truck parking is also a concern for the private-sector trucking industry. The American Transportation Research Institute's (ATRI's) annual survey, "Critical Issues in the Trucking Industry," shows truck parking steadily increasing in importance from the eighth most important issue in 2012 to the fourth most important issue in 2016 (ATRI 2016).

Figure 20 provides the amount of shortages of safe truck parking by country region, according to an ATRI study of truck driver diaries from the American Trucking Associations (ATA), the Owner-Operator Independent Drivers Association (OOIDA), and survey of ATA professionals (Boris and Brewster 2016). The report *Managing Critical Truck Parking Case Study—Real World Insights from Truck Parking Diaries* (Boris and Brewster 2016) used the same regional designations used in the FHWA Jason's Law report (FHWA 2015b), which divides the four I-10 Corridor Coalition states among three regions: California in the Pacific, Arizona and New Mexico in the Mountain, and Texas in the Southwest. The Southwest, Mountain, and Pacific regions had among the lowest reported shortages of safe truck parking according to ATA professionals surveyed, while driver surveys reported the Southwest region along a median among all other regions (Boris and Brewster 2016). Figure 21 indicates that I-10 is ranked fifth among the top 15 worst interstate routes for truck parking noted by drivers and professionals.



Source: Boris and Brewster (2016)

Figure 20. Percentage of Drivers Reporting Shortages of Safe Truck Parking by Region



Source: Boris and Brewster (2016)

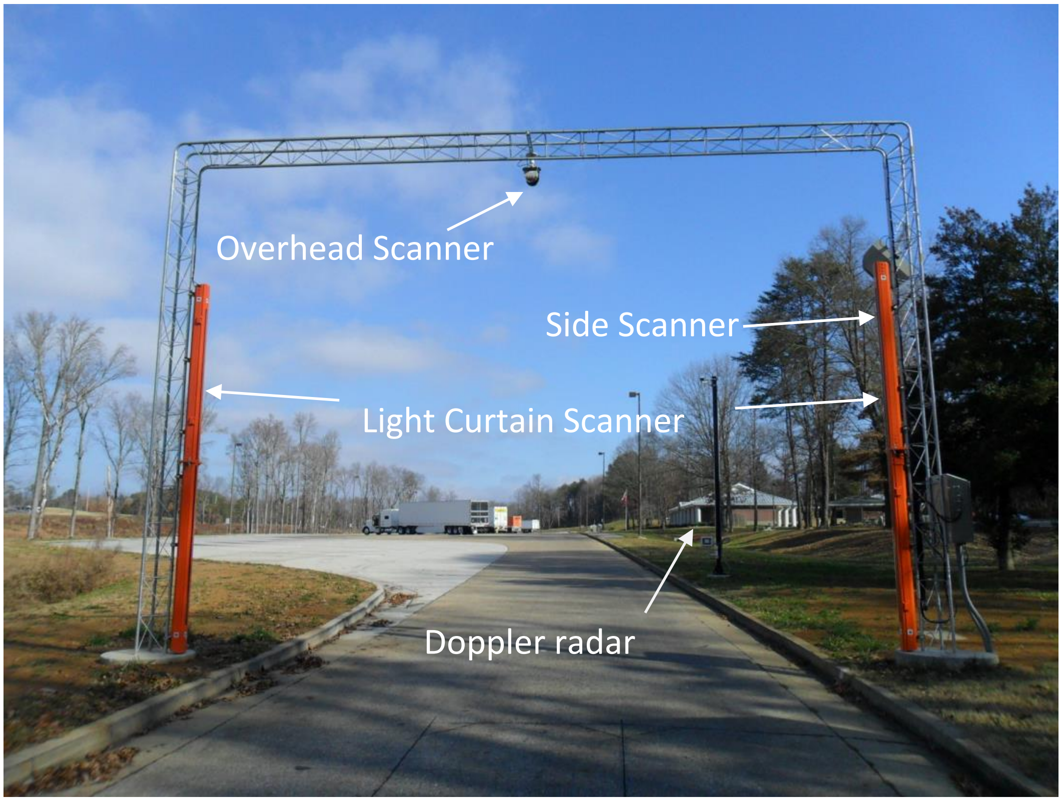
Figure 21. Top 15 Cited Interstates with Shortages by OOIDA/ATA Truck Drivers and Professionals

