SPR-752 MAY 2019

Interstate 10 Western Connected Freight Corridor, Volume 1: Improvement Strategies

Arizona Department of Transportation Research Center

ADOT

Interstate 10
Western Connected Freight Corridor, Volume 1: Improvement Strategies

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Prepared by:
Allan Rutter, Rafael Aldrete, Dan Middleton, Curtis Morgan, Kevin Balke,
Beverly Kuhn, Ed Seymour, and Roberto Macias
Texas A&M Transportation Institute
Texas A&M University System
3135 TAMU
College Station, Texas 77843-3135
and
Mark Jensen and Daniel Stock
Cambridge Systematics
2715 Southview Avenue
Arroyo Grande, California 93420

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16. Abstract

The Interstate 10 (I-10) western connected freight corridor extends from the Ports of Long Beach and Los Angeles in California to the Port of Beaumont in Texas. Collaborating through a Federal Highway Administration (FHWA) pooled fund study, the state departments of transportation in California, Arizona, New Mexico, and Texas (the I-10 Corridor Coalition) produced improvement strategies supporting development of a planning framework for a connected freight corridor.

This publication documents five strategies to improve freight movement on the I-10 Corridor: truck parking availability systems, freight traveler information systems, freight technology enviroment, roadside safety communication, and oversize/overweight permit standardization. Included are functional descriptions of the corridor, stakeholders informed about this study, a synthesis of freight improvement technologies and strategies considered for application, stakeholder engagement, use case scenarios and implementation considerations, and a planning framework for strategy implementation.

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m^2	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
^oC	Celsius	1.8C+32	Fahrenheit	^oF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	candela/m^2	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003)

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LIST OF ABBREVIATIONS AND ACRONYMS

511 ..... State traveler information systems
AADT ..... Annual average daily traffic
AASHTO ..... American Association of State Highway and Transportation Officials
ADOT ..... Arizona Department of Transportation
AFTIS..... Advanced freight traveler information systems
ANSI..... American National Standards Institute
ATA..... American Trucking Associations
ATRI ..... American Transportation Research Institute
AV..... Automated vehicle
BOE..... Bureau of Equalization
CACC..... Cooperative adaptive cruise control
Caltrans ..... California Department of Transportation
CAN ..... Controller area network
CAV ..... Connected and automated vehicle
CHP..... California Highway Patrol
C-ITS ..... Cooperative intelligent transportation system
CMV..... Commercial motor vehicle
ConOps ..... Concept of Operations
COTS..... Commercial off-the-shelf
CPA..... Comptroller of Public Accounts
CSHA..... California State Highway Account
CST..... Central Standard Time
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
DSRC..... Dedicated short-range communications
EB ..... Eastbound
EDI..... Electronic data interchange
ELD ..... Electronic logging device
EMS ..... Emergency medical services
FAF ..... Freight Analysis Framework
FAST Act ..... 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
HOS ..... Hours of service
HPMS..... Highway Performance Monitoring System
HURF ..... Highway User Revenue Fund
I-10 ..... Interstate 10
ICM ..... Integrated corridor management
ITS..... Intelligent transportation system
LiDAR ..... Light Detection and Ranging System
MAASTO ..... Mid America Association of State Transportation Officials
MAP-21 ..... Moving Ahead for Progress in the 21st Century
MARAD..... Maritime Administration
MDOT ..... Michigan Department of Transportation
MDT..... Mountain Daylight Time
MPO ..... Metropolitan planning organization
MST ..... Mountain Standard Time
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
OS/OW ..... Oversize/overweight
PATH..... Partners for Advanced Transit and Highways
PDT ..... Pacific Daylight Time
POE ..... Port of entry
PST..... Pacific Standard Time
RFID ..... Radio-frequency identification device
RFTA ..... Revenue and Fuel Tax Administration
SCMS ..... Security Credentialing and Monitoring System
SHA..... State Highway Administration (Maryland)
SHF ..... State Highway Fund
SI..... Systems integrator
SRF..... State Road Fund
SRI ..... Smart Roadside Initiative
TAC ..... Technical Advisory Committee
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
WASHTO..... Western Association of State Highway and Transportation Officials
WB..... Westbound
WIM ..... Weigh-in-motion
WRI..... Wireless roadside inspection

CHAPTER 1. INTRODUCTION

RESEARCH NEED

The purpose of this project was to identify strategies for supporting future connected vehicle operations along the Interstate 10 (I-10) freight corridor running from California ports to Texas ports—through the states of California, Arizona, New Mexico, and Texas. This effort was the first step in realizing an integrated corridor management system for commercial vehicle operations moving along I-10 from the Ports of Long Beach and Los Angeles to the Ports of Houston and Beaumont and all points between.

For the state departments of transportation (DOTs) in California, Arizona, New Mexico, and Texas, the overall goal for an I-10 western connected freight corridor is to enhance safe and efficient freight movement by integrating existing corridor infrastructure through institutional and stakeholder collaboration. By identifying strategies for supporting a connected freight corridor, this project creates a framework for future improvements in technology, governmental policies, and procedures intended to help shippers and carriers thrive by doing business along the I-10 corridor. The pursuit of this enhanced freight corridor led the four state DOTs to collectively execute an Organizational Charter for the I-10 Corridor Coalition in June 2016. This project is the first cooperative action undertaken by the I-10 Corridor Coalition.

The four DOTs recognized that state laws related to commercial motor vehicles, such as those determining how closely commercial vehicles may follow each other (which can affect vehicle convoys), vary from state to state. Some states may have laws that address truck platoons, mandate specific lanes for commercial vehicle operations, or designate hours or routes for commercial vehicles, in addition to other laws that add impediments to the movement of freight along the I-10 corridor. The issue of coordinating operations with existing—and possibly conflicting—state laws needed to be explored and addressed. This project's objectives included harmonizing transportation standards across state lines and facilitating successful deployment of technologies and applications for commercial vehicle movement along the corridor.

Research Context

Freight demand is expected to increase nationwide by 42 percent by 2040 (USDOT 2015a). Projections for the four states in the 1-10 western connected freight corridor predict an average 110 percent increase in freight by value for all four states by 2045 (FHWA 2015a). Therefore, improving freight movement was an important motivation for this project.

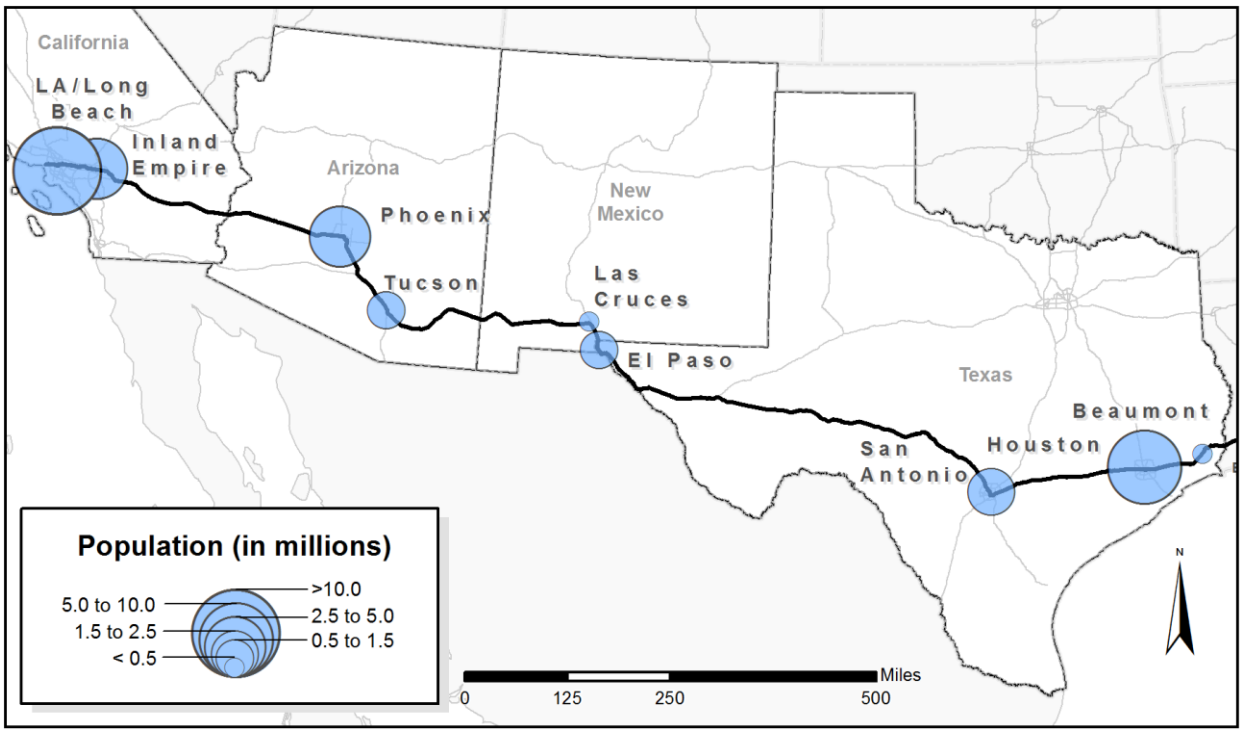
Even as freight volumes along I-10 and other corridors are expected to grow, the freight industry has been rapidly changing as information and communications technologies transform freight vehicles; logistics relationships among carriers, shippers, and intermediaries; distribution networks; and supply chains. The draft National Strategic Freight Plan (USDOT 2015b) identified these three major trends in freight technology:

- The use of enhanced logistics management systems to analyze demand and quickly adjust supply chains
- Advances in automated vehicle, aircraft, and terminal technologies that could transform the freight industry
- Technological advances that will lead to continued improvements in safety, emission reductions, and productivity

"Automated vehicles" is a shorthand term for vehicles equipped with an array of onboard technologies—sensors, cameras, and vehicle controls (for acceleration, steering, or braking)—that constantly assess the driving environment and make real-time adjustments, allowing degrees of vehicle control to automatically bypass the driver and be assumed by the vehicle. "Connected vehicles" refers to vehicles equipped with technologies to transmit and receive information to and from other vehicles, roadway infrastructure, and other objects (such as pedestrians or activated highway rail grade crossing devices). The transmitted data provide each connected vehicle with more relevant detail about the driving environment and informs programmed vehicle adjustments. These vehicle technologies have been developed and tested for trucks, in automated operations (such as adaptive cruise control and lane departure warnings), fully autonomous operations (such as driverless cabs), and connected operations (such as truck platooning, where a convoy's lead vehicle controls the spacing, acceleration, braking, and steering of the following trucks). These advances offer multiple benefits; truck platooning, for instance, allows for tighter following distances that improve aerodynamics and reduce fuel consumption.

The US Department of Transportation (USDOT) led research efforts to explore technologies that could advance the use of automated and connected vehicles for passengers and freight. This federal research in highly automated vehicles (i.e., automated and connected vehicles) falls within the federal jurisdiction of setting vehicle-based standards (such as size and weight, design and materials, and fuel and emissions). State governments have been generally responsible for establishing laws related to vehicle operations (including registration and taxes, traffic laws, driver education, and law enforcement). States have entered into compacts and agreements that offer uniform regulatory treatment of interstate trucking for fuel taxes, vehicle registration, and motor carrier safety standards; however, a number of state-specific laws have created hurdles for interstate motor carriers, particularly those with specialized equipment for oversize and overweight shipments. Some of these laws could also impede long-distance testing of truck automation and truck platooning. This project establishes a process for reviewing a range of programs and technologies that can enable higher volumes of freight and increase truck autonomy and connectivity.

The four state DOTs in this project have also been motivated by the role I-10 plays in the economic connections among these four states (described further in Chapter 2) Figure 1 indicates the study section of I-10 and the associated major metropolitan areas.

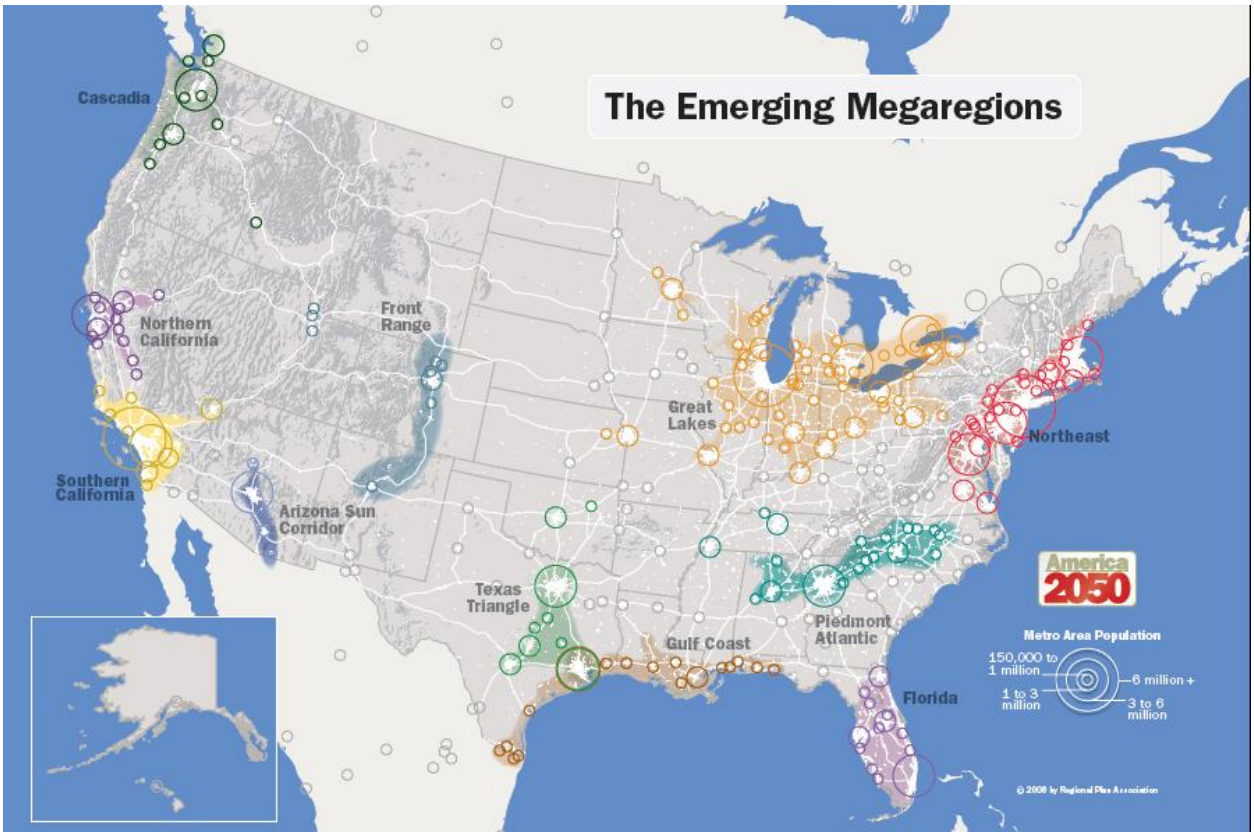


Source: TTI (Metropolitan Statistical Area Population from the US Census Bureau)

Figure 1. I-10 Western Connected Freight Corridor

I-10 connects the Ports of Los Angeles and Long Beach, the nation's busiest container ports, and Port Houston, the nation's second-biggest port in terms of tons of cargo. I-10 also connects four economic "megaregions"—Southern California, Arizona Sun Corridor, Texas Triangle, and Gulf Coast (Figure 2)—related by the following commonalities:

- Environmental systems and topography
- Infrastructure systems
- Economic linkages
- Settlement patterns and land use
- Shared culture and history (Regional Plan Association 2016)



Source: Regional Plan Association 2016

Figure 2. Map of National Megaregions

Project Execution

The DOTs pooled their state transportation planning resources for this project using the Transportation Pooled Fund program administered by the Federal Highway Administration (FHWA 2004).

PROJECT PROCESS AND METHODOLOGY

At its highest level, this effort can be defined by the following attributes:

- User oriented, describing systems' operational characteristics from the end-user viewpoint
- Developed at the enterprise (or organizational/agency) level, independent of specific solutions or programs
- A foundation for multiple operational concept documents, to be prepared at the acquisition and developer level (when a solution is ready to be procured or designed), that describe how systems would be defined to satisfy user needs
- Based on accepted practices
- Accessible for the broader community of I-10 stakeholders and users

For freight stakeholders along the I-10 corridor, the prospect of a connected freight corridor could involve a number of individual technologies, information systems, or operational programs to improve freight movement and efficiency. Before beginning to implement any given solution, the DOTs in this project decided that an important first step was to determine stakeholder interests, stakeholder needs, possible solutions to those needs, and barriers to implementation of those solutions, and to develop a framework for developing and integrating freight solutions along the corridor.

Volume 1 connects user needs with technical specifications, so that the Coalition partners can guide the development and deployment of a high-priority connected freight corridor running from the Port of Los Angeles to the Port of Beaumont. It documents system concepts, operational scenarios, and the rationale behind key decisions affecting its design and deployment. It has been developed to incorporate the USDOT's Connected Vehicle Reference Implementation Architecture (CVRIA), the department's framework for the integration and standardization of connected vehicle technologies (and incorporated into the USDOT National ITS Architecture, the framework for all intelligent transportation systems) (USDOT 2015a).

The process began with an inventory of the I-10 corridor itself—its existing freight related facilities, operational conditions and characteristics, current intelligent transportation system (ITS) assets and operational programs, and other freight mobility attributes. This information was captured in corridor-level geographic information systems (GIS) for future steps in the process. Freight stakeholders along the corridor were identified for communication and coordination purposes.

As the inventory was being collected and managed, the process continued with a thorough review of published sources for the latest technologies, innovations, and successful practices in developing common systems 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. The results of this information review and the corridor inventory are discussed in Chapter 2.

With this information on the existing corridor conditions and possible solutions to improve freight movement in the corridor, the process sought stakeholder input to identify critical user needs and issues associated with deploying connected freight operations and other solutions. Stakeholders confirmed the kinds of freight systems and solutions that would most directly address their mobility needs. The results of this needs assessment are described in Chapter 3.

These user needs generated initial concepts and operational scenarios, a series of operational concepts and descriptive use cases that defined how public- and private-sector stakeholders could experience and achieve benefits from implementing the concept. The development and evaluation of these operational-concepts use cases is detailed in Chapter 4. These operational-concepts use cases were assessed and evaluated by a User Advisory Group of freight stakeholders, tested for implementation issues and opportunities, and finally ranked by the DOT representatives of the states participating in the pooled

fund. That ranking determined the final operational concepts detailed in in Chapter 5 and in Volume 2: Planning Framework.

CHAPTER 2. INTERSTATE 10 TODAY

This chapter not only describes 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. It covers the current state of the interstate highway corridor, the current state of freight applications, and potential improvements to freight operations within the corridor. This information provides a foundation for the development of strategies and a basis for gathering views and inputs from stakeholders (discussed in Chapter 3). This chapter covers two major components related to the corridor study process: (1) an inventory of the corridor's condition and capabilities, and (2) a survey of available information regarding freight technologies and operational improvements that might be applied in the corridor.

CORRIDOR INVENTORY

The I-10 western connected freight corridor was assessed for a broad spectrum of elements that are essential to efficient freight mobility. The corridor's freight handling/transport capabilities and deficiencies were characterized through cataloging and assessing transportation facilities along the corridor; documenting existing operational conditions and characteristics; cataloging network transportation management and ITS assets; detailing corridor institutional characteristics; and documenting any other essential assets and/or elements that may contribute to freight mobility.

Freight Corridor Inventory

The inventory of the I-10 corridor focused on documenting the corridor's freight-related infrastructure, transportation management assets, and operational conditions. This information was compiled into a GIS database with geolocation features and was 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 the corridor's ability to contribute to freight mobility. It also identified 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. 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. The database is in a GIS shapefile format compatible with ADOT databases

Organization of the Database

The GIS database consists of several geospatial data layers that describe the attributes defining the six inventory categories listed above. Geospatial data layers are geographically referenced databases; in other words, geospatial data layers relate data items to their specific locations. Figure 3 shows how the database is organized. The six inventory categories are defined by a set of attributes (such as the number of lanes) 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 entities in the database. The categories, attributes, data layers, and data items are listed in an inventory log.

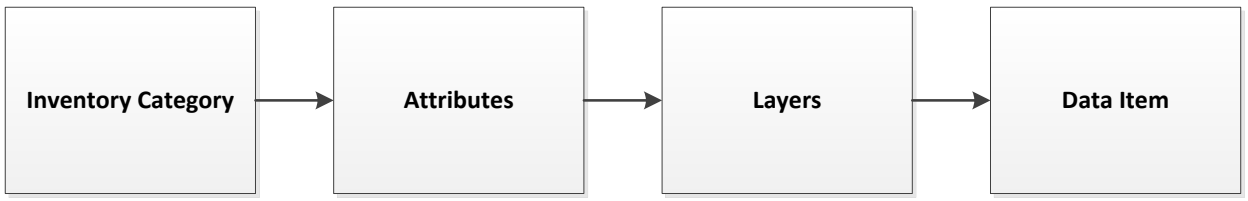


Figure 3. Database Organization

Table 1 lists the database categories, attributes, and sources of information. The sections that follow describe inventory categories, attributes, layers, and data items in more detail.

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

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

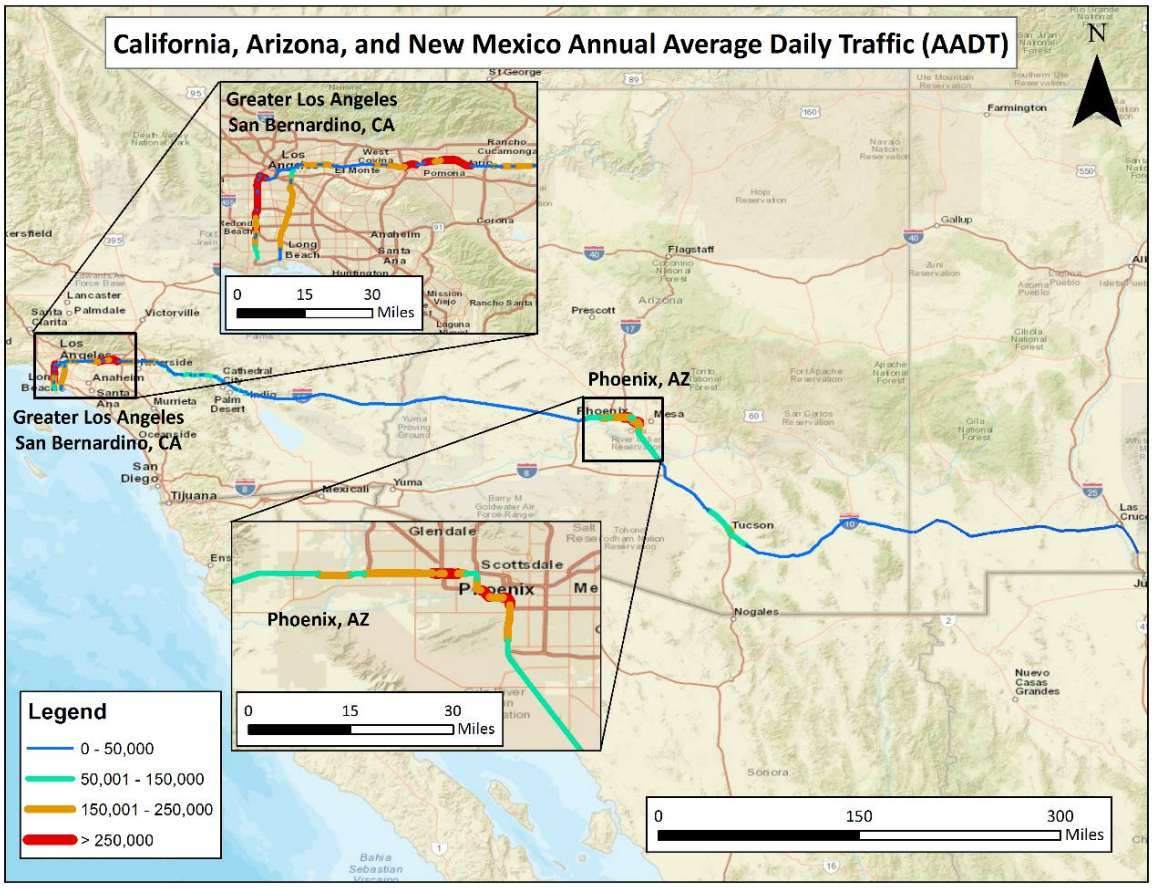
Corridor Inventory Analysis

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, including truck parking and safety enforcement facilities, interact with freight travelers

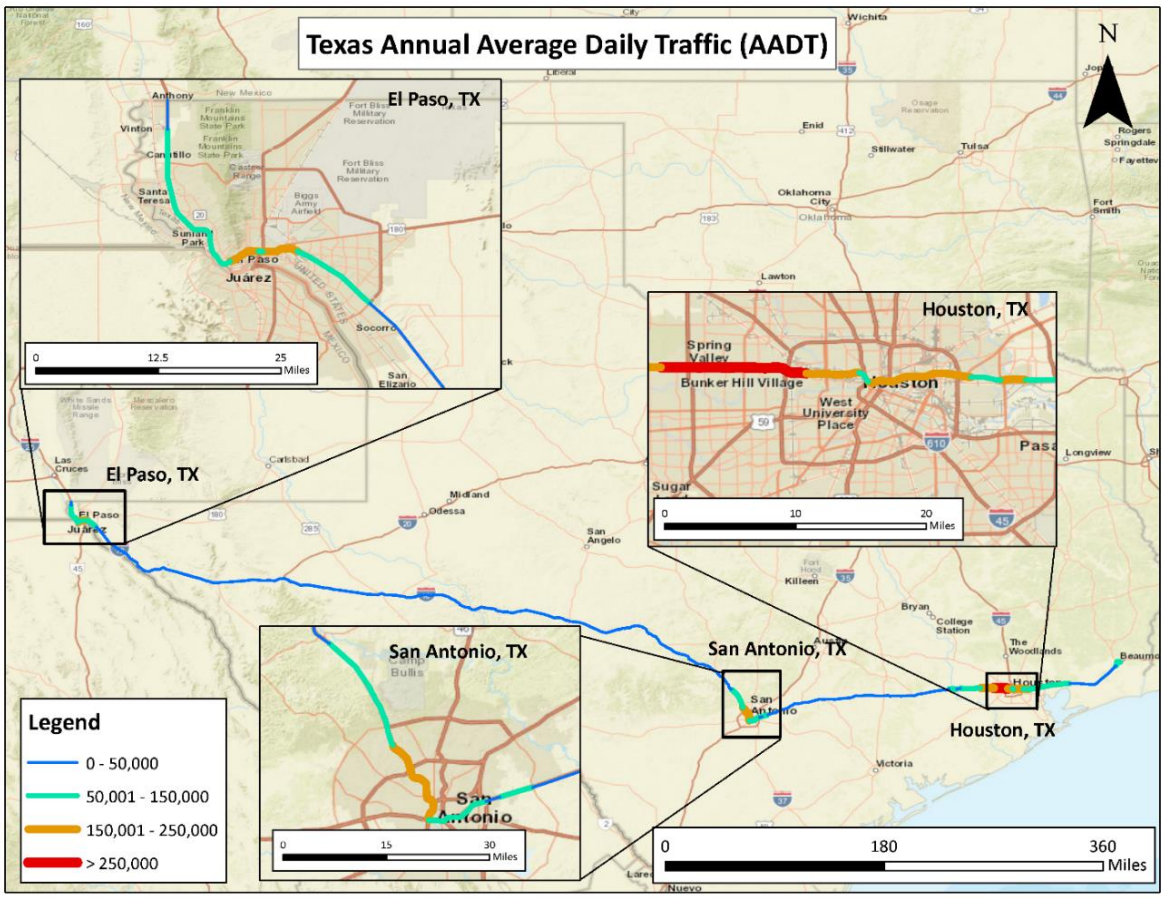
Corridor User Functionality

Figure 4 and Figure 5 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. On much of I-10, traffic volumes are modest, but in urban areas, total traffic increases with urban commuting and regional freight traffic.



Source: GIS Database Mapped by Project Team

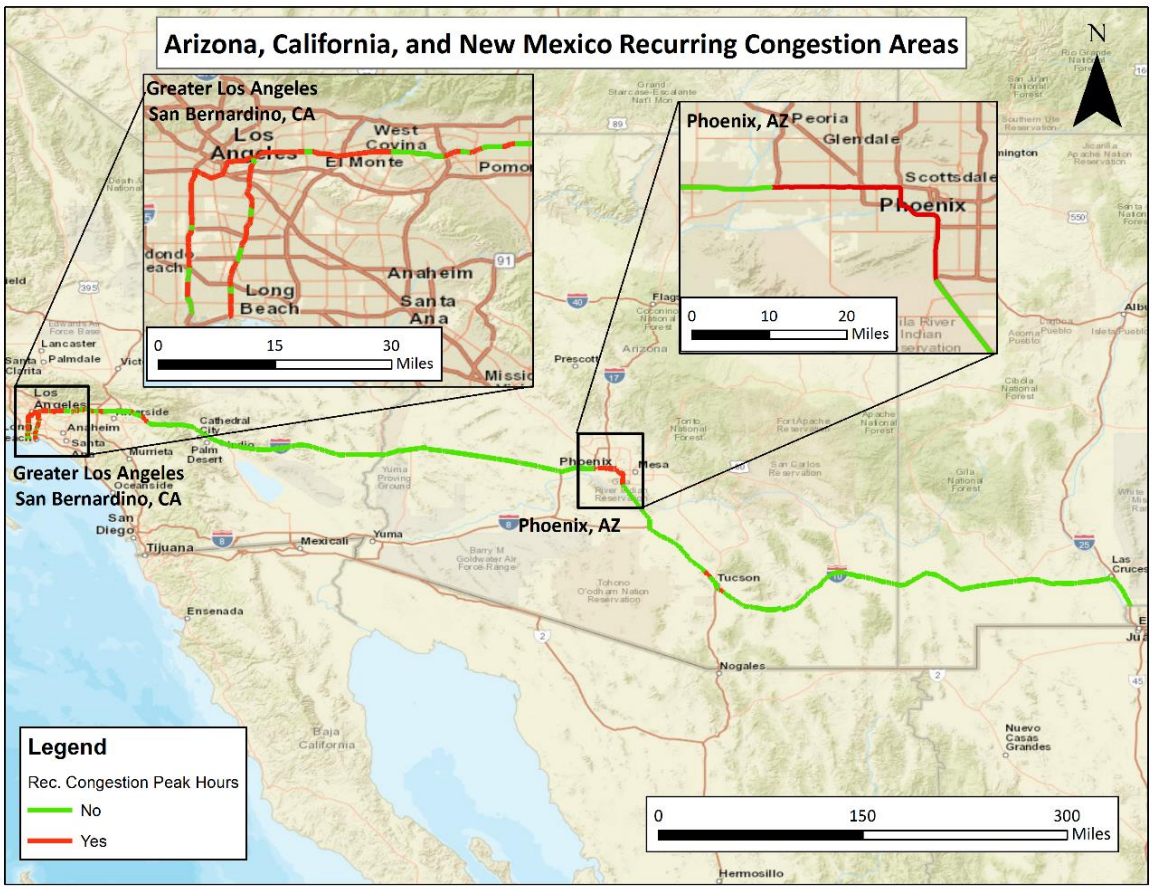
Figure 4. Annual Average Daily Traffic Along I-10 in California, Arizona, and New Mexico



Source: GIS Database Mapped by Project Team

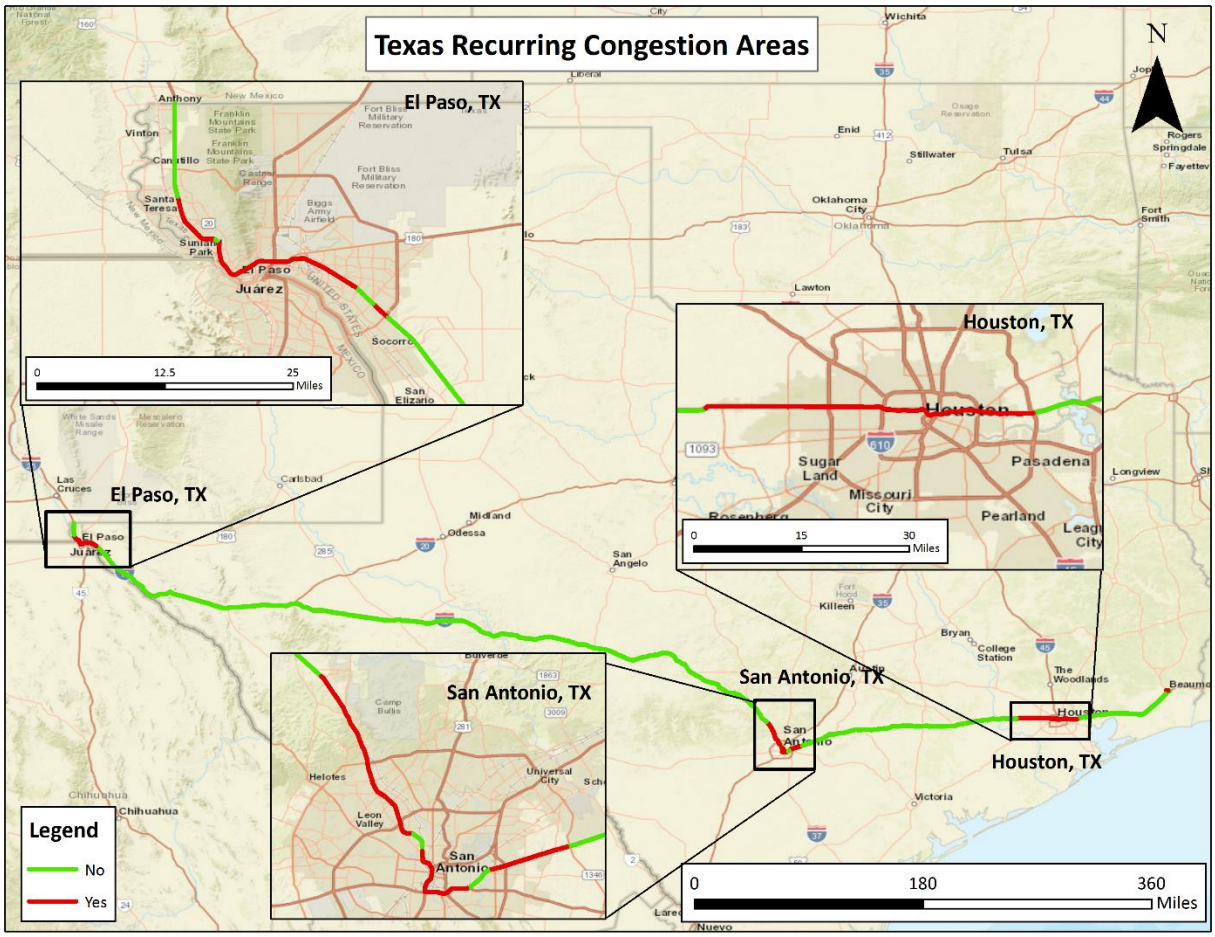
Figure 5. Annual Average Daily Traffic Along I-10 in Texas

Figure 6 and Figure 7 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. and 4:00 p.m. to 7:00 p.m.). Again, overall congestion increases within urban areas, where more freight vehicles are entering and exiting the highway and competing with other local traffic.