The ATRI truck parking case study offered recommendations related to public-sector parking and parking at truck stops. State transportation agencies are creating information systems to provide real-time parking availability information to drivers. Low-cost solutions to expand public truck parking capacity include increasing public rest area time limits and allowing weigh stations and public works facilities to be used for truck parking. Longer-term solutions involve developing new facilities, expanding existing facilities, and reopening rest areas that have been closed (Lopez-Jacobs et al. 2013). Local governments are encouraged to consider how local regulations on truck stop size and location could be amended to encourage more private-sector truck parking capacity. Truck drivers prefer private truck stops for 10-hr required hours-of-service breaks. Two major chains, TA/Petro and Pilot/Flying J, currently offer parking reservations for peak-time capacity. Even though reservations may help match supply with demand, they do not solve the problem of overall inadequate supply. The ATRI diary findings indicate that removal of non-CMVs (e.g., recreational vehicles, bobtail tractors, dropped trailers, and construction equipment) from truck stop parking areas would make a significant difference in meeting the parking challenge. Dedicated bobtail parking or allowing bobtails (i.e., tractors traveling without trailers) to park in the car lot could free up space for a full combination vehicle (Boris and Brewster 2016). Motor carriers are encouraged to consider carrier-paid reservations, in which carriers pay for reserved parking in advance for their drivers. Shippers are encouraged to offer more flexibility in scheduling appointments for pick-ups and deliveries.

Truck Parking Technology Research and Demonstrations

In 2000, the National Transportation Safety Board (NTSB) recommended that FMCSA create a guide to inform truck drivers about availability and locations of parking (NTSB 2000). Two years later, FHWA completed a congressionally mandated study on the adequacy of truck parking facilities. One study recommendations was to develop ITS deployments that would provide CMV drivers with real-time parking information—both locations and availability (Flegler et al. 2002). In response, in 2005, FMCSA initiated SmartPark (Loftus 2013), a program to demonstrate a technology to provide parking availability information to truck drivers in real time. Phase I of SmartPark was intended to demonstrate a technology capable of counting truck parking space occupancy and determine the availability of parking in a truck rest area (Lopez-Jacobs et al. 2013).

FMCSA conducted field operational tests in 2007 and 2009 of two technologies to demonstrate the feasibility of determining parking space occupancy. The two projects investigated the use of video imaging and magnetometers, but they were unsuccessful. A third project was then commissioned in 2011 to test Doppler radar combined with laser scanning on I-75 near Athens, Tennessee. Data collection for the test system exceeded expected performance criteria for parking count accuracy and technology availability. Figure 22 shows the successful detection setup (O'Connell 2014).



Source: O'Connell (2014)

Figure 22. Test Site Ingress—Technology Array

Subsequently, a number of states began their own demonstration/research projects, including Michigan and Maryland.

Michigan DOT I-94 Demonstration. The Michigan Department of Transportation (MDOT) worked with its consultants and vendors to develop and implement a truck parking and information management system. This smart truck parking system started with a 129-mi section of I-94 in Southwest Michigan using federal funding through the MAP-21 legislation.

Collecting accurate parking availability data required installation of detection cameras and other sensors at rest areas and private facilities. MDOT's vendors developed business agreements with truck stops, allowing the firms to collect parking data and license the information to MDOT and other third-party information providers. Parking availability information is made available through the state's third-party-hosted cloud computing service and is distributed to users (truck drivers) through the project website, smartphone applications, roadside signs, MDOT's website, and third-party data services (Truck Smart Parking Services [TSPS] n.d.).

In its initial version, MDOT publishes and manages information on parking availability, parking reservations, high-security parking reservations, and lot management. Drivers can determine where to find truck parking before beginning their trip or while stopped along the way. The program constantly monitors participating truck stops and parking lots to automatically update information on how many truck parking spots are available, communicated to drivers via smart devices. Drivers can also reserve parking, based on anticipated travel times and hours-of-service limits. For high-value loads, the program provides information about high-security features in certain facilities (camera surveillance, perimeter gates, and guarded entry/exit points). Program vendors provide additional safety for certain facilities (electrified fences, gated access, continuous monitoring, and physical trailer barriers) (TSPS n.d.).

Maryland Research Project. In another demonstration project, University of Maryland researchers investigated the use of wireless magnetometers for monitoring car parking spaces and truck parking spaces, in a project sponsored by the Maryland State Highway Administration. A pilot deployment on an SHA truck parking facility on northbound I-95 in January 2013 resulted in a customized algorithm for truck parking information. In this test, researchers placed two sensors in five parking spaces, essentially at about the one-third points within the space. They collected data over a year, with 1239 detection events. An *event* refers to an arrival or departure in the monitored parking space.

Results using a video camera for ground truth and recording an image at 1-min intervals defined the error rate as the percentage of time in which the system experienced an error (either a false positive or a miss). The average error rate for all five spaces was 3.75 percent. Error rates fluctuated over time but remained below 5 percent (Haghani et al. 2013).