Source: GIS Database Mapped by Project Team

Figure 6. I-10 Corridor Congestion During Peak Hours in California, Arizona, and New Mexico



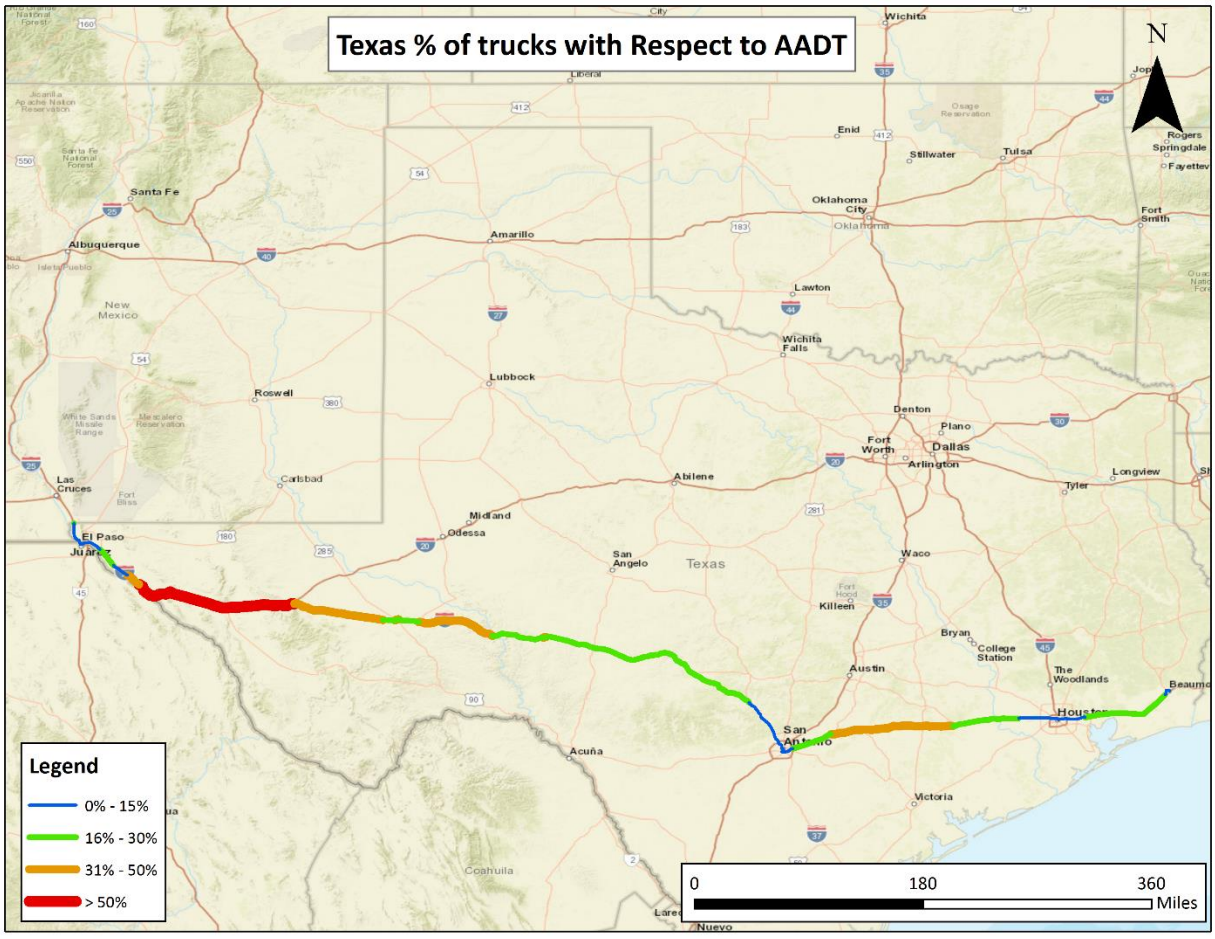
Source: GIS Database Mapped by Project Team

Figure 7. I-10 Corridor Congestion During Peak Hours in Texas

While Figures 6 and 7 indicate relatively lower traffic and congestion in rural segments of I-10, a larger proportion of that traffic consists of trucks. Figure 8 and Figure 9 show the ratio of trucks to overall annual average daily traffic.

Source: GIS Database Mapped by Project Team

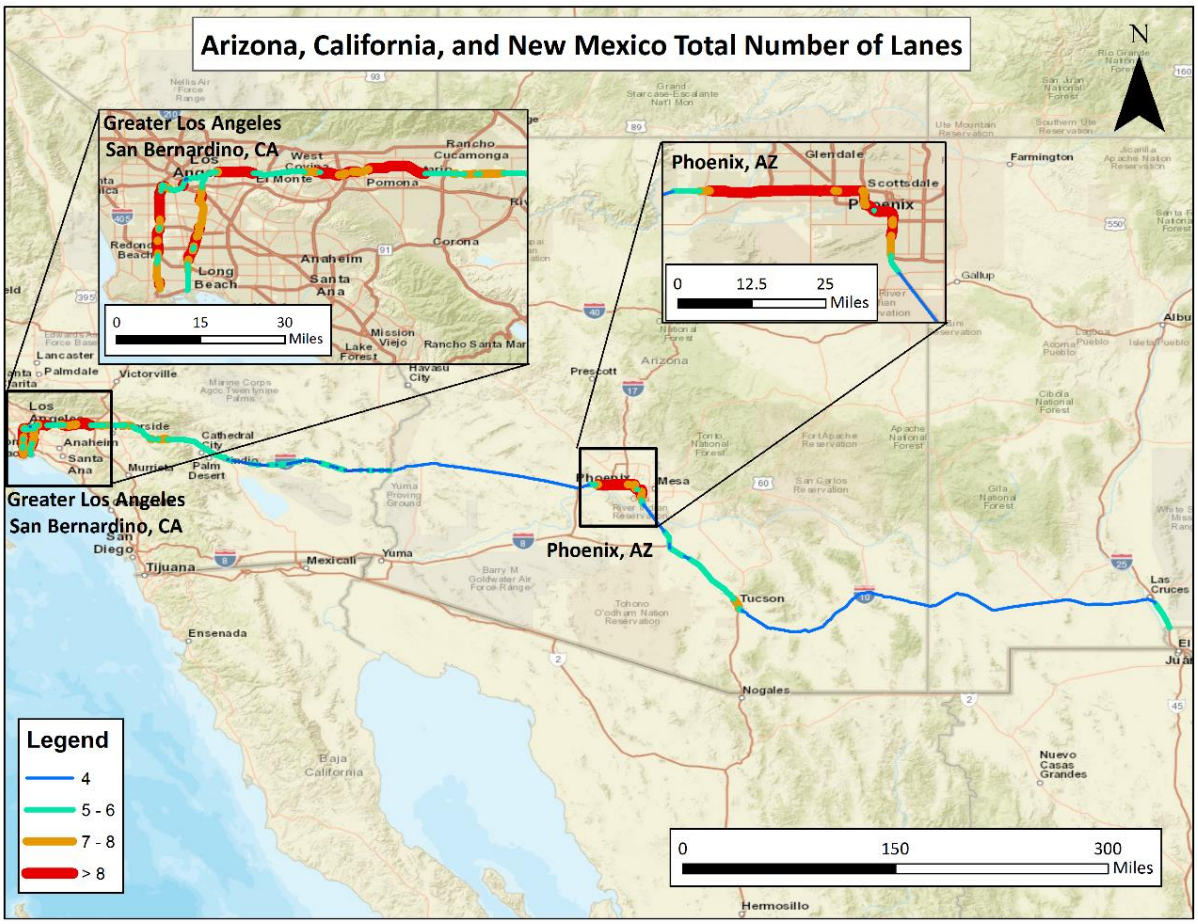
Figure 8. Percentage of Trucks in Overall Annual Average Daily Traffic (AADT) on I-10 in California, Arizona, and New Mexico



Source: GIS Database Mapped by Project Team

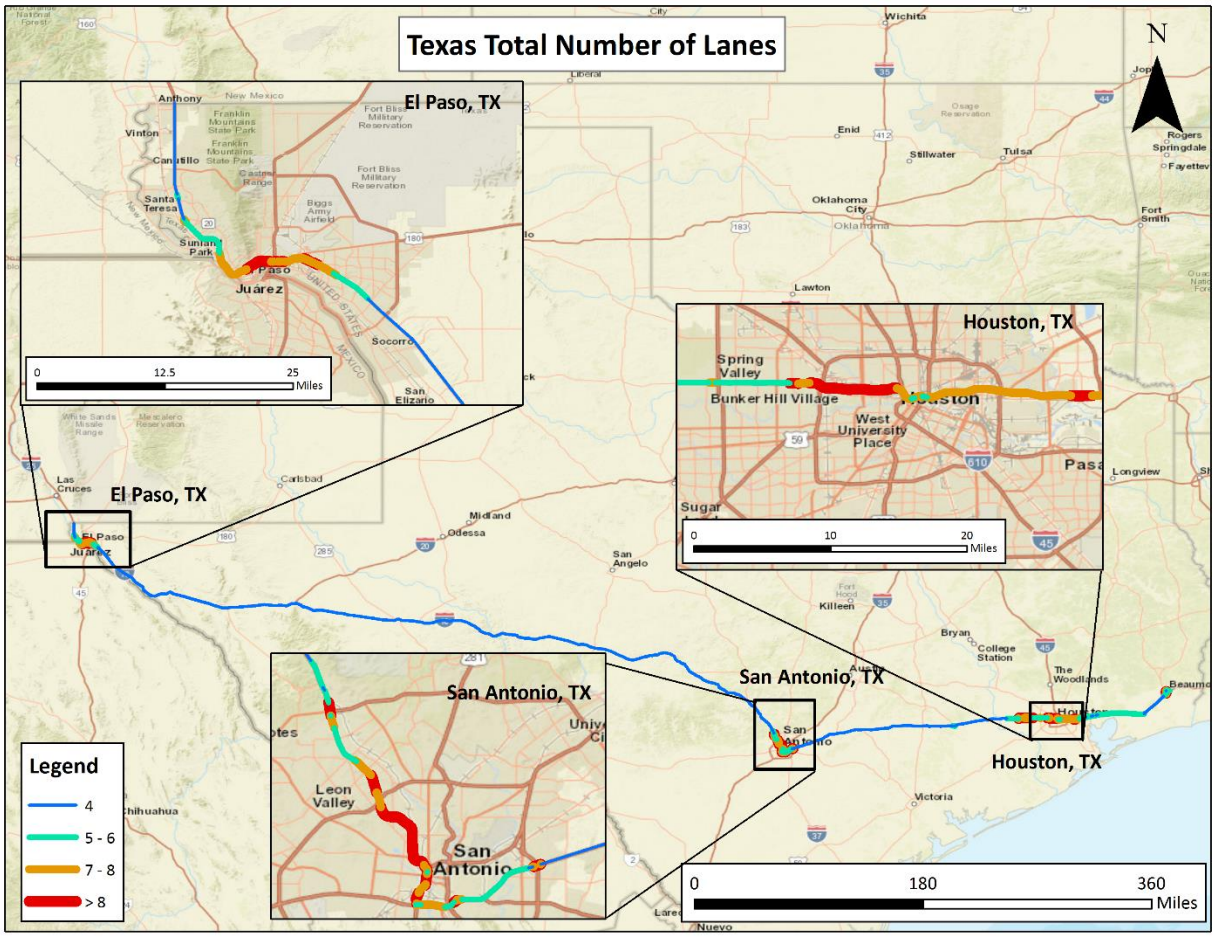
Figure 9. Percentage of Trucks in Overall AADT on I-10 in Texas

Figure 10 and Figure 11 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

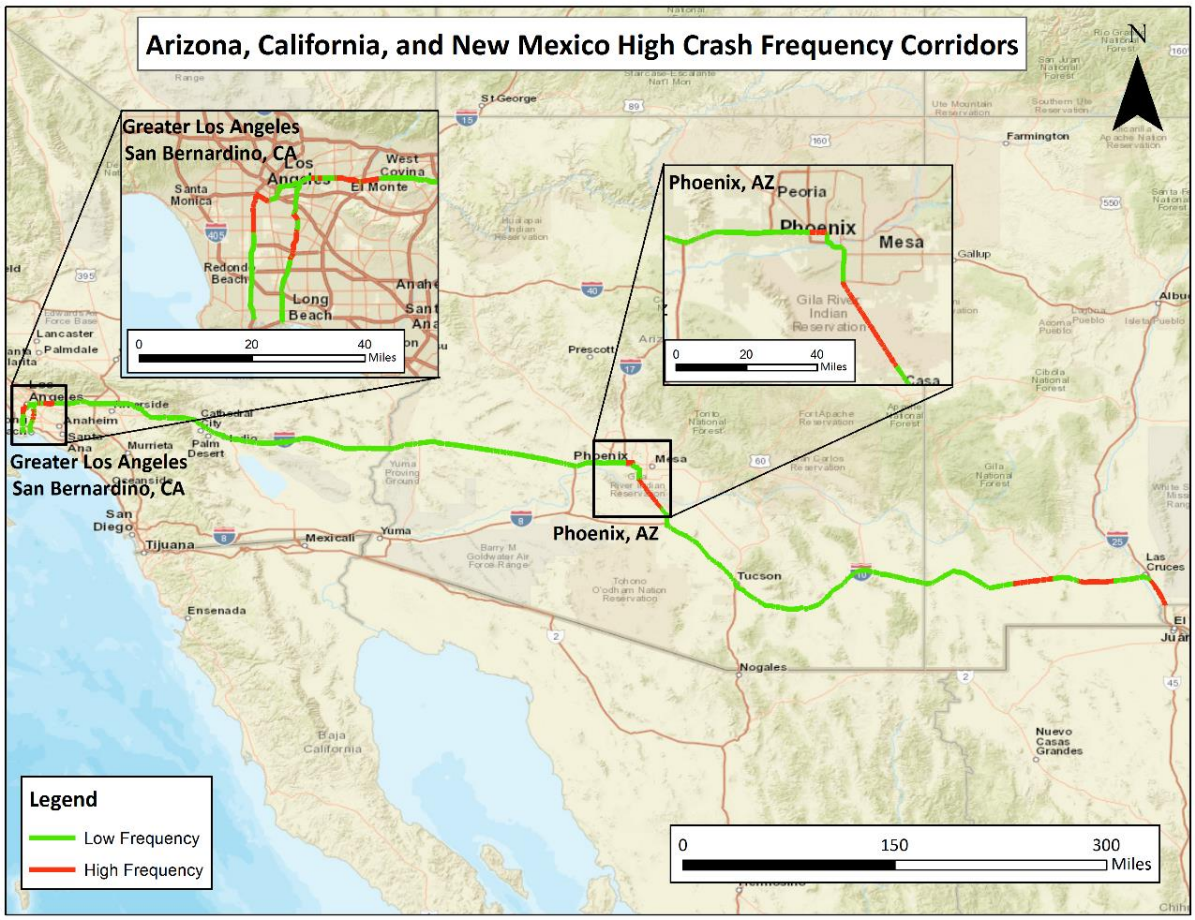
Figure 10. Number of Lanes on I-10 in California, Arizona, and New Mexico



Source: GIS Database Mapped by Project Team

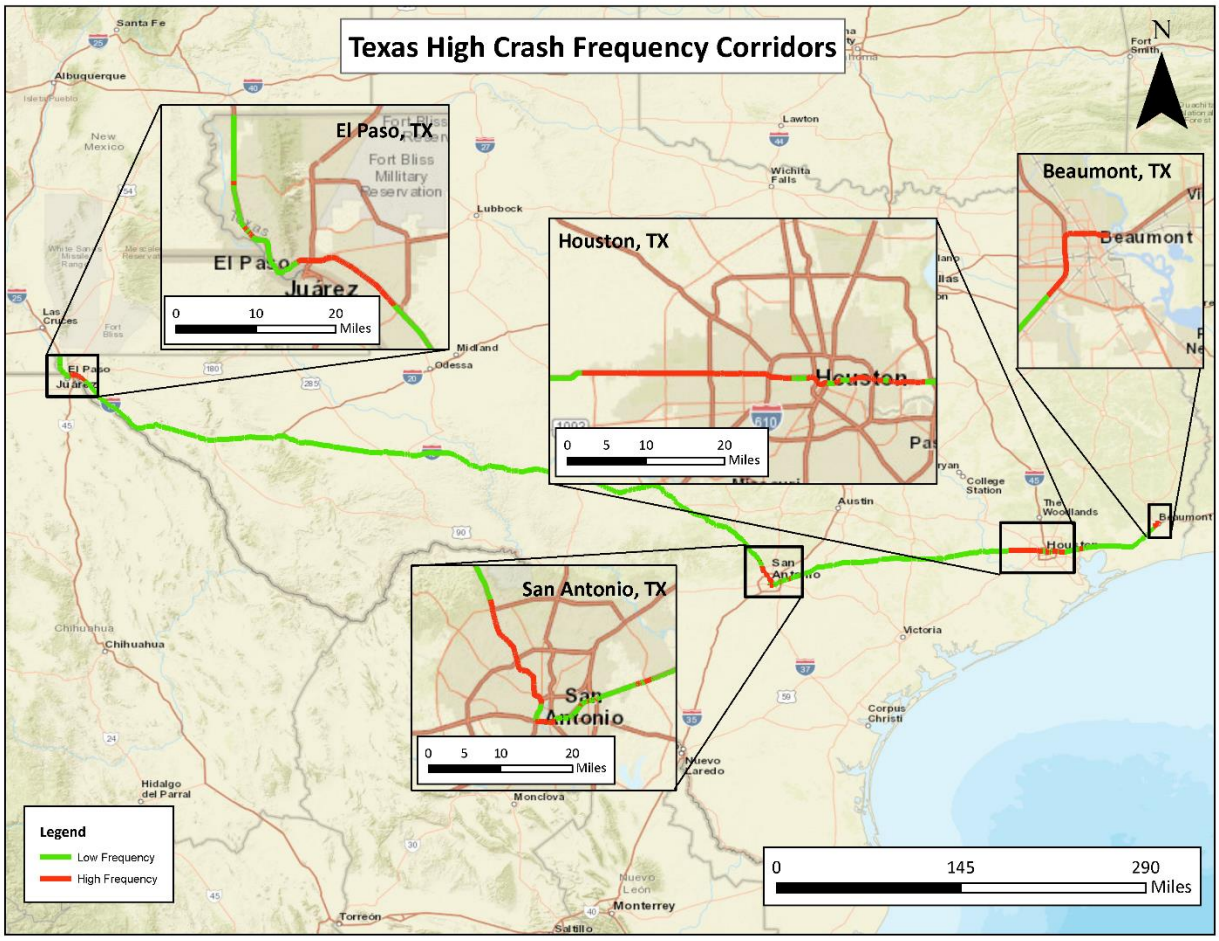
Figure 11. Number of Lanes on I-10 in Texas

Figure 12 and Figure 13 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. (Safety corridors are subject to increased traffic education and enforcement because of the high number of severe crashes in those areas.)



Source: GIS Database Mapped by Project Team

Figure 12. Corridors of High Crash Frequency on I-10 in California, Arizona, and New Mexico



Source: GIS Database Mapped by Project Team

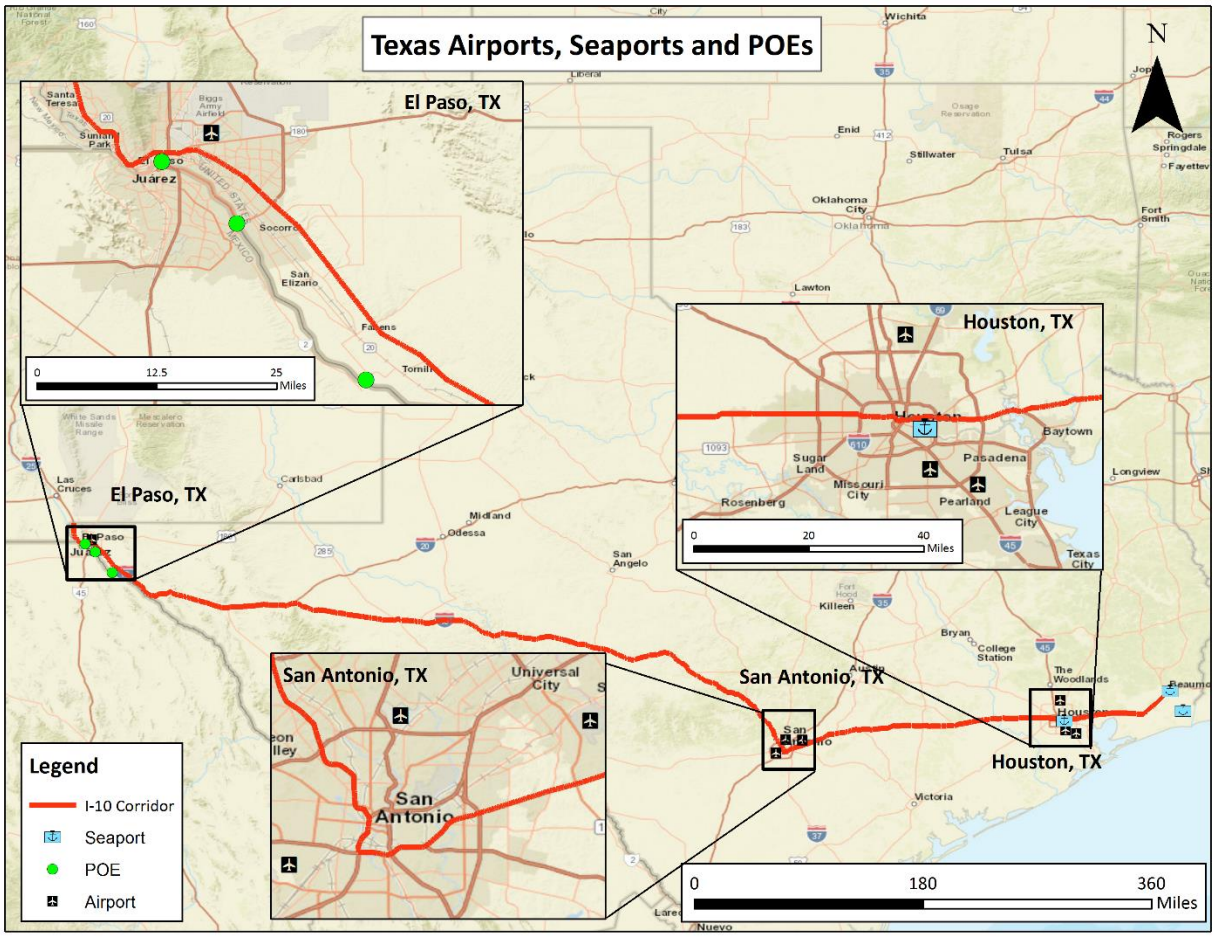
Figure 13. Corridors of High Crash Frequency on I-10 in Texas

Multimodal Freight Generators

Figure 14 and Figure 15 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 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 miles 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

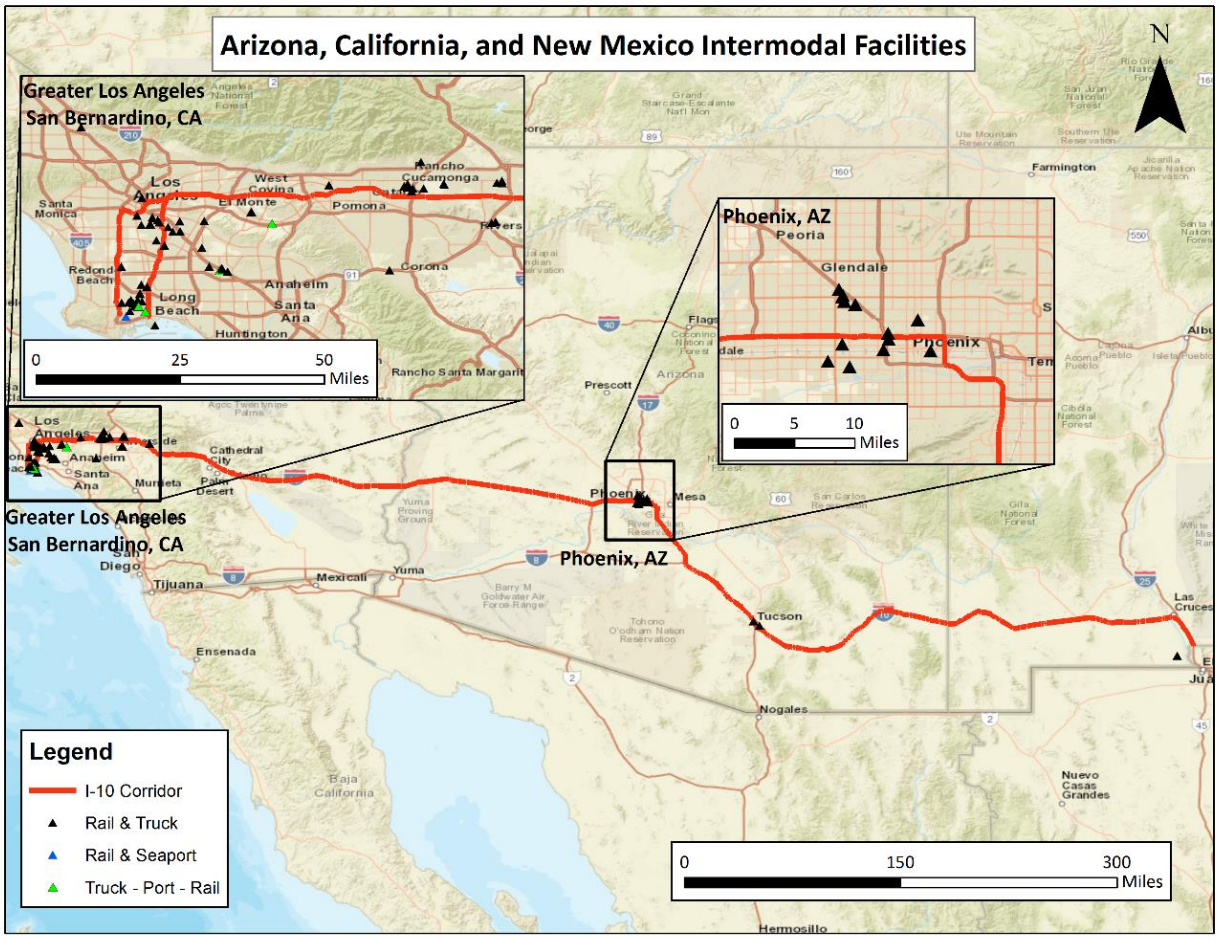
Figure 14. Airports, Seaports, and POEs near I-10 in California, Arizona, and New Mexico



Source: GIS Database Mapped by Project Team

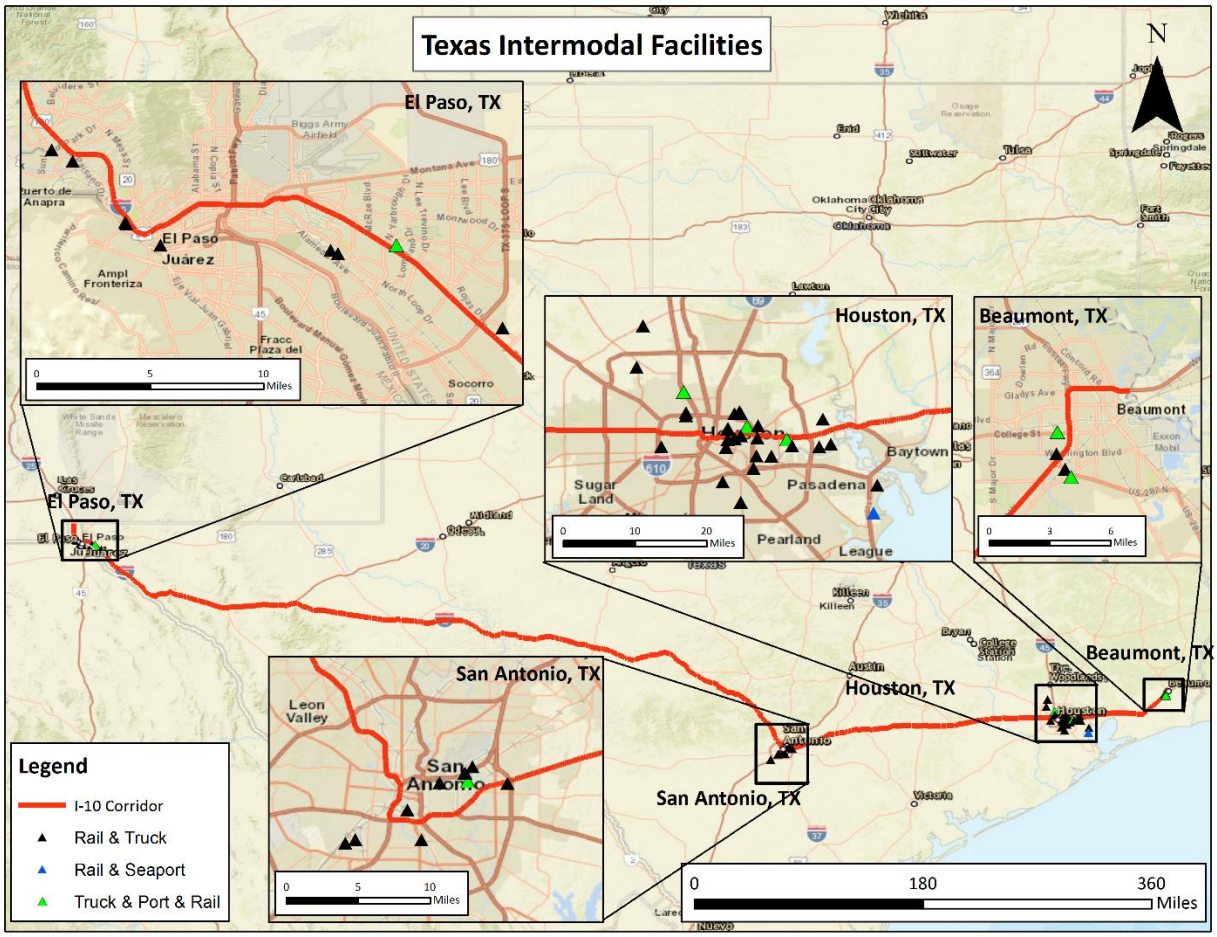
Figure 15. Airports, Seaports, and POEs near I-10 in Texas

Figure 16 and Figure 17 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 within 10 mi of I-10 are included. This database does not include all intermodal facilities, resulting in a gap in the GIS database.



Source: GIS Database Mapped by Project Team

Figure 16. Intermodal Facilities Along I-10 in California, Arizona, and New Mexico

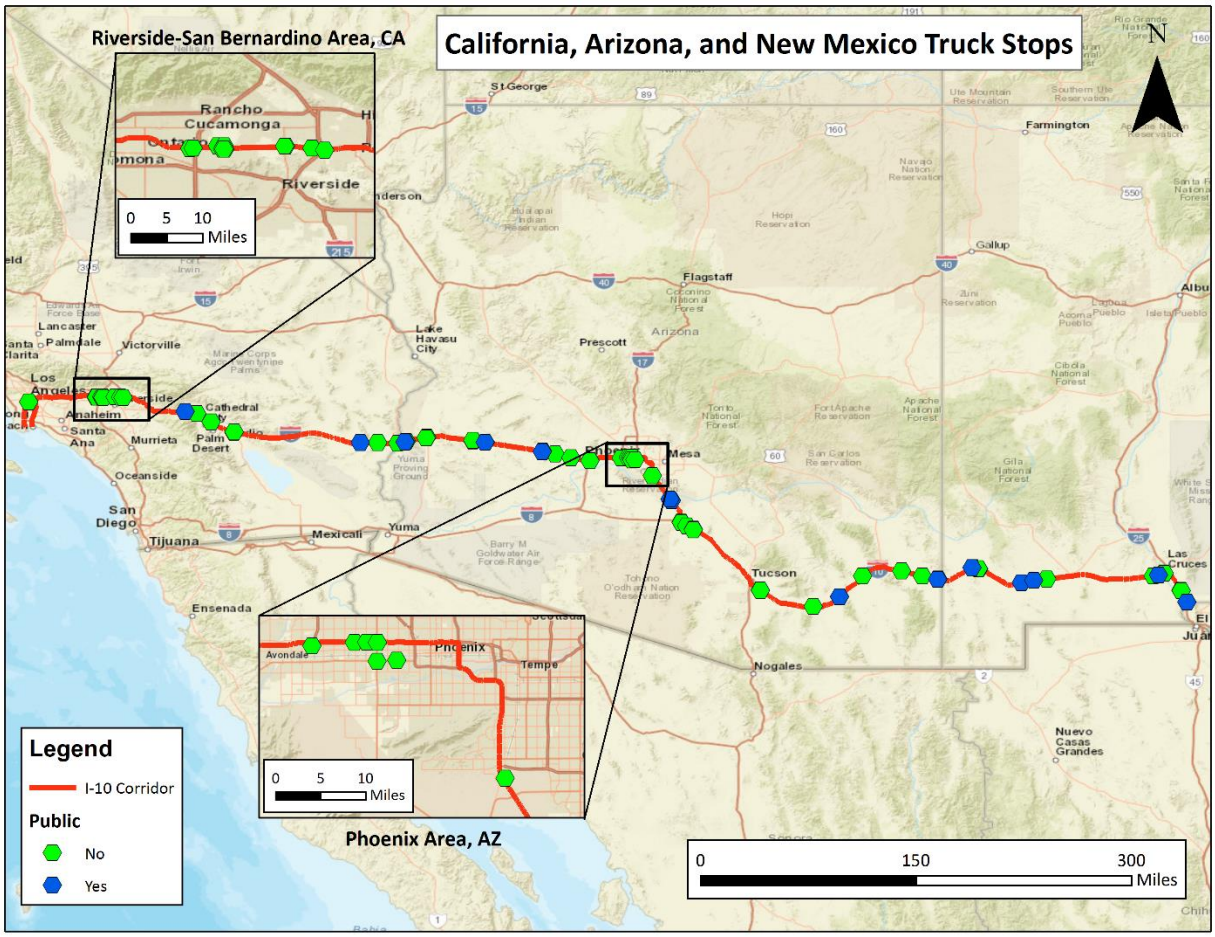


Source: GIS Database Mapped by Project Team

Figure 17. Intermodal Facilities Along I-10 in Texas

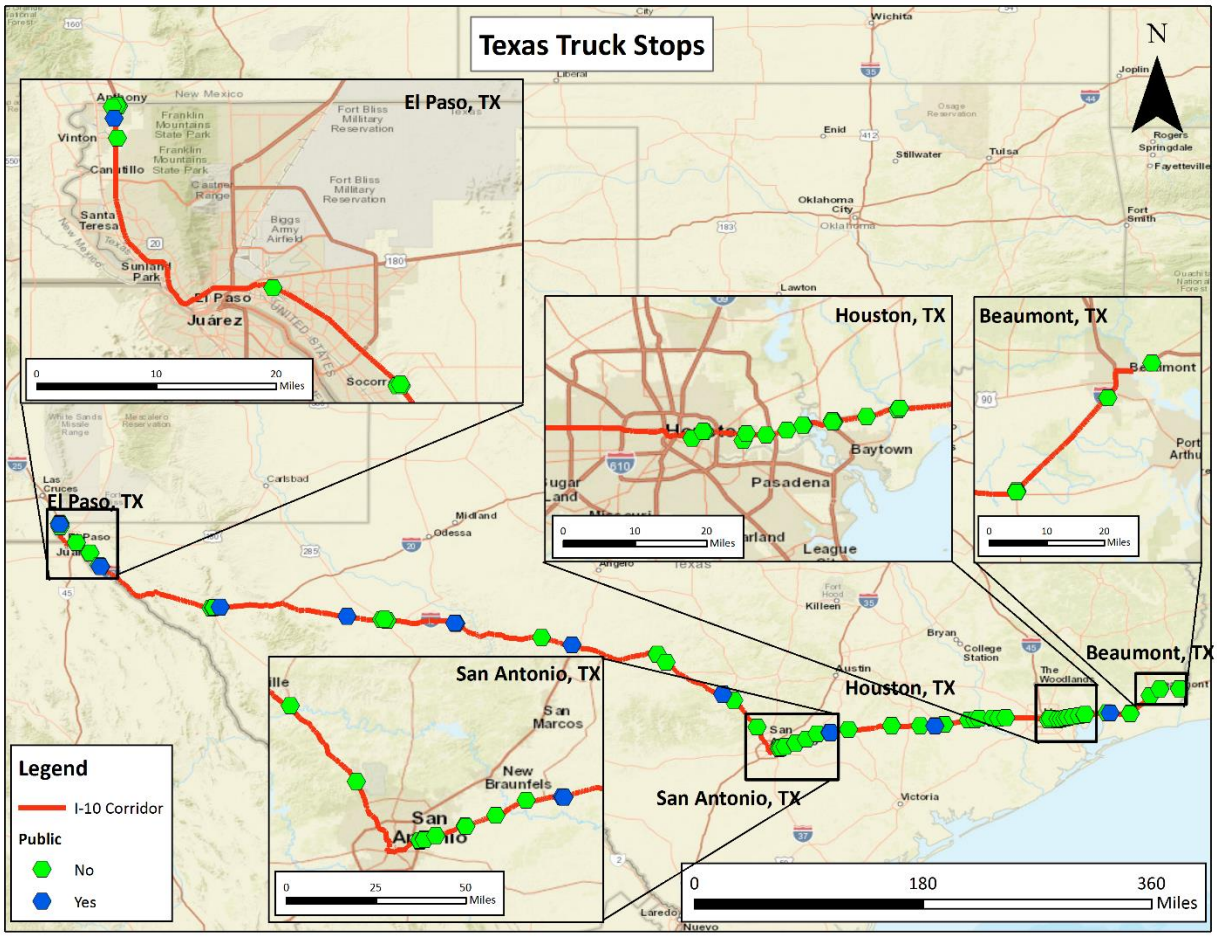
Truck Freight Interaction

Figure 18 and Figure 19 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 at truck stops and rest areas 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 18. Truck Stops and Public Rest Areas Along I-10 in California, Arizona, and New Mexico