To disseminate parking information to prospective users, the research team developed a transmission control protocol/Internet protocol (TCP/IP)–enabled user interface, which relied on activities stored in a database for each truck parking space. Besides providing real-time parking availability to truck drivers, the system could analyze historical data for each parking space and for the parking lot as a whole to reveal the dynamics of events and assist managers to make informed decisions regarding the facility operations. The research concluded that if all parking facilities in an area were equipped with similar systems, the use of all facilities could be optimized (National Association of Truck Stop Operators [NATSO] n.d.).

Other Federally Funded Implementation Projects. States are also pursuing agreements with others to form regional truck parking systems such as the Mid America Association of State Transportation Officials Regional Truck Parking Information Management Systems (TPIMS). Kansas, in partnership with Indiana, Iowa, Kentucky, Michigan, Minnesota, Ohio, and Wisconsin, is developing such a regional partnership through a $25 million 2015 federal TIGER grant and state funds. The regional TPIMS will be a network of parking areas with the ability to collect and broadcast real-time CMV parking information through a system of outlets such as dynamic message signs (DMSs), smartphone applications, and websites. This system will be implemented in two phases: Phase 1 is a design phase, and Phase 2 results in operational implementation by September 2018 (FHWA 2015b).

Florida DOT is implementing the Truck Parking Availability System (TPAS) in two phases. First, seven rest areas and weigh stations along I-4 and I-95 in Central Florida will be equipped to measure truck parking.

In rest areas, wireless in-pavement sensors will determine if trucks are occupying available spaces, and closed-circuit television cameras will validate the sensor measurements. Weigh stations will measure trucks entering and exiting the station to monitor parking in available capacity. Florida DOT received a $10 million discretionary freight grant award authorized by the FAST Act (the FASTLANE grant) to equip all remaining 74 public facilities along Florida interstate highways and extend to some private facilities. Parking information will be conveyed on roadside signage and through web and mobile applications, in partnership with travel information firms WAZE and HERE.

National Association of Truck Stop Operators. NATSO offers a truck parking app called Park My Truck, which is designed to be used by truck drivers to find a place to safely stop and rest. The Truck Parking Leadership Initiative, comprised of the NATSO Foundation, NATSO Inc., and ATRI, developed the app based on feedback from truck drivers and motor carrier professionals. Park My Truck allows any parking provider, whether public or private, to report its parking availability at no charge. Internet access is reportedly the only requirement for using the app. It can be downloaded from the iTunes store or from the Google Play store. For the app to work as intended, it requires parking providers to take an active role in reporting the number of available spaces in their lots. This source indicates a commitment by truck stop operators nationwide to engage with stakeholders in a series of working groups to determine how to improve parking availability for trucks (Mulero 2016).

MULTIMODAL FREIGHT CONSIDERATIONS

Introduction

The information provided in this section is sourced from both public and private programs intended to make multimodal freight operations more efficient. The first subsection outlines the plans by USDOT's Maritime Administration (MARAD) to incorporate ITS in its future operations. The second subsection provides appropriate information based on investigating innovative and automated freight systems.

ITS MARAD Program

Within the larger USDOT ITS Strategic Plan, the ITS MARAD program has three phases (Leonard 2016):

- Phase 1: Pre-deployment Preparation and Analysis:
    - Establish understanding of current and potential ITS solutions related to MARAD and prepare a business case.
    - Identify a candidate set of promising applications for deployment in Phase 2.
- Phase 2: Development and Demonstration Planning:
    - Begin development work on the high-priority ITS solutions identified in Phase 1.
    - Develop preliminary procurement documents as needed.
    - Conduct outreach with stakeholders such as Maritime Administration Gateway directors.
    - Address policy and institutional issues.

- Phase 3: Demonstrations and Assessment:
    - Demonstrate ITS solutions for maritime usage.
    - Conduct technology transfer to enable deployment across maritime facilities such as ports and harbors.

As the ITS MARAD program proceeds and identifies ITS systems to improve port and terminal operations, these ITS programs may extend to motor carrier operations on I-10 from ports in California and Texas.

Relevant Multimodal Research

This subsection describes an ongoing literature search related to the use of technology in intermodal and multimodal freight, which may not be originally designed to apply to interstate corridors but may have possible applications for I-10 Corridor Coalition states.

Truck Priority Logic

FHWA sponsored research to evaluate a concept developed by researchers called the Detection-Control System (D-CS) (Middleton et al. 2015). The goal of D-CS is to reduce the number and severity of crashes at signalized intersections, especially those involving CMVs. D-CS was originally conceived to address a mandate to reduce speed limits to improve air quality but that, once installed, would be immune to changes in speeds. With the existing fixed detection method, TxDOT would have been required to relocate existing point detectors. D-CS solved the problem by placing a pair of detectors at 1000 ft from the intersection to predict the arrival of each truck and non-truck and allowing the signal controller to make better control decisions based on vehicle length and speed. Since trucks exhibit different stopping characteristics compared to non-trucks, D-CS could accommodate both safely by integrating a classification algorithm based on vehicle length. Research findings indicate that the after-study periods experienced 82 percent fewer red-light violations, 73 percent fewer vehicles in the decision zone, and 51 percent fewer max-outs than the before-study periods. The emphasis of D-CS on trucks is a salient feature that makes it unique in comparison to other methods of decision zone protection (Middleton et al. 2015). These improvements could affect signalized intersections that connect other highways and major roads to I-10 in urban areas in all four states.