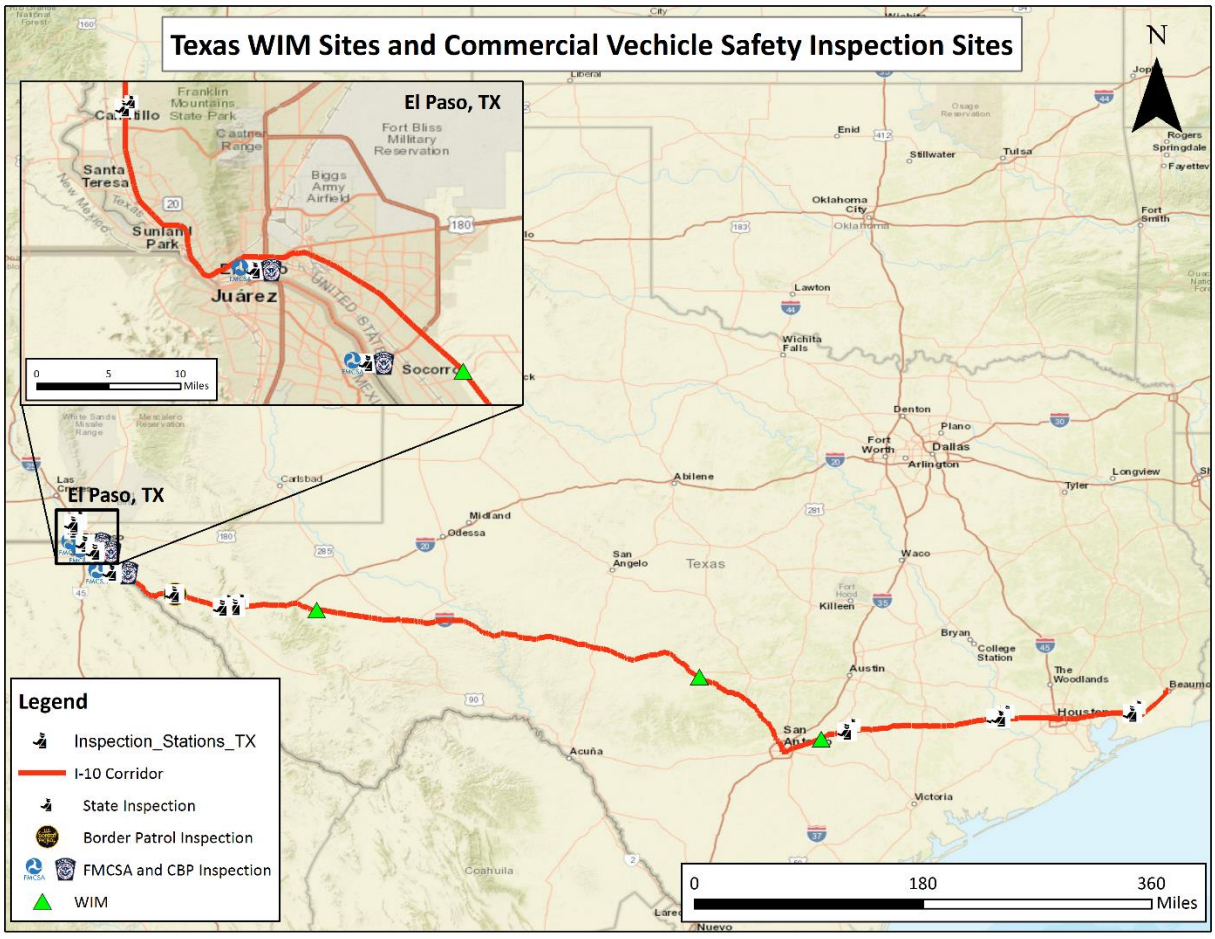
Source: GIS Database Mapped by Project Team

Figure 19. Truck Stops and Public Rest Areas Along I-10 in Texas

Figure 20 and Figure 21 show 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 20. Commercial Motor Vehicle Safety Facilities Along I-10 in California, Arizona, and New Mexico



Source: GIS Database Mapped by Project Team

Figure 21. 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 of the United States and indirectly impacts the national economy by serving as an important gateway to international trade from Asia and Europe by sea, and from Mexico by land. Sustaining these impacts in the 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 freight infrastructure along the corridor, and identify recent analyses 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 in relation to the number of intercity trade corridors connecting to that same metropolitan 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 metropolitan 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 metropolitan areas. Table 4 shows that the metropolitan 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 metropolitan 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, a 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 estimate the revenue generated 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

BOE = Bureau of Equalization 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 California's State Highway Account (CSHA), 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 used for public transit. In addition, local sales taxes imposed by individual counties fund public transit, local roads, and CSHA 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 funding 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 of funds, 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 from 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 based on the weight of trucks and the miles traveled on New Mexico highways. Because the freight traffic volume is highly correlated with economic conditions, the revenue stream from the weight distance tax 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 used 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 the SHF, at 50 percent each. Most of the revenue from the special motor vehicle registration fees is 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 the SHF and TMF 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
	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. The benefits of such a system cannot be fully realized without a significant and continuous investment of resources, not only in the system's 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 in corridor capacity needed 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 a funding shortfall of $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, less than 2 miles 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 highlights the impact of a major corridor's freight mobility on the regional economies.

Corridor Asset and Data Gap Analysis

This section analyzes the gaps among the data collected and the assets inventoried during this project. At this point, no gaps have been found in capabilities, features or functions, policies, or regulations. The gaps revealed in the corridor inventory development process 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 (FHWA 2015b). Coalition states may wish to update the corridor inventory database as soon HPMS versions are updated. 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 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 that drivers can use to access traffic information across the entire corridor via smartphones or tablets.

Freight Corridor Stakeholders

A number of I-10 freight corridor 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.

INFORMATION SEARCH AND SYNTHESIS

In order to characterize 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 USDOT Office of the Assistant Secretary for Research and Technology. Other information is also based on input from stakeholders and DOT representatatives of the states participating in the pooled fund.

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 CV/AV initiatives related specifically to commercial vehicles. Key words and concepts include 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 connected vehicle (CV) research initiative. It 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 in 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

Although truck parking systems were initially developed as safety-related ITS programs under the SRI program, they are discussed in a separate section of this chapter. First, the programs are moving beyond concept design and demonstration into widespread implementation. Second, unlike the other SRI measures, which are focused on public CMV safety agencies, the truck parking measures are 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 would be activated by a signal from a roadside or overhead antenna and would then transmit vehicle-specific information back to the antenna. 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

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 at Mile Marker 160 (westbound only).

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 only New Mexico uses both on I-10.

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 use alternate routes to bypass these sites. Bypassing trucks are thought to represent a subset of the likely size and weight offenders.

Roadside safety inspections are another aspect of enforcement at fixed facilities. Each year, fewer trucks are inspected than 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 conducted in the United States each year, 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 and are less expensive to operate. At least 14 jurisdictions received FMCSA Innovative Technology Deployment grants in fiscal years 2006 to 2008 to deploy VWSs. At the present time, the components of a VWS are not standardized; however, as time goes on, it may become important for a common footprint to be developed (Cambridge Systematics 2009).

States have investigated VWSs to determine their usefulness in deterring illegal CMV operations. The Maryland State Highway Administration (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 effectiveness.
- 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

The FMCSA undertook WRI research 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 intended to support the Commercial Vehicle Safety Alliance (CVSA, an organization of state CMV safety enforcement agencies) in developing a national wireless inspection program.

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

- Phase I—Proof of Concept Test: Testing commercially available off-the-shelf (COTS) or near-COTS technology to validate the concept
- Phase II—Pilot Test: Demonstration of the selected technology capabilities and back-office components
- Phase III—Field Operational Test: 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 purpose of the WRI field operational test 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 the I-10 Corridor Coalition could consider adding enforcement resources to respond to data extracted from truck onboard computer systems.

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 (Capecci 2015)

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-second window, contingent on essential and timely connectivity to credentialing systems.

Other Safety and Enforcement Technologies

Onboard Safety Inspection

Onboard safety inspection uses onboard diagnostics or similar technology to transmit data to roadside devices and send confirmation back to the driver/owner. This technology could report emissions- and/or safety-related data elements from the onboard diagnostics II (OBD-II) parameter IDs to alert regulatory

entities, enforcement personnel, or vehicle owners remotely to 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, may come from the following vehicle diagnostic indicators:

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

Tests of this 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—specifically, the potential for hacking the communications pathway into the vehicle—would have to be researched and mitigated. The study's security portion could be applicable to any future technology (e.g., CV/AV) that sends and receives vehicle information and could be vulnerable to allowing unauthorized access to vehicle controls.

HAZMAT Route Preclearance and En-Route Monitoring

Hazardous material (HAZMAT) cargo that is involved in a crash and is released can cause significant damage to any state department of transportation infrastructure and threaten the public 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.
- 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 or choosing 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 a truck driver killed in his parked truck in 2009), established a system for facilities to provide truck parking as part of the National Highway System (NHS).

The FHWA *Jason's Law Truck Parking Survey Results and Comparative Analysis* (FHWA 2015c), 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 analysis of just the number of truck parking spaces. The VMT and GDP are indicators of truck activity in a particular state or area. These indicators can be used to identify major corridors that carry significant truck traffic and thus 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 through 18

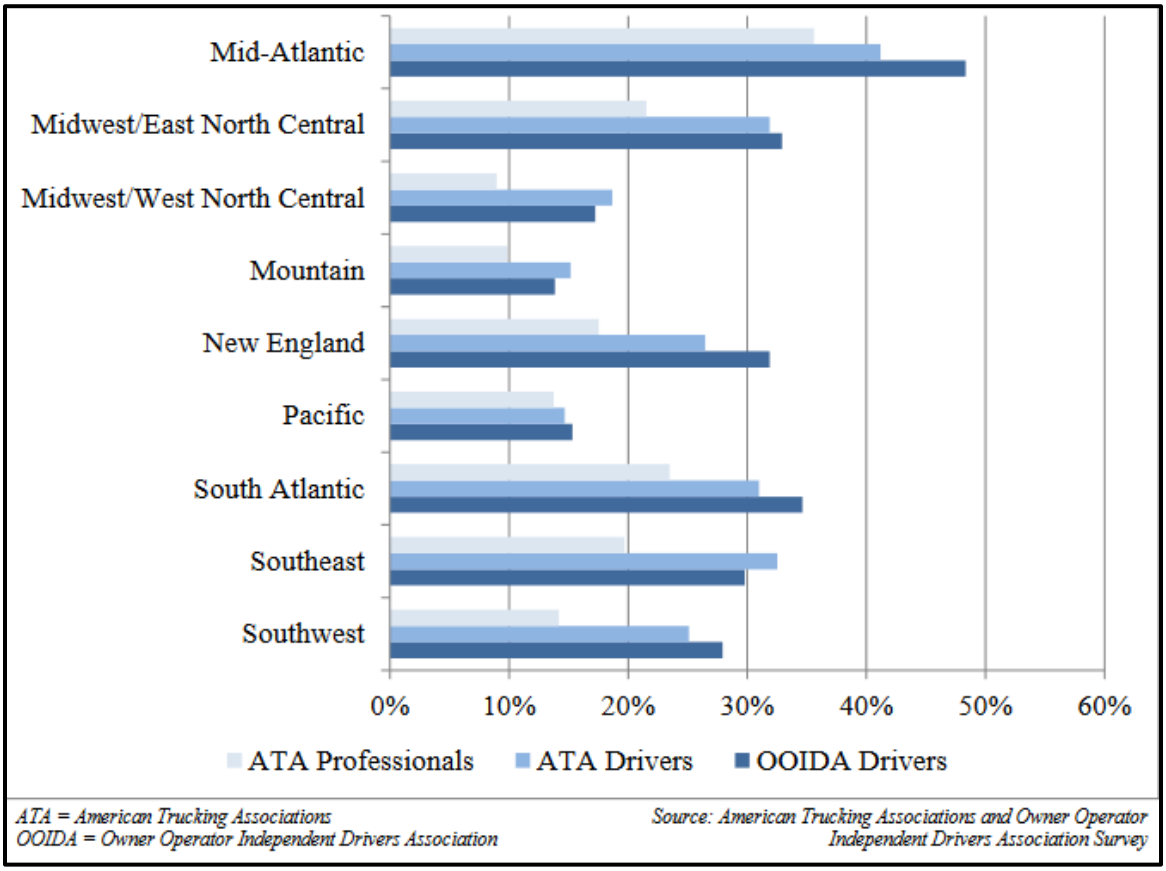
Texas and California reported high numbers of parking but still had shortages at private truck stops. Both states reported fewer spaces along the NHS relative to VMT. Texas and adjacent states (including New Mexico) were among the states with the lowest ratio of spaces to NHS miles; however, Texas is in the top 25 percent of states with spaces relative to GDP.

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).

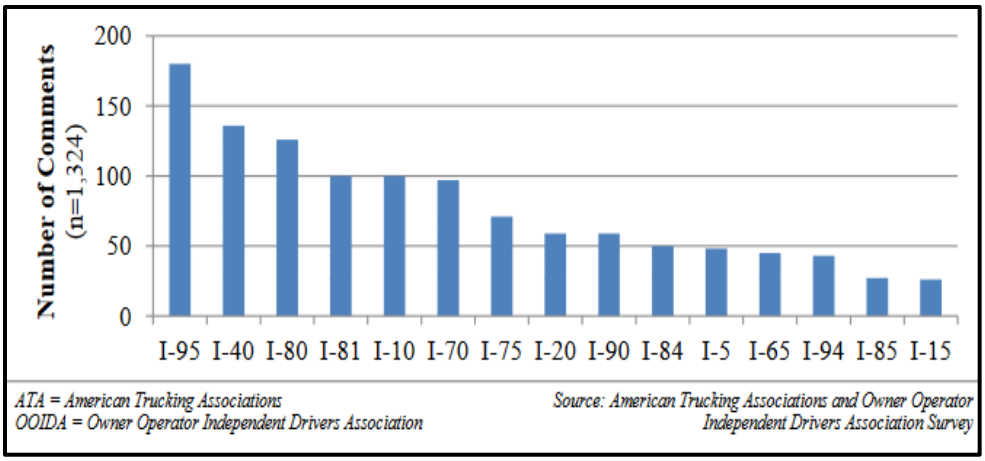
Figure 22 provides the amount of shortages of safe truck parking by country region, according to an ATRI study of truck driver diaries from the American Trucking Associations (ATA), the Owner-Operator Independent Drivers Association (OOIDA), and survey of ATA professionals (Boris and Brewster 2016). 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 2015c), 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 Pacific, Mountain, and Southwest regions were among those with the fewest reported shortages of safe truck

parking according to ATA professionals surveyed, while driver surveys reported that the Southwest region was about average among all other regions (Boris and Brewster 2016). Figure 23 indicates that I-10 is ranked fifth among the 15 worst interstate routes for truck parking noted by drivers and professionals.



Source: Boris and Brewster (2016)

Figure 22. Percentage of Drivers Reporting Shortages of Safe Truck Parking by Region



Source: Boris and Brewster (2016)

Figure 23. Top 15 Interstates with Shortages Reported by OOIDA/ATA Truck Drivers and Professionals

An ATRI 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 truck parking at weigh stations and public works facilities. 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 increase private-sector truck parking capacity.

Truck drivers prefer private truck stops for 10-hour required breaks. Two major truck stop 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, "bobtails" (i.e., tractors traveling without trailers), 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 to park in the car lot could free up space for a full combination vehicle (Boris and Brewster 2016).

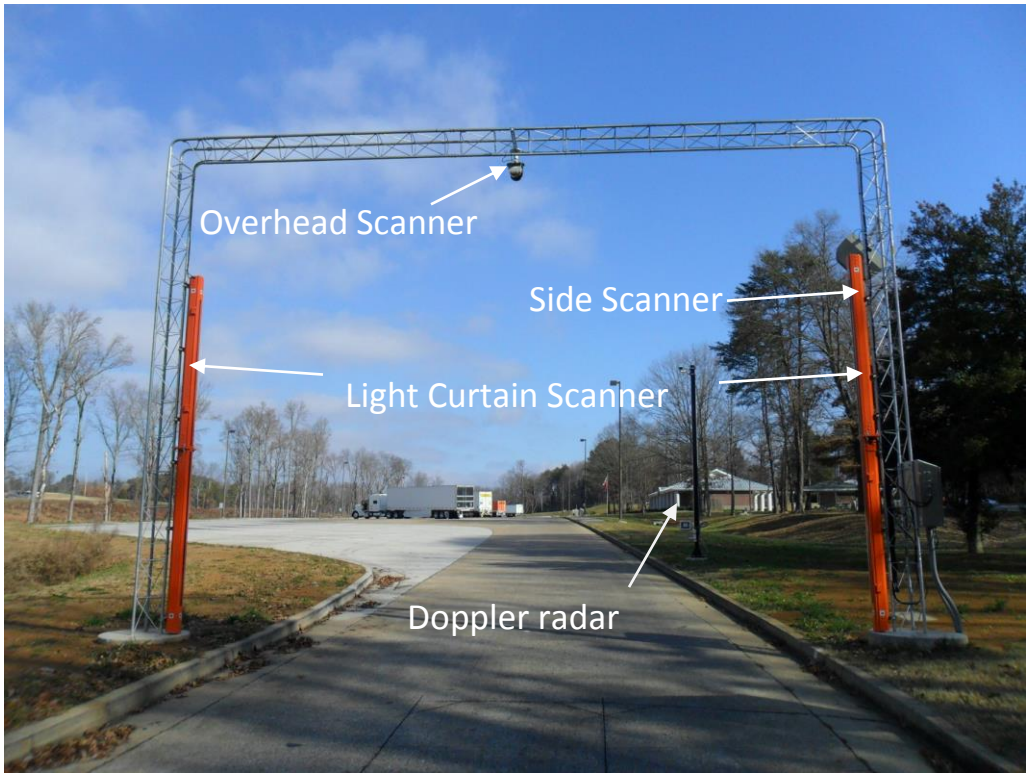
Motor carriers are encouraged to consider carrier-paid reservations, in which carriers pay for reserved parking in advance for their drivers. Shippers are encouraged to offer more flexibility in scheduling appointments for pick-ups and deliveries.

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 determining the availability of parking in a truck rest area (Lopez-Jacobs et al. 2013).

In 2007 and 2009, FMCSA conducted field operational tests 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 24 shows the successful detection setup (O'Connell 2014).



Source: O'Connell (2014)

Figure 24. Technology Setup at the I-75 Test Site Ingress

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, sponsored by the Maryland SHA, University of Maryland researchers investigated the use of wireless magnetometers for monitoring car parking spaces and truck parking spaces. A pilot deployment at 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, at about the one-third points within each space. They collected data over a year, with 1239 detection events (i.e., an arrival or departure in the monitored parking space).

Results using a video camera for ground truth, and recording images at 1-minute 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 in making 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 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.

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 whether 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 available parking 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 the system 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. Mulero (2016) 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.

MULTIMODAL FREIGHT CONSIDERATIONS

Introduction

Both public and private programs to make multimodal freight operations more efficient have been established. The following subsection describes other investigations of innovative and automated freight systems.

Relevant Multimodal Research

The results of a literature search related to the use of technology in intermodal and multimodal freight are summarized in this subsection. The search included technology that was not necessarily designed to apply to interstate corridors, but that 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 inflexible 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. The emphasis of D-CS on trucks is a salient feature that makes it unique among 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

The *Signal Timing Manual* covers signal timing concepts and addresses program elements such as setting multimodal operational performance measures and outcomes, determining staffing needs, and monitoring and maintaining the system. Some of the advanced concepts include the systems engineering process, adaptive signal control, preferential treatment (e.g., for 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. Over-height vehicle detection systems have been tested in Houston to alert truck operators of low-clearance conditions ahead and indicate alternative actions. 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

Another way to improve the safety and operational efficiency of motor carriers is to monitor railroad grade crossings by direct connection to the signal controller and transmit roadside or DMS messages about alternate routes. Trucks stopped at railroad crossings often experience significant delay. This delay depends on the type of grade crossing, 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 for the CMV operator to take an alternative route and potentially save valuable time. Modern signal controllers can accommodate numerous modules to facilitate rail monitoring systems. Such applications can then provide this information on DMSs or by 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 costs to CMV owners (Ruback et al. 2007).

Trucking Industry Efficiency

Virtual Container Yard

A research project in the New York–New Jersey region ("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 research involved a critical review of literature dealing with local, US, and international experience in applying web-based shared information systems. Special attention was given to system security architecture. Proprietary products dealing directly with either street-turn matching or other types of matching were critically evaluated in view of the user requirements. An analytical formulation and simulation model was developed to evaluate the potential benefits of a virtual container yard under different market conditions. Results also presented 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 by reducing the number of empty trips, which are sometimes the result of competition between different industry segments. These firms demonstrated that a simulation system incorporating the dynamic relations of supply and demand could create virtual markets for carriers and shippers to match loads with available capacity. The resulting quantitative estimates would 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). Table 11 shows the Internet-based freight improvements that have

been identified; these systems could offer efficiencies in truck movements both 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 spent waiting for information exchange between supply chain partners. The cross-town component of the shipment was part of this process and was 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 on the highway to be reloaded onto another railcar. These movements involve 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 system 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 whether or not a reroute is warranted. It also provides information to drivers, as they are en route to a destination port, pertaining to a potential return load from this destination. The overall system core is the Intermodal Exchange, through which all of the data from components pass. Other components are the chassis Utilization Tracking and the Wireless Drayage Updating modules (Symoun et al. 2010).

USDOT expanded and enhanced the functionality that had been developed during C-TIP and designed FRATIS. The outcome was a process that was more scalable and transferable than before; further, FRATIS addressed a much wider array of applications than just rail-to-rail and cross-town movements. These included 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 on traffic 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. In truck platooning, two or more trucks equipped with advanced driving support systems follow one another closely and communicate with each other 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 adopting this practice.

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 in a 2015 research study: market needs, testing commercial trucks, and evaluating potential benefits for the I-710 corridor in California. The study stated 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 truck operation within a platoon. The four types of operation 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 if 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 driven manually by a driver, and drivers of the following trucks can disengage 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 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 or 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

Freight performance measures (FPMs) are needed to measure the need for improvements or quantify the effects of improvements. 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 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 impediments to mobility along various roadways (ATRI 2012). It could be used to investigate the I-10 corridor through the four I-10 states.

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. Route 54 in El Paso, ranked 20th
- I-10 at I-410 in San Antonio, ranked 22nd
- I-10 at State Route 51/ State Route 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. Route 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. The report outlined a process for working with private-sector partners and the federal government to develop standards for cooperative intelligent transportation systems (C-ITS). 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 respondents also felt 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, which apply primarily to tall vehicles with large surface areas and high centers of gravity. An example of a current study focused on CMV weather-related events is the I-80 CV Pilot.

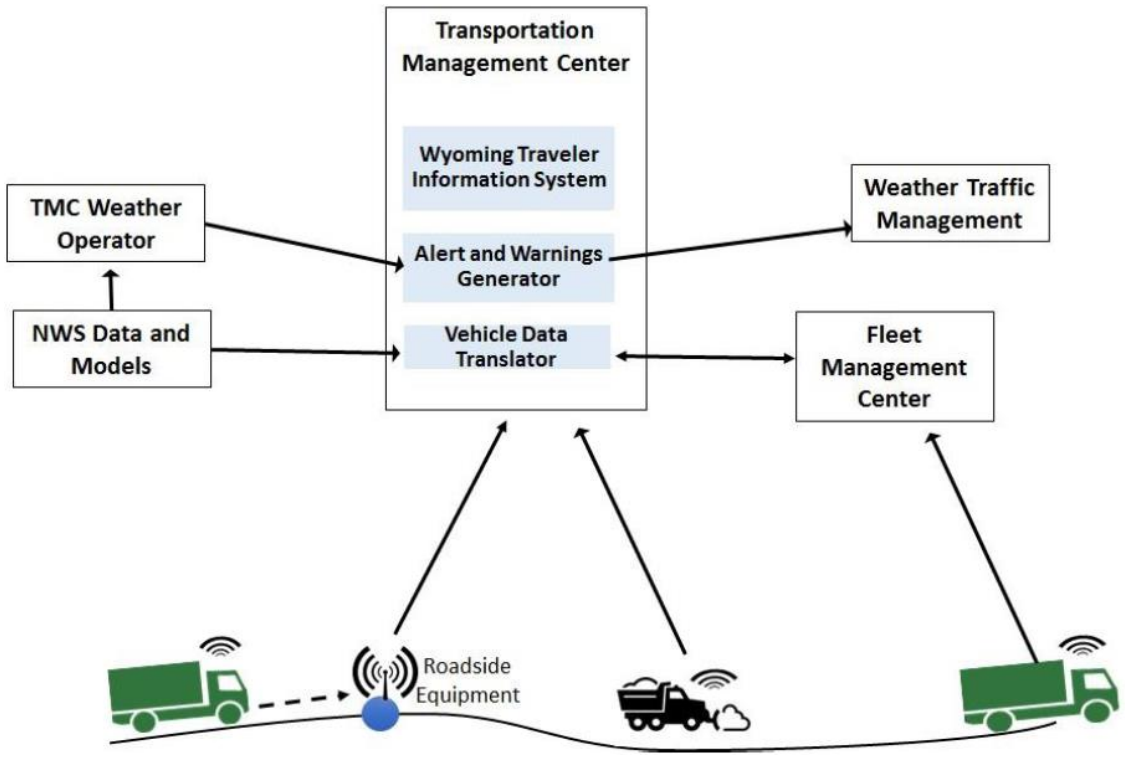
The Wyoming Department of Transportation was one of the first pilot agencies identified by USDOT to test and possibly show the value of CV technology in the United States. The Wyoming Department of Transportation is leading a project to implement new methods of communicating roadway and safety information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

The primary capabilities and functions of the I-80 system 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 be distributed directly to CVs and roadside infrastructure. Commercial vehicles would also be able toto send messages directly to other trucks driving along the corridor. Figure 25 shows a 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 purpose of the I-80 ConOps was to develop a standard set of practices and a shared agreement about roles and responsibilities for deploying 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 certificates that comply with the Institute of Electrical and Electronics Engineers 1609.2 standards for encrypting and signing messages (Gopalakrishna et al. 2015).

Weather issues 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 a weather information system for CVs operating along either corridor.



Source: Gopalakrishna et al. (2015)

Figure 25. 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 shows, 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 sources and make them available in a comprehensive repository. 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 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.

CHAPTER 3. STAKEHOLDER-IDENTIFIED CORRIDOR ISSUES

The connected freight corridor infrastructure, technologies, and operating strategies identified in Chapter 2 were discussed with public-sector transportation and public safety agencies, and with private-sector trucking industry companies and associations. In workshops and one-on-one interviews, stakeholders discussed a range of significant freight issues and recommended they be considered in identifying improvement strategies. This chapter discusses the process for obtaining this information from stakeholders and the issues that were identified.

CORRIDOR ISSUE IDENTIFICATION PROCESS

Stakeholders' opinions were solicited through structured workshops and follow-up interviews. Input was solicited from commercial fleet operators and agencies responsible for operating I-10 in Texas, New Mexico, Arizona, and California.

Stakeholder Workshops

Each department of transportation within the I-10 Corridor Coalition sponsored a workshop. The workshops were at the following locations and dates:

- Las Cruces, New Mexico, on June 11, 2017
- Phoenix, Arizona, on June 13, 2017
- Houston, Texas, on June 20, 2017.
- Riverside, California, on July 11, 2017

Using the stakeholders identified during the corridor inventory described in Chapter 2, each DOT invited representatives from the state DOTs, metropolitan planning organizations (MPOs), and commercial fleet operators to attend a local workshop. Stakeholders also included participants in state freight plan and state rail plan outreach, as directed by each DOT. Sixty-three stakeholders attended the four workshops.

Each workshop followed a consistent structure, beginning with a quick overview of the project followed by a review of different connected/automated technologies as described in Chapter 2. In larger workshops, facilitators then divided the attendees into breakout groups, where more detailed information was solicited from the stakeholders using common questions. Following each workshop, workshop organizers prepared meeting notes summarizing the discussion and highlighting the critical points raised in each workshop. Workshop materials are available on the i10Connects.com website, and discussion questions are included in Appendix A.

Stakeholder Interviews

In addition to the workshops, each state DOT identified at least five stakeholders to be interviewed. These stakeholders included representatives from state DOTs, local DOTs, regional mobility authorities, MPOs, commercial fleet operators, and state or regional trucking associations. Interviews were conducted with an interview script, consistent with the interview protocols of the project team's

Institutional Review Board approval process. Interview subjects were contacted to arrange a convenient time for conducting the interview, and an interview script was shared with each stakeholder in advance of the interview. Notes were taken during each interview to document responses to the interview questions. Appendix A contains the interview protocol.

FREIGHT CORRIDOR ISSUES

Stakeholders identified several freight corridor issues for discussion. Table 13 lists the issues stakeholders emphasized during the workshops and interviews. The table also indicates the relationship between the kinds of stakeholders that own or provide the information and the kinds of stakeholders that use the information. In the case of truck parking, private truck stop operators provide parking and may choose to participate in a truck parking availability system. Some private-sector third-party providers collect and disseminate information on traffic congestion and truck parking through websites and smartphone applications, and some private companies collect motor carrier safety records and provide that information to public-sector motor carrier safety agencies. In the future, more traveler information and permitting information may be provided by private-sector third-party agencies. Cross-cutting issues such as technology adoption involve all stakeholders, while freight planning is owned by public infrastructure agencies but engages all other stakeholders. These relationships are discussed further in Chapter 4.

Table 13. Freight Corridor Issues Identified by Stakeholders

Freight Corridor Issues	Public		Private			Relation to Other Issues
	Facility Owner	Agency Function	Highway User	Third Party	Facility Owner	
Traveler information:						
• Traffic incidents/nonrecurring congestion	PRO	ADD	REC	PRO		
• Construction and work zones	PRO		REC	FUT		OS/OW
• Weather	PRO		REC	PRO		OS/OW
• Truck parking availability	PRO		REC	PRO	PRO	
• Bridge heights	PRO		REC	FUT		
Safety enforcement	ADD	PRO	REC	PRO		OS/OW
Oversize and overweight issues	ADD	PRO	REC	FUT		
Technology adoption	PRO	PRO	PRO	PRO	PRO	ALL
Freight planning	PRO	ADD	ADD	ADD	ADD	ALL

PRO = provide or own
ADD = contribute
REC = receive or use
FUT = future possibility
OS/OW = oversize/overweight
ALL = all other issues

Freight Context

The discussion of these issues, as raised by stakeholders across the corridor, necessitates an understanding of the motor carrier industry, the public-sector agencies that regulate the industry, and the public-sector agencies that own and operate transportation infrastructure used by motor carriers. For example, motor carrier companies, responding to market demands by shippers and receivers, organize their operations with different kinds of scales, operating practices, and labor relations. Not all carriers and truck drivers have the same business relationships in terms of employment or pay, nor do all shippers have the same relationships with carriers and drivers. These complicated interrelationships, contractual agreements, and regulatory obligations and enforcement affect the way freight stakeholders perceive freight corridor issues that could improve freight movement along I-10. Providing a background of the motor carrier industry is beyond the scope of this study, but additional context is available in *Trucking 101: An Industry Primer*, a Transportation Research Circular published by the Transportation Research Board (Stephen Burks, 2010). Additional information on state-specific freight issues and trends is available in state freight plans adopted by each of the four I-10 Corridor Coalition states, as required by federal legislation:

- California: *California Freight Mobility Plan* (2014)
- Arizona: *Arizona State Freight Plan* (2016)
- New Mexico: *New Mexico Freight Plan: Moving Freight Forward, through 2040* (2015) and *New Mexico 2015 Freight Plan, 2017 Addenda* (2017)
- Texas: *Texas Freight Mobility Plan 2017* (2017)

Traveler Information

One of the most significant themes expressed by the stakeholders was the value of better, more accurate, and more timely information about traffic conditions in the corridor. Information flow to carriers and the traveling public has a significant impact on the economic vitality of the communities connected by I-10. Information about the location and severity of congestion was most critical to the stakeholders. This information included not only current traffic conditions but, to the extent possible, forecasted travel conditions.

The pressure for better and more accurate information about travel conditions is being driven, in part, by the new electronic logging device (ELD) mandate regulation from the Federal Motor Carrier Safety Administration (49 Code of Federal Regulations 395 Subpart B, effective December 18, 2017)—a further level of enforcement of truck driver hours of service (HOS) regulations. These new rules provide added accountability for compliance with HOS rules that were lacking, to a degree, from the previously used paper records of on-duty status.

The HOS rules require that truck drivers drive a truck for no more than 11 hours within a period of 14 consecutive hours. Drivers carefully consider driving conditions within this 11-hour window to keep from violating the new HOS requirements. Truck drivers and dispatchers expect state DOTs to collect and

disseminate information on significant events that can affect driving during the 11-hour working time. These events include substantial construction lane reductions and wait times, weather events (e.g., hurricanes, flooding/washouts, and ice storms), crashes with significant time delays (particularly crashes with fatalities, which involve extensive police investigations), and other events that affect trucking operations.

Several smaller commercial fleet operators noted that they do not have access to commercial services that provide larger firms with traffic congestion and travel time information, so the smaller fleets must rely on state DOTs to provide them with that information. Overall, stakeholders expressed an expectation that current travel time systems (public and private) will be more accessible to all users in the corridor. State DOTs may find it beneficial and cost-effective to leverage existing private and crowdsourced traveler information systems and make the data easier to use.

Several commercial fleet operators mentioned that congestion information is also essential for shipments of time-sensitive cargo—produce, live animals, perishable items in refrigerated trailers, and high-value goods (e.g., pharmaceuticals and electronics). Traffic delays due to congestion have the potential to damage these loads and create a financial hardship for some fleet operators.

Traffic Incidents and Nonrecurring Congestion

Traffic incidents and the resulting congestion constitute a significant source of delays to freight operators. Each state DOT in the I-10 Corridor Coalition provides real-time information about the location and severity of incidents on certain segments of I-10. Freight operators indicated that such congestion information is accurate and timely in urban areas but less so in some of the rural areas in the corridor. While many fleet operators indicated that incident information is readily available through state DOT websites, operators expressed a desire for a multistate traffic data clearinghouse, with options for pushing incident-related information to different systems and platforms. This traffic information would be more widely used if it were compatible with the navigation and fleet management technologies already embedded in commercial vehicles. Transmitting and accessing this traffic information via websites, text alerts, or other smartphone applications might conflict with federal and state legislation that prohibits vehicle operators from using cell phones to access the internet or to receive text messages while the vehicle is in motion. Stakeholders suggested that DOTs coordinate information flows within the public sector and among law enforcement and other agencies.

Freight vehicle operators expressed interest in information about the availability and viability of alternate routes to avoid incident conditions. When state DOTs and law enforcement agencies detour traffic to avoid crash sites and related chokepoints, those detours do not always consider the size and operating restrictions of larger trucks. Detours or recommended alternatives along I-10 or other freight routes are not always compatible with truck operations (e.g., roundabouts with limited geometry, roads with heights limited by vegetation or structures, or municipal limitations on brake usage). Many commercially available traffic reporting and mapping services suggest alternate routes that are aimed at passenger cars and are not suitable for commercial vehicles.

Not only are freight stakeholders interested in obtaining more timely information about severe incidents, but they also expressed an interest in improved public-sector incident management and crash clearance practices across the I-10 corridor. Motor carrier stakeholders suggested research and implementation of technology applications that can speed incident clearance and fatality investigations (e.g., vehicles with light detection and ranging systems [LiDAR] or drones with photogrammetry). Freight stakeholders stated that they would benefit from state DOTs disseminating incident-related information more quickly and farther away from the incident scene so commercial vehicle operators would have more time to consider options (e.g., taking alternate routes or adjusting break/rest periods).

Major traffic incidents can also adversely affect a route designated for the movement of oversize/overweight (OS/OW) cargo. Freight stakeholders expressed an interest in better sharing of incident information with OS/OW permitting agencies. The suggested that, when major crashes or construction work zones close or constrict a route, state and local traffic management personnel notify the OS/OW permitting offices. The permitting agency would also benefit from knowing the expected duration of the closure so the agency could offer alternate route information to motor carriers with permitted loads.

Construction and Work Zones

State DOTs provide information on roadway construction and work zones, but freight stakeholders reported that their information needs were slightly different from those of the general public. Work zones can pose particular challenges for truck drivers—narrow lanes are less forgiving, changing traffic patterns must be negotiated, and unpredictable queuing and lane closures can create drastic changes in traffic speed. Construction information on lane closures, incidents, and crashes—particularly dynamic information—would help carriers plan their routes more efficiently. Information about work zones and construction areas needs to be accurate and updated to reflect actual conditions. Stakeholders suggested that perhaps highway contractors could be incentivized to provide dynamic information that drivers could use in planning travel.