Signal Timing Manual

In addition to covering basic and advanced signal timing concepts, the second edition of the *Signal Timing Manual* addresses establishment of a signal timing program including setting multimodal operational performance measures and outcomes, determining staffing needs, and monitoring and maintaining the system. Some of the advanced concepts addressed include the systems engineering process, adaptive signal control, preferential treatment (e.g., rail, transit, and emergency vehicles), and timing strategies for oversaturated conditions, special events, and inclement weather. The manual is geared toward traffic engineers and signal technicians at agencies operating traffic signals (Urbanik et al. 2013). These signal timing improvements could focus on arterials that connect to I-10.

Over-Height Vehicle Detection Systems

Collisions of over-height trucks with bridges and overhead structures can cause significant damage to those structures and significant impacts to facility operations. A single impact can cost more than $200,000 for repairs. Testing of over-height vehicle detection systems in Houston, and soon in Austin, has been used to alert truck operators of low-clearance conditions ahead and can indicate alternative actions to take. Typically, infrared technology is used to sense when a vehicle is over a height threshold and deliver a message via flashing sign or DMS to the offending vehicle. Newer technologies can not only sense the height of a vehicle but also its profile (taking measurements of height), identify which lane the truck is in, and, in association with video technologies, provide positive identification of the offending vehicle. This information can then be used to inform law enforcement and the vehicle owner in real time of a possible violation and/or enforcement action, assess the owner/driver/carrier's adherence (or lack thereof) to TxDOT and/or local permit status, and potentially assign penalties for nonadherence to permitted routes (Curtis Morgan, TTI engineer, unpublished data, March 1, 2017).

Railroad Grade Crossing Monitoring

Monitoring railroad grade crossings by direct connection to the signal controller and providing messages (roadside or DMS) for alternate routes would be helpful to improve the safety and operational efficiency of motor carriers. Trucks stopped at railroad crossings often experience significant delay. This delay depends on the type of grade crossings, frequency of trains, length and speed of trains, and location of sidings in the vicinity of grade crossings. Prior knowledge of either the presence of a train or the impending arrival of a train at a grade crossing can provide an opportunity to the CMV operator to take an alternative route, potentially saving valuable time. Modern signal controllers can accommodate numerous modules that can facilitate rail monitoring systems and perform such functions. Such applications can then provide this information on DMSs or means such as highway advisory radios. Implementation of such systems can not only reduce delay but also reduce fuel consumption and emissions, which directly impact the costs to CMV owners (Ruback et al. 2007).

Trucking Industry Efficiency

Virtual Container Yard

A research project in the New York–New Jersey region entitled Investigating the Feasibility of Establishing a Virtual Container Yard to Optimize Empty Container Movement defined user requirements and potential business and institutional impediments to successful and efficient multimodal freight movement. This involved critical review of literature dealing with local, US, and international experience in applying web-based shared information systems to support user requirements, production, and solutions and to address potential impediments. Special attention was given to system security architecture to make the application robust and attractive to potential partners. Proprietary products dealing directly with either street-turn matching or a wide range of matching applications were critically evaluated in view of the developed user requirements. Findings present an analytical formulation and simulation model developed to evaluate the potential benefits of a virtual container yard under different market conditions. Results also present financial and economic evaluation, potential funding alternatives, and investment recovery strategies to ensure successful development and long-term viability of system operations (Theofanis and Boile 2007).

Freight Technology Applications and Software

Many firms have been working to improve the efficiency of trucking deliveries. Empty trips are sometimes the result of competition between different industry segments. The probability of any of these segments transporting a shipment is a function of the percentage of empty trips and the probabilities of pick-ups and deliveries. These firms demonstrated that the dynamic relations of supply and demand could be made operational in a simulation system, and then used to create virtual markets for carriers and shippers to match loads with available capacity. The resulting quantitative estimates provide an upper bound on the benefits attributable to market efficiency enhancers such as Internet-based freight clearinghouses (Curtis Morgan, TTI engineer, unpublished data, March 1, 2017). The Internet-based freight improvements shown in Table 11 have been identified and could offer efficiencies in truck movements along I-10 and in drayage operations at ports and intermodal yards that connect to I-10.

Table 11. Internet-Based Freight Efficiency Applications

Brand Name	Services Offered	Website
123Loadboard	Carrier-focused load matching	https://www.123loadboard.com/
Cargomatic	Load matching for short-distance trips in Los Angeles, New York, and San Francisco	https://www.cargomatic.com/
Convoy	Load matching, carrier screening, load tracking, carrier payment	https://convoy.com/
Direct Freight	Load matching	https://www.directfreight.com/home/
Exel Freight Connect	Online broker, matching shippers and carriers	http://exelfreightconnect.com/
Fr8Connect	Online database of carriers and shippers, virtual broker service	https://www.fr8connect.com/home
FreightFriend	Load matching among selected brokers and carriers	https://www.freightfriend.com/
Loadsmart	Load matching for truckload shipments	https://loadsmart.com/#/
Logistitrade	Shipper-focused electronic international trade bidding	https://logistitrade.com/
Posteverywhere	Service that links to multiple load matching boards	http://www.posteverywhere.com/
ShipperNet	Load matching among registered shippers and carriers	http://www.shippernet.com/index.aspx
TransFix	Load matching	http://transfix.io/
Trucker Path	Online information on truck stops, parking, weigh stations, fuel; includes load matching	https://truckerpath.com/
TugForce	Load matching	https://tugforce.com/index.html
uShip	Load board for small and large shipments of different types	https://www.uship.com/
VeriTread	Load matching for heavy-haul movements	http://www.veritread.com/

LESSONS LEARNED FROM OTHER INITIATIVES

Freight Advanced Traveler Information System

FRATIS has its origins in the Cross-Town Improvement Project (C-TIP) in Kansas City, Missouri, and Chicago, Illinois. C-TIP originated with the Intermodal Freight Technology Working Group, which focused on improving productivity and public benefits through technology. In tracking the processing that was occurring at that time for a container from a waterborne vessel to drayage, to rail, back to drayage, and then into and out of a distribution center, the group found that 40 percent of the transportation time was waiting for information exchange between supply chain partners. The cross-town component of the shipment was part of this process and the focus of early efforts to reduce the 40 percent value.

In major railroad terminal cities like Chicago, Kansas City, St. Louis (Missouri), and Memphis (Tennessee), a container has to be taken off a railcar and moved over the highway to be reloaded onto another railcar. These movements involved no backhaul and were acknowledged as inefficient, leading to better coordination between terminals and reducing some of the bobtail trips and the associated inefficiency, excess fuel usage, and pollution. C-TIP's goal was to develop and deploy an information-sharing capability to coordinate movements and minimize unproductive movements.

Part of the system that evolved from this C-TIP process is a real-time traffic monitoring component. It reports on any incidents along the designated route that may cause a problem with the travel time, and determines if a reroute is warranted. The component also includes providing information to drivers as they are en route or upon arrival at a destination port pertaining to a return load from this destination to avoid a bobtail trip. The overall system core is the Intermodal Exchange, where all of the data from components pass through. Other components are the chassis Utilization Tracking and the Wireless Drayage Updating modules (Symoun et al. 2010).

Using C-TIP as a foundation, USDOT looked to expand and enhance the functionality that had been developed and designed FRATIS to serve the various functions that were identified. The outcome was a process that was more scalable and transferable, and it had to expand from a rail-to-rail program and cross-town movements to include a much wider array of applications. These included at least port-to-rail, port-to-truck, airport-to-truck, and over-the-road freight movements.

The four major components of FRATIS are (Symoun et al. 2012):

- Intermodal exchange, identifying freight to be moved
- Real-time traveler information, which basically deals with traffic conditions and weather conditions, with the objective of getting more real-time information to CMV operators
- Dynamic route guidance, including road construction, traffic congestion information, predicted travel times, and freight-specific information to build on what was learned in C-TIP
- Drayage optimization, which ensures that loaded moves are coordinated between freight facilities, with the goal of maximizing loaded trips and minimizing bobtail trips (this component will improve on the information that was available in the Kansas City element of C-TIP)

Truck Platooning

Another possible technological advancement that could be tested and implemented in I-10 is truck platooning. Truck platooning involves two or more trucks equipped with advanced driving support systems closely following one another, and mutually communicating among the platooning trucks through smart technologies and short-range communications systems. Truck platooning could offer aerodynamic benefits leading to fuel savings and emissions reductions. California and Texas DOTs have already conducted research on this topic and will likely lead most other states in its adoption.