While the state DOTs have been successful in notifying the public about the overall location of construction and maintenance work zones on I-10, freight stakeholders stated they would value information that is tailored to their trip. Freight operators need to have information about specific attributes associated with construction and maintenance work zones, such as lane width reductions, speed limit reductions, sharp turns, detours that route onto the local street network, etc. Furthermore, freight vehicle operators also want to know how construction and maintenance activities impact their overall trip. Specific work zone and construction information expectations reported by freight operators include the following:

- Forecasts of travel times and delays due to congestion in work zones
- Information about when and where lane closures occur during long-duration construction projects
- Time estimates of when lane closures within a construction project will re-open (particularly applicable for night construction cycles)

- Information about where work crews and equipment are likely to be situated adjacent to travel lanes within the work zones
- Information about access points to construction zones where equipment may be entering the travel lanes
- Information about work zones on alternate routes during incident rerouting

Weather

In addition to traffic incidents, weather events—particularly dust storms—significantly impact freight movement in the I-10 corridor. These events occur most frequently along I-10 during the spring and summer in central and eastern Arizona and in western New Mexico. Springtime cold fronts or downdrafts from summertime thunderstorms can propel desert sands or tilled soils into the air, resulting in sudden reductions in visibility. Winter weather can also create operational difficulties for many freight operators because roadway ice can hamper truck operations on even the slightest grades. Commercial vehicle operators reported that they often use I-10 as an alternate route when winter weather impacts traffic operations on I-40 from Arizona to Texas. Commercial fleet operators value useful, accurate information about current and forecasted weather conditions and road surface conditions in the corridor. While details about weather conditions are readily available through commercial weather information providers, carriers report difficulties in obtaining information about real-time road surface conditions. Critical weather-related information of value to freight stakeholders includes the following:

- Visibility restrictions (e.g., fog and blowing dust)
- High-wind advisories, alerts, and road closures
- Road surface conditions

Weather information is important in helping freight vehicle operators plan contingencies for potential problems. Some stakeholders described a future scenario in which weather information and anticipated travel restrictions could be passed along at the corridor level through screens or kiosks at traveler rest stations or through mobile hands-free applications. These stations and applications could also contain information related to parking availability and locations where drivers can safely wait out a weather event. Some stakeholders suggested that commercial vehicle operators could deploy vehicle-based technology that would directly measure road surface conditions, just as truck GPS signals are used as probe data for freight-specific travel information.

Several freight operators indicated that weather could also have an impact on permitted OS/OW vehicle movements. OS/OW permits may prohibit movements during inclement weather conditions. Some stakeholders requested that weather impacts be incorporated into the OS/OW permitting process so that time-limited permits could be automatically extended to allow movement to occur when weather

conditions are favorable. Several freight operators indicated that consistent enforcement of permit limitations across states would be valuable in light of weather delays.

Truck Parking Availability

Freight stakeholders expressed support for information systems that give information about truck parking availability in public and/or private truck parking facilities. Freight stakeholders echoed the opinions given in the truck parking surveys and reports discussed above. Two types of truck parking challenges were primary concerns: parking for longer-distance truck travel, and parking and staging areas near urban areas. As mentioned previously, HOS regulations (and new enforcement mechanisms) add pressure for drivers so that finding and securing parking have become a vital component in planning a trip. Limited HOS for warehousing operations and shipper/receiver loading docks, coupled with peak-period highway congestion, lead many truckers to seek parking outside urban areas to rest before reaching their urban destinations. Some commercial fleet operators reported that they frequently spend up to an hour searching for parking once they decide to leave the interstate. The time that a commercial vehicle operator spends searching for parking counts against the 11-hour driving restrictions, so many fleet operators indicated that having better, more dynamic information about parking locations and availability would be helpful.

Stakeholders reported that in addition to real-time information on truck parking availability, predictive models for parking capacity would help drivers and their dispatchers plan for parking well in advance of the HOS limits, at least with a few hours' advance notice. Several fleet operators suggested that truck parking reservation systems could be helpful.

Stakeholders would value truck parking information systems that could link to roadside signage and web-accessible information on public and private parking availability. Chapter 2 includes information about a number of states deploying such truck parking information systems, and the I-10 Corridor database also includes a platform for identifying truck parking capacity along I-10.

Bridge Heights

Adequate bridge heights are an important element of a highly functional freight corridor so that even oversized freight can move unimpaired. According to design guidelines, bridges over interstates should have a vertical clearance of 16 feet 6 inches, with no bridges less than 14 feet 6 inches. The I-10 Corridor database includes bridge height information on I-10. Because bridge strikes are expensive and dangerous for the traveling public, DOTs strive to determine additional means of providing information about bridge height restrictions. Stakeholders request that DOTs consider integrating bridge height information into OS/OW permitting processes and routing determinations. Several fleet operators recommended that bridge height information from multiple states be accessible through a single system. Stakeholders suggested that DOTs engage with private-sector navigation providers to include bridge height information as an element in common navigation software systems, particularly those used by commercial trucking operators.

One survey participant said that state DOTs should consider adopting new height standards for all bridges throughout the four-state I-10 corridor. Under the suggested requirements, agencies would increase the height of all newly constructed structures and rehabilitated structures to account for higher vehicles.

Safety Enforcement

Safety inspections involve more than drivers and tractor/trailers—commercial motor vehicle safety agencies are also concerned about hazardous materials, contraband, high-weight loads, and human trafficking. According to stakeholders, safety enforcement preclearance services (e.g., PrePass or DriveWyze) are used by approximately one out of every four commercial vehicles traveling on I-10. The remaining 75 percent of trucks traveling from state to state could be selected for a safety inspection. However, once a truck is inspected in one state, it may be examined again in subsequent states. Stakeholders also explained that roadside safety inspections and HOS enforcement should make allowances for time-sensitive cargo (e.g., live loads and perishable produce).

Several stakeholders contended that rules and regulations related to commercial vehicle operations could be harmonized among all four coalition states. This harmonization would help improve the consistency of enforcement among all four states, at least as experienced by the trucking industry. One of the harmonization issues is the difference in state labor laws that can affect how HOS regulations are enforced for drivers in those states.

Another commercial fleet operator expressed support for additional consistency in point-of-entry (POE) inspections along I-10 between states. In some states, the state police agency performs POE inspections, while in other states, the state DOT conducts POE inspections. Even if states choose to administer these inspections through different agencies, trucking firms may benefit from additional consistency among agencies at POEs.

Oversize and Overweight Issues

OS/OW vehicles have their own set of unique information requirements along the I-10 corridor. Because each state OS/OW permitting agency has its own set of requirements, specialty OS/OW trucking firms are well versed in the process of securing permits for those loads. States often have different criteria and requirements for permitting OS/OW loads, with California having more distinct requirements than the other three states. Harmonizing these rules and regulations could be very difficult as part of a connected corridor development process. However, states may have other means of offering value to OS/OW permit seekers. When carriers and shippers need to move goods in more than one state, they are often required to enter the same information in multiple permitting systems. Each state may have a different timeline for processing and approving OS/OW permits. Stakeholders assert that common elements found in the OS/OW permits of all four states could, ideally, be shared among the states' permitting platforms.

OS/OW vehicles experience significant impacts when roadway incidents occur or construction work zones limit OS/OW movements. According to stakeholders, a single OS/OW move can take 6 to 8 weeks

to plan and requires coordination across multiple systems. It would be helpful for these shippers and carriers to receive dynamic updates on changing circumstances on routes associated with planned and permitted moves. This information could be shared between state DOTs and related OS/OW permitting entities so that real-time adjustments to OS/OW moves could be coordinated among state permitting systems.

Technology Adoption

Many commercial fleet operators already have sophisticated technologies installed on their vehicles to help manage, dispatch, track, and monitor their fleet. As manufacturers offer more onboard technology on the way to connected and automated vehicle (CAV) operations, adoption of these new technologies would need to be integrated within existing vehicle monitoring and tracking systems, according to commercial vehicle operators. Commercial operators believe that if the public sector wishes to encourage the adoption of new systems for the public goals of improved safety, added fuel efficiency, or better use of roadway capacity, public agencies need to make a compelling business case for adopting this technology. Otherwise, most commercial fleet operators indicated that they would likely wait to incorporate these technologies as they replace their fleet.

Interoperability is a major issue for many stakeholders. Most of the commercial fleet operators interviewed indicated that they would look for national standards and requirements for CAV systems and equipment. Any CAV equipment or application would need to work in every state—not just the four western I-10 states—because tractors and trailers must be able to move freely where business takes them. Most of the commercial fleet operators believe that significant regulatory, insurance, privacy, proprietary, and liability issues must be resolved before CAV technologies can achieve widespread adoption in commercial fleets. Other issues identified by stakeholders include the following:

- What are the business models for connected freight information systems along the corridor?
- When should the states own the systems, and how would public data feed into private-sector systems?
- What kinds of public-private partnership opportunities would be appropriate (from a business standpoint) and allowed (from a statutory standpoint)?

Other than safety applications such as forward collision warning and blind spot monitoring, commercial truck platooning is the one CAV application receiving the most attention among the I-10 stakeholders. As explained in Chapter 2, commercial truck platooning involves electronically linking two or more commercial vehicles so that the connected vehicles follow a lead vehicle at significantly reduced headway and following distance. While the industry is currently developing these technologies, interviewed stakeholders expect state DOTs to consider other operational and institutional issues to enhance the implementation of truck platooning in the I-10 corridor. Some of these issues include the following:

- How would truck platoons operate across state lines?
- Should platoons be operated with escorts?
- Should platooned vehicles be limited to specific lanes or certain roadways?

- What will be the interoperability among different carriers by third-party platooning services?
- How will insurance and liability concerns be addressed?

Freight Planning

Freight planning has become ubiquitous in state DOTs because of the requirement of federal surface transportation authorization bills. Freight planning is also beginning to expand in MPOs and local jurisdictions. Each of the coalition state DOTs has recently completed state freight plans with lists of projects and is starting to take steps to implement those plans. Stakeholders said that freight movement is critical to the economy in the four states and also matters to the tribal governments of the areas that I-10 traverses. Stakeholders encouraged all four state DOTs to engage their freight advisory committees/councils to review their state freight plans and ensure they adequately address I-10 issues and opportunities.

CHAPTER 4. TECHNOLOGY CONCEPTS AND OPERATIONAL STRATEGIES TO IMPROVE FREIGHT OPERATIONS ON I-10

The DOT representatives of the four participating states identified five technology concepts and operational strategies for further exploration in this project. These five technologies and strategies are based on the user needs and technology concept definitions documented in earlier chapters and developed through stakeholder workshops and interviews (described in Chapter 3).

Based on the results of the stakeholder workshops and interviews, the interested parties from the four states and the Federal Highway Administration participated in an interactive workshop on April 3, 2018, in Phoenix, Arizona. At this workshop, participants reviewed proposed user needs and technology concepts and discussed implementation issues. This workshop achieved its major objective of providing clear input from the participating DOT representatives about the use cases and technology concepts to be included in this chapter.

The original work plan for this project had envisioned narrowing the list of use cases after the workshop so that project documentation could describe a few subjects in detail. The DOTrepresentatives chose a broader set of use cases, thus accomplishing two results:

- Preserving options for the I-10 Corridor Coalition to decide on implementation strategies (as exemplified by the truck parking information system grant application development)
- Limiting the depth of detailed analysis in the use cases and the improvement strategies, with the understanding that detailed systems engineering will be part of the implementation strategies to come

This chapter focuses on five selected technology concepts and operational strategies to improve freight operations on I-10. These five technologies and strategies are considered “corridor concepts.” Three of the corridor concepts involve technologies or technical solutions, and two involve strategies for improving freight operations. The five corridor concepts are listed below, according to their level of importance as determined by the DOT representatives:

1. Advanced freight traveler information systems (AFTIS) (technology)
2. Truck parking information systems (technology)
3. Creation of a highway environment conducive to delivery of the next generation of advanced technologies (strategy)
4. Roadside safety communication (technology)
5. Permitting standardization (strategy)

For the three technology-oriented corridor concepts, the following elements are described:

- **User needs summary**—A summary of the needs identified by stakeholders at workshops, interviews, and working sessions with the participating DOT representatives
- **User roles**—Identification of the relationships of stakeholders of the system: direct system users and other project stakeholders that operate the system, provide data to or receive data from the system, or otherwise benefit from or interact with the system
- **User needs and concept functions**—Identification of user needs and the technology concepts that may meet those needs
- **Framing the technology concept**—A high-level overview, including examples, that serve as a basis for the improvement strategies
- **Benefits**—An estimation of the positive results of implementation along the I-10 corridor and reasons for pursuing the concept
- **Implementation barriers**—A discussion of the likely barriers to implementation by Coalition states
- **Institutional issues**—Identification of the practical elements of implementation among the affected institutions, organizations, and stakeholders, including issues of authority and relationships among stakeholders

For the two operations strategy-oriented corridor concepts, the following elements are described:

- **Framing the strategy concept**—An overview of the primary technology, operations infrastructure, and/or regulatory elements that the concept includes, as well as key issues, elements, stakeholders, and operational constraints
- **Building the strategy concept**—Guidance to support development of the concept, and a list of all the elements that should be addressed in the strategy, providing the Coalition starts with a blueprint to implement the strategy
- **Benefits**—An estimate of the positive results of implementation along the I-10 corridor and reasons for pursuing the concept in the future
- **Implementation barriers**—A discussion of the likely barriers to implementation by Coalition states
- **Institutional issues**—Identification of the practical elements of implementation among the affected institutions, organizations, and stakeholders, including issues of authority and relationships among stakeholders

ADVANCED FREIGHT TRAVELER INFORMATION SYSTEMS

User Needs Summary

One of the themes emphasized by the stakeholders in the I-10 workshops and interviews was the value of better, more accurate, and more timely information about traffic conditions in the corridor. Information about locations and severity of congestion was most critical to the stakeholders. This

information includes not only current traffic conditions but, to the extent possible, forecasted travel conditions. Providing traffic-related information to motor carriers, trucking fleets, and freight facilities on I-10 is difficult because traffic and roadway information comes from many different channels, making it challenging to find relevant information efficiently. Some examples of the numerous information sources are:

- State DOT websites
- State traveler information systems (511) applications
- Private-sector applications (e.g., WAZE and Google Maps)
- Weather applications
- Satellite radio
- Social media feeds

Most trucking companies are aware of at least some of the resources available, but they may lack dedicated staff responsible for consolidating relevant route-planning information to help drivers navigate detours in the event of incidents. Instead, truck drivers largely estimate travel times and traffic impacts on the basis of their experience or reports by other drivers in the field. Smaller fleets typically do not have access to commercial services that provide larger firms with traffic congestion and travel time information, so they tend to rely on state DOTs to provide that information.

Moreover, to avoid serious violations, drivers must make careful travel routing and timing decisions to comply with the 11-hour HOS requirements. HOS are now automatically logged with ELDs mandated by the FMCSA. Truck drivers and dispatchers often rely on state DOTs to collect and disseminate information on significant events that can affect driving during the drivers' 11-hour working period. These events include major construction lane reductions and wait times, weather events (dust storms, hurricanes, flooding/washouts, and ice storms), and crashes with significant time delays (particularly crashes with fatalities).

User Roles

Table 14 provides an overview of key stakeholders and their roles and relationships for the AFTIS corridor concept. The primary end users for this technology concept will be private-sector freight transportation stakeholders: truck drivers, trucking dispatchers, and freight facility operations managers.

Table 14. Primary Users and Stakeholders of Advanced Freight Traveler Information Systems

Primary Users/Stakeholders	Roles
Truck drivers and dispatchers	• Primary system users. • Receive and act upon traveler information data.
Other freight transportation users	• System users—carriers, third-party logistics firms, customs brokers. • May also provide data (e.g., truck GPS probe information).
State DOTs	• System implementation and operations. • Provide major traveler information data feeds for the I-10 corridor, work zone information, performance measurement.
State and local law enforcement agencies	• Incident management. • Respond to crashes and major highway incidents, implement crash reporting and investigation protocols, and tailor traffic control procedures to resolve crash locations.
Local/regional travel information systems	• Urban area information providers. • Provide additional traveler information data feeds for metropolitan regions on the I-10 corridor.
Private travel data providers	• Motor carrier information providers. • Provide advanced location-based data feeds (e.g., truck routing, traffic conditions, and incident information).

User Needs and Concept Functions

Table 15 describes the essential functions of the AFTIS concept based on the set of specific user needs identified by stakeholders at workshops, interviews, and working sessions with the participating DOT representatives.

Table 15. Advanced Freight Traveler Information Systems—Function Development

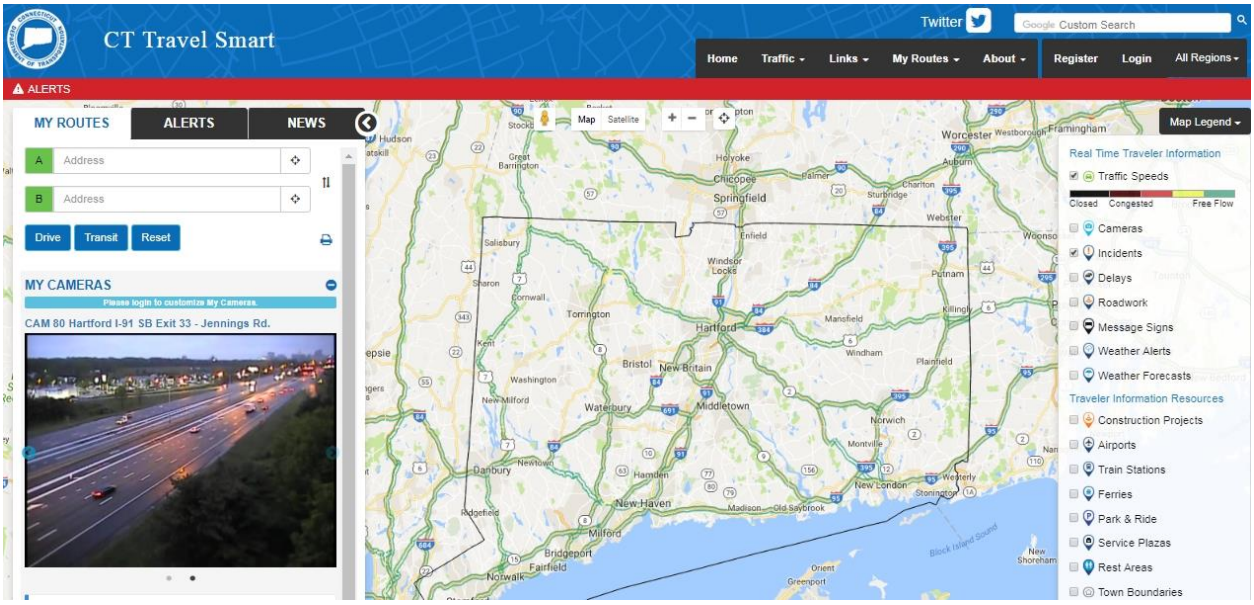
User Needs	Concept Function(s) to Meet Needs
General information on roadway conditions across the I-10 corridor, including speed and congestion information, incident information, and other event information. Information should be provided through many dissemination methods to ensure access by motor carriers using I-10.	• Real-time reliable traffic information for the I-10 corridor • Preplanning regional truck trips • Congestion avoidance dynamic routing for trucks • Incident severity reporting (crash recovery time estimates from law enforcement based on crash type) • Visualization of traffic patterns (speed maps, incidents, bottlenecks)
Real-time notification of traffic delays (location of delays and reasons for delay are useful for planning alternate routes and providing advanced notice to customers who will be impacted by the delayed delivery of goods).	• Real-time reliable traffic information for the I-10 corridor • Congestion avoidance dynamic routing for trucks • Visualization of traffic patterns (speed maps, incidents, bottlenecks) • Enable HOS pre-planning to maximize driver efficiency
Forecasted/planned information and real-time information on work zone closures across the I-10 corridor. Information should include advanced information to support truck dispatcher planning.	• Closure information, at least 24 hours in advance when possible • Reliable real-time traffic information for the I-10 corridor • Preplanning regional truck trips • Congestion avoidance dynamic routing for trucks • Number of lanes open during an incident • Visualization of traffic patterns (speed maps, incidents, bottlenecks)
Trip-specific weather information, including real-time information, forecasts, and emergency weather alerts.	• Real-time route-specific weather conditions • Forecasted weather information tailored to the user profile • Real-time emergency weather alerts (location-specific) • Potential alternate routes
Real-time traffic queue warning alerts to truck drivers.	• Real-time alerts on non-recurring queues/traffic stoppages (at least five minutes in advance)
Live camera images/streams to support user evaluation of conditions and incidents.	• Corridor map with user-selectable locations for traffic camera views

Framing the Technology Concept

The I-10 AFTIS concept would provide travel time, weather, and incident information to regional and long-haul trucking company operations staff, dispatchers, and drivers who move freight on the I-10 corridor. This information would be as consistent as possible with standard trucking company operational terminology and dispatching functions/systems. The provision of this information would optimally be electronic and provided through multiple delivery channels, such as websites, e-mail alerts, mobile applications, outputs to DMSs, and outputs to regional traveler information centers/511 centers.