The California Partners for Advanced Transit and Highways (PATH) Program, as part of the University of California, Berkeley, described basic operational characteristics about a cooperative adaptive cruise control (CACC) system as part of a 2015 research study. The study outlined identifying market needs, testing commercial trucks, and evaluating potential benefits for the I-710 corridor in California. The study cited that commercial truck platooning could reduce fuel costs by 20 to 25 percent. However, platooning often requires trucks to move at very close distances to one another, with a gap as little as 10 to 20 ft. Having short gaps would likely require that platooning trucks operate within dedicated lanes. Safety would be the main reason for pursuing dedicated lanes because close distances would leave very little chance for other vehicles to change lanes in the platoon's vicinity. Additionally, platoons encounter difficulty in safely responding to emergency conditions and reacting to the behavior of other, non-connected vehicles (Nowakowski et al. 2015).

The California study specifically defined four different types of operational platooning concepts, states, or phases of how a truck operates within a platoon. The four types of operational concepts are (Nowakowski et al. 2015):

- **String formation**: A string formation starts the CACC operation with the driver activating the CACC system and setting his or her desired gap and speed setting. Then, the joining driver is shown a list and map of potentially connecting trucks and selects the vehicle to join or create a platoon.
- **Steady-state cruising**: Steady-state cruising is the mode in which platooning drivers spend most of their time. Drivers in steady-state cruising actively monitor roadway conditions and are only interrupted if another truck enters or leaves a platoon or a non-platooning vehicle manages to interrupt and enter in the middle of the platoon.
- **Split-string maneuvers**: A split-string maneuver is activated when a truck indicates that it will leave the platoon. The respondent truck's actions depend on the leaving truck's location within the platoon. If the leaving truck is in the middle, then the front and rear trucks form two separate strings and reattach when the leaving truck departs the active lane.
- **Fault or abnormal conditions**: A series of fault condition scenarios entails a separate operational concept to cover all potential occurrences of errors and abnormal situations. This scenario comprises the incorporation of a kill switch that disengages the CACC system and stops the trucks from responding to CACC signals or commands. Specific situations that might trigger a kill switch include stopped vehicles, roadway debris, data mismatches, and faulty sensors.

TxDOT has sponsored research by TTI to investigate practices related to commercial truck platooning. The first phase of the project was completed in August 2016. Researchers on the project considered regulatory or legislative roadblocks that could hinder or advance the introduction of platooning into fleet operations. The research team tested and demonstrated the technology as a proof of concept, with a demonstration workshop showing a two-vehicle truck platoon. Specifically, the type of technology tested was defined as Level 2 truck platooning, which offers some attributes of automation. Level 2 is an extension of CACC that uses automated lateral and longitudinal vehicle control while maintaining a tight formation of vehicles with short following distances. The lead truck is manually driven by a driver, and drivers of the following trucks have the capability of disengaging from driving tasks. A cited benefit of commercial truck platooning is saving fuel and reducing emissions from vehicles within the platoon (Kuhn et al. 2016).

As part of the research project, TTI investigated the practicality of commercial truck platooning by developing a series of microsimulation models and test driving a two-truck platoon along a closed track. The primary test purpose was measuring the potential for fuel savings while engaged in platooning mode. Microsimulation modeling found that platooning could reduce fuel consumption up to 12 percent on average. For individual trucks, the fuel savings could reach a high of 20 percent for the lead truck and 40 percent for the follower truck. Test driving found that platooning vehicles were able to keep a relatively consistent gap distance. The vehicles were also able to navigate tight turns with little to no oscillation observed for steering and direction of travel. The study indicated that more research was needed to investigate variances given differences in vehicle power, braking performance, and loading (Kuhn et al. 2016).

Freight Bottlenecks

Measuring the need for improvements or quantifying the effects of improvements requires freight performance measures (FPMs). Since 2002, ATRI has worked in collaboration with FHWA to implement the freight performance measures and National Corridors Analysis and Speed Tool (N-CAST). The program monitors performance measures related to the highway freight system, using GPS to monitor truck travel data, patterns, and performance. One FPM initiative component displays truck average operating speed on interstate highways and other roadways within the NHS. Data contained within the N-CAST cover a significant NHS portion, including all of the interstate mileage. This tool can be particularly useful in determining when and where trucks are moving at less-than-desired speeds to evaluate mobility impediments along various roadways (ATRI 2012). It could be a valuable tool for investigating the I-10 corridor through the four I-10 states.

I-10 Bottlenecks

In 2008, ATRI conducted an analysis of 30 US freight bottlenecks using the FPM analysis techniques and tools. Bottleneck locations initially listed on I-10 in the four states were (Short et al. 2009):

- I-10 at I-15 in San Bernardino, California, ranked eighth
- I-10 at I-17 (the stack) in Phoenix, ranked 12th
- I-10 at I-110/U.S. 54 in El Paso, ranked 20th
- I-10 at I-410 in San Antonio, ranked 22nd
- I-10 at SR 51/SR 202 (the mini-stack) in Phoenix, ranked 25th

In the 2017 ATRI Top 100 Freight Bottleneck report, the following I-10 bottleneck locations were identified:

- I-10 at I-45 in Houston, ranked 11th
- I-10 at U.S. 59 in Houston, ranked 13th
- I-10 at I-15 in San Bernardino, ranked 26th
- I-10 at I-610 West in Houston, ranked 33rd

- I-10 at I-17 in Phoenix, ranked 40th
- I-10 at I-610 East in Houston, ranked 88th

Connected Vehicle Harmonization

MDOT investigated the potential for global harmonization of CV communication standards in a January 2016 research report. MDOT outlined a process for working with private-sector partners and the federal government to develop standards for cooperative intelligent transportation systems (C-ITSs). The report highlighted the need to develop C-ITS standards through independent standards-development organizations. Part of the research consisted of surveying 19 targeted individuals to assess the current status of C-ITS technologies and to gather feedback about the implications of standardization. Those individuals represented experts from universities, technology firms, and consultants. Generally, most respondents agreed that centralized government involvement was essential to harmonizing CV standards. In contrast, the respondents tended to feel that regional and state involvement was not essential. The survey also found that deployment of public-private partnerships was very important to the advancement of CV technology (Hong et al. 2016).

Dissemination of Weather Information

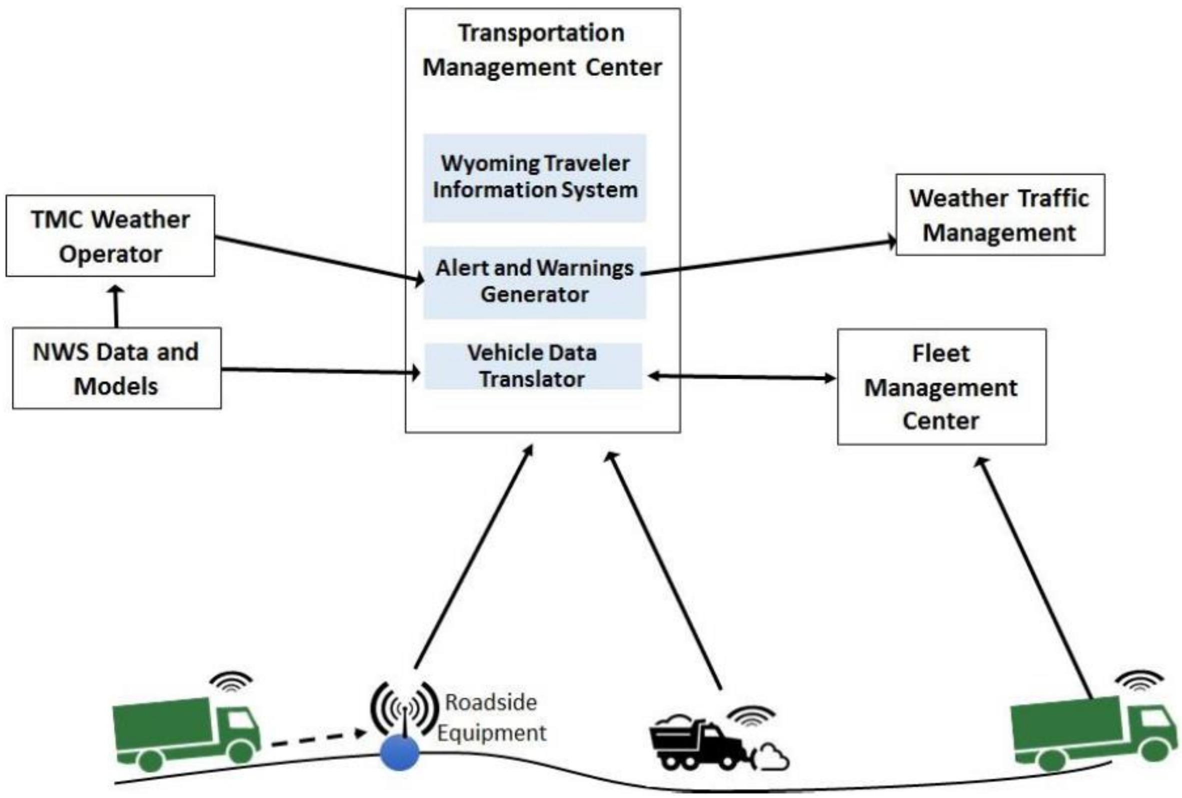
Freight-specific weather information is rare, but most road weather information is appropriate for CMVs as well as other vehicles. An exception is high cross-wind warnings that apply more to tall vehicles with more surface area and high centers of gravity. An excellent example of a current study focused on CMV weather-related events is the I-80 CV Pilot.

The Wyoming Department of Transportation was one of the first pilot agencies identified by USDOT to test and possibly show the value of CV technology in the United States. The Wyoming Department of Transportation is leading a project to implement new methods of communicating roadway and safety information for commercial truck drivers and fleet managers along almost 400 mi of I-80. Frequent closures and weather-related incidents were principal reasons for the I-80 corridor selection. The first steps of the project led to the ConOps development, and the physical system deployment will start in the fall months of 2017 (Gopalakrishna et al. 2015).

The primary I-80 system capabilities and functions are to collect data and distribute them to drivers before and during their trips. Examples of data that serve as input into the system include road and weather data, work zone information, travel times, and advisories. Information would then be distributed directly to CVs and roadside infrastructure. Commercial vehicles will also have the capability to directly send messages to other trucks driving along the corridor. Figure 23 shows a visual schematic of the process that will be used to transmit weather-related information between the National Weather Service, the transportation management center (TMC), and CVs (Gopalakrishna et al. 2015).

The primary I-80 ConOps purpose was to have a standard set of practices and a shared agreement about roles and responsibilities for deployment and managing the CV program for that corridor. The ConOps referenced the importance of ensuring the Security Credentialing and Monitoring System (SCMS) within the TMC. The SCMS's role is to ensure that systems and processes within the TMC are capable of producing Institute of Electrical and Electronics Engineers 1609.2–compliant certificates that safeguard encrypting and signing messages (Gopalakrishna et al. 2015).

Weather issues that are more focused on the I-10 corridor might involve dust storms in arid areas, represented mostly by conditions in New Mexico and Arizona. Such storms can arise without warning and reduce driver visibility to the point that freeway closure becomes a reasonable option. Another weather event is flash flooding. Although rare, flooding can also cause closure of a major interstate in an extreme weather event. Even though the conditions along I-10 are different from those along I-80 in Wyoming, the same or similar principles will apply to CVs operating along either corridor.



Source: Gopalakrishna et al. (2015)

Figure 23. Schematic of Vehicle-to-Infrastructure Weather Data Collection

Data Sources and Standards

Table 12 summarizes some of the current data sources for freight operations and applicable standards (Jensen et al. 2012). As Table 12 demonstrates, some data are publicly available, but other critical data such as terminal information are controlled by private firms. Most users do not have access to all of this information in one location. Currently, no system is in place that can pull together data from various disparate sources and make them available in a more comprehensive way. Private firms involved in moving freight could greatly benefit from integrated information about intermodal freight shipments. This information might include load availability, ship/train arrivals, vehicular movements, chassis availability, and empty containers.

Table 12. Current Data Sources for Freight Operations

Data Type	Sources	Applicable Standards
Traffic sensor data	• State/local TMCs • Private data providers (e.g., INRIX, TomTom, and highway loops)	• Traffic Management Data Dictionary • American National Standards Institute (ANSI) X12 Electronic Data Interchange (EDI)
Incident/event reports	• State/local TMCs • Private data providers	• Traffic Management Data Dictionary • Universal traffic data format
Images	• State/local TMCs • Private data providers	• Traffic Management Data Dictionary • Universal traffic data format
Road/environmental sensor station data	• State/local TMCs • National Oceanic and Atmospheric Administration and National Weather Service	• Traffic Management Data Dictionary • XML
Parking data	• Private sources (e.g., Parking Data Ventures, ParkingCarma, Parking in Motion, Sarcopenia, and Streetline)	• ANSI X12 EDI
Terminal data	• Marine and rail terminal websites • Railroad and ocean carriers • Truck dispatch platforms (e.g., Profit Tools and Trinium) • Chassis movements • Airport/seaport terminal systems	• ANSI X12 EDI • XML
Load matching and shipment information	• Shippers/receivers • Third-party logistics firms • Load matching sites (e.g., www.loadmatch.com)	• ANSI X12 EDI • XML
Truck movement data	• Truck GPS probes • Location-enabled cellphones	• Vendor Specific

Toolbox Applications

Seedah et al. (2013), in response to provisions of MAP-21, developed a truck-rail intermodal toolkit for multimodal corridor analysis to enable planners and other stakeholders to examine freight movement along corridors based on mode and route characteristics. The toolkit uses techniques to simulate line-haul movements and models to evaluate multiple freight movement scenarios along corridors. This methodology could also be applied to the I-10 corridor or the national freight network as a whole.

This same research study used the Truck-Rail Intermodal Toolkit (Seedah et al. 2014) to examine truck and rail movements along multiple freight corridors and the Gulf Coast megaregion. The Truck-Rail Intermodal Toolkit has two components: the truck operating cost model and the rail operating cost model. This toolkit provides the ability to incorporate roadway and track characteristics such as elevations, grades, travel speeds, fuel prices, maintenance costs, and labor costs. Outputs include fuel consumption and cost, travel time, and payload cost.

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