To implement an AFTIS, a public-sector back-office system could be developed that intelligently integrates the type of transportation and incident information previously provided from the four state DOTs, regional public-sector sources, and some private-sector sources. A comprehensive system like

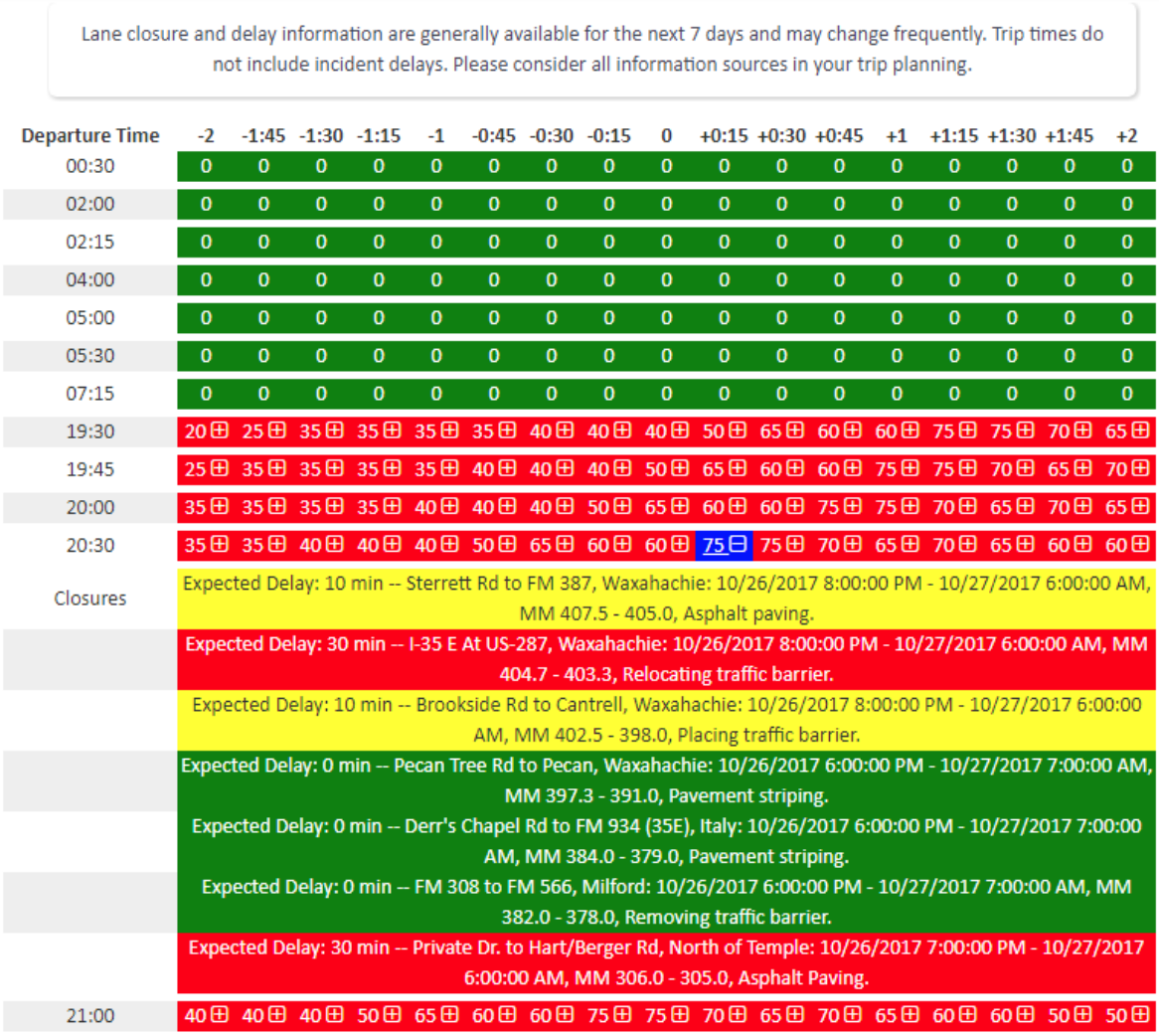
this, tailored for freight transportation, has not been deployed in the United States. However, several state DOTs have deployed public-focused advanced traveler information systems that support the types of web and mobile applications of interest here. For example, Figure 26 shows a screenshot of the Connecticut Department of Transportation's public-facing CT Travel Smart traveler information website. This system integrates sensor information from all the state's interstates and major highways, providing detailed information on multiple types of alerts (e.g., congestion, weather incidents, and closures). Additionally, it allows users to enter their own routes and receive customized alerts.



Source: Connecticut Department of Transportation (2018)

Figure 26. Connecticut Department of Transportation's CT Travel Smart Traveler Information System Example

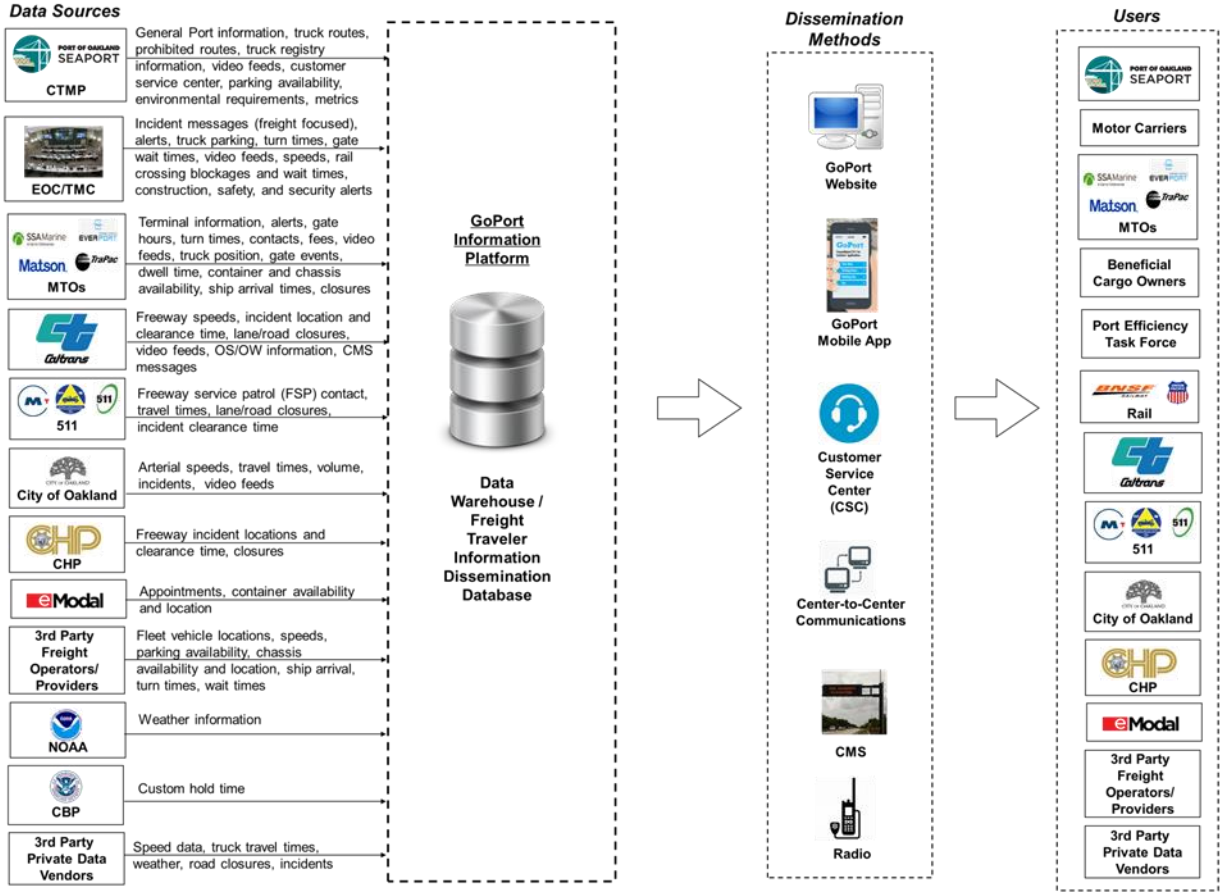
Another example of a traveler information system involves the provision of tailored information on work zone status and closures. Recent work sponsored by the FHWA and implemented by TxDOT offers new system capabilities that can provide this specialized information to trucking companies. The I-35 FRATIS integrates elements of the existing TxDOT travel information system with applications derived from the FRATIS connected-vehicle concept. Figure 27 illustrates how companies can use this information to better plan trips around scheduled closures and measure real-time congestion on the I-35 corridor between Dallas and San Antonio. Motor carriers are provided information on scheduled construction closures based on departure times and expected delays, here showing the extensive delays after a series of closures after 7:30 p.m.



Source: Hallenbeck et al. (2018)

Figure 27. I-35 FRATIS FreightSolver Delay Information Table

The back-office technology to implement the AFTIS concept could integrate information from multiple data sources across the four state DOTs and include traffic management center information from major metropolitan regions on the corridor. Additional information sources could include feeds from regional 511 systems, online weather information, work zone/closure information, and private-sector/third-party information sources. Integrated information could be disseminated through websites, mobile applications, DMS, e-mail alerts, and social media. Figure 28 presents an example of this approach that was recently developed for the GoPort freight intelligent transportation system being designed for the Port of Oakland.



Source: Alameda County Transportation Commission (2017)

Figure 28. Example High-Level Architecture for an AFTIS (Port of Oakland GoPort ITS)

Benefits

Stakeholders may benefit from the implementation of the AFTIS concept in various ways. Providing real-time information to freight carriers may minimize delays for all road users and may enhance the overall efficiency and safety of publicly owned roads and highways. Private-sector stakeholders may benefit from:

- Improvement in the productivity and efficiency of their fleet or trucks;
- Flexibility of dispatchers to make faster and better routing decisions; and
- More reliable travel time estimates for trucks and shipments due to more information about elements such as waiting times at terminals, weather conditions, and driver availability.

Implementation Barriers

The AFTIS concept will depend on consistent data across a number of public and private data providers. Challenges to building this data system include:

- Inconsistent definitions of data fields
- Data availability in terms of timing and geography
- Data quality and completeness
- Data sharing and exchange across entities
- Integrating data from different sources
- Data security

Other barriers include:

- Public sector agencies would need to identify common data to be collected and shared across the states, determining how to ensure those data are compatible with legacy systems and new information networks.
- Private sector stakeholders would expect that AFTIS data that interact with their systems are secure.
- Traveler information systems would need to be available in-vehicle to maximize the utility for the fleet operator or driver.
- Current in-vehicle systems lack interoperability across state lines.

Institutional Issues

Institutional and organizational issues can affect successful implementation of the AFTIS concept:

- Interagency agreements may be necessary to share data and information across agencies and particularly across state lines. Any private information collected by third-party providers may also require specific agreements related to the sharing of those data.
- Additionally, public and private entities may need to agree on the specific data to be shared prior to AFTIS implementation.
- The reliability of information will be critical to gain private-sector stakeholders' buy-in and acceptance of an AFTIS.
- Consistency across states in terms of data availability and common messaging will also be important to reduce confusion by system users as they cross state lines.

TRUCK PARKING INFORMATION SYSTEMS

User Needs Summary

Issues affecting truck parking needs can be divided into two categories—a lack of supply and a lack of information. According to state freight plans published by the four I-10 Corridor Coalition states, demand for truck parking exceeds the available supply in some locations on the I-10 corridor. (Portions of the corridor, especially in Arizona and California, lack in parking capacity, particularly around urban areas.) Drivers often do not know where to find available parking spaces. For example:

- Some smaller fleet drivers and independent owner/operators may not have access to good information about parking locations.
- Information about public rest area truck parking availability is generally unknown, except by word of mouth. Not all drivers use available truck parking smartphone applications (e.g., Trucker Path and Smart Park).
- Private-sector truck parking availability differs significantly across the corridor.

Drivers managing their HOS at the end of their shifts can be frustrated if a a parking lot becomes full while they are en route. According to state and national truck parking reports, the inability to find safe truck parking can result in several negative consequences for both public- and private-sector stakeholders:

- The FMCSA HOS and ELD regulations act together to rigorously enforce the rule that truck drivers operate for no more than 11 hours within a 14-consecutive-hour period (as discussed in Chapters 2 and 3). Drivers carefully consider truck parking stops along their route, well in advance of stopping if possible. This creates several issues related to truck parking along the I-10 corridor:
    - Tired truck drivers and those approaching their HOS limits may continue to drive because they are unable to locate safe parking locations to rest, posing risks to public safety.
    - Truck drivers may stop driving before reaching their HOS limits to secure a space to park because they are unsure whether parking is available farther along their route, diminishing productivity and resulting in increased costs to companies and consumers.
    - Truck drivers, who typically plan where they will park and take their HOS breaks, have difficulty finding parking when circumstances change (weather, equipment issues, and delays at origins or destinations).
- Truck drivers may have few choices except for parking in unsafe locations, such as the shoulder of the road and exit ramps, if they are unable to find available parking. In addition to the safety risk, this causes additional damage to publicly owned infrastructure not designed to accommodate heavy trucks.

- Truck drivers searching for parking incur costs associated with increased trip miles, vehicle wear, and fuel consumption. This search also has negative impacts on highway infrastructure and increases vehicle emissions.

New Mexico, Arizona, and Texas have all recently finished or are in the process of conducting truck parking studies to better identify these critical shortfalls and develop plans to address them. Comments provided by stakeholders at the four I-10 corridor stakeholder workshops and in study interviews confirmed and provided additional information on potential user needs for truck parking. These sources identified the following needs in developing a truck parking technology concept for public truck rest stops on the I-10 corridor:

- Provide real-time truck parking availability information for all public rest stops on the corridor
- Provide a dedicated truck parking DMS, in advance of each public rest stop on the corridor, with real-time parking availability information
- Provide websites and mobile applications (to be used by smartphones) that also provide basic parking availability information, and potentially additional metrics and functionality that are not provided by the DMS network
- Support a future capability for truck parking reservations at public rest stops

Regarding the potential inclusion of private-sector truck parking information, users supported truck parking information systems that functioned as a clearinghouse application (available for any private-sector company to share information with) to support one-stop shopping of private-sector truck parking information (availability and reservations) on the corridor. The application might work as follows:

- Private truck stop/parking lot operators agree to share information to support the parking application.
- Private parking lot operators may need to add technology at their lots to automatically determine availability.
- The application would need to be integrated with the truck ELDs and the private-sector fleet management systems.

User Roles

Table 16 provides an overview of key stakeholders and their roles for this concept. The primary end users for this technology concept will be truck drivers, with a supporting role for trucking fleet dispatchers who assist the drivers in trip planning.

Table 16. Primary Users and Stakeholders of Truck Parking Information Systems

Primary Users/Stakeholders	Roles
Truck drivers	• Primary system users. • Receive and act upon truck parking availability information data.
Trucking fleet dispatchers	• Secondary system users. • Manage or plan truck trips for some trucking fleets. Information is conveyed to the driver from the dispatch center either electronically or via phone.
State DOTs	• System implementation and operations. • Implement and operate the truck parking technologies at the public rest stops across the corridor, the parking information DMS network, the web and mobile parking availability applications, and the back-office system that integrates, controls, and disseminates the parking availability information.
State/local/regional 511 systems	• Information dissemination. • Provide additional dissemination outlets for truck parking availability information.
Private truck stop operators	• Parking availability information providers. • Can potentially provide information on private truck stop parking availability in real time.

User Needs and Concept Functions

Table 17 describes the essential functions of this technology concept based on the set of specific user needs that have been derived from the stakeholder workshops, interviews, and working sessions with the participating DOT representatives.

Table 17. Truck Parking Information Systems—Function Development

User Need Description	Essential Technology Concept Function(s)
Provide truck parking availability at public truck rest stops	• Sensors to measure parking spot availability at public truck rest stops • Real-time reliable truck parking spot availability information displayed on DMSs upstream of each rest stop • Real-time reliable truck parking spot availability Information made available on websites and mobile applications (511 systems and I-10 AFTIS)
Provide forecasted information of projected truck parking availability at public truck rest stops to better support freight trip and dispatcher planning	• Analytics used to forecast projected parking availability given current and historical information by truck stop on parking availability
Provide locations, total number of parking spots, and other services offered at public and private truck stops on the corridor	• Static database containing all public and private truck rest stop locations with total number of parking spots • Information on other available services at all public and private truck rest stop locations
Provide truck parking availability at private truck rest stops	• Open system approach to allow private truck stops to easily link and share availability information on truck parking spot availability • Web links allowed for private truck stops that offer parking reservations (pass-through)

Framing the Technology Concept

The I-10 corridor states have applied for a grant from the Advanced Transportation and Congestion Management Technologies Deployment Program to deploy a truck parking information system to serve public rest areas along the corridor. Since this technology concept is moving into implementation planning, the technology conceptual framework outlined in this section is more detailed than the framework presented for the other technology concepts in this chapter. This grant application will seek funding for a system referred to as the I-10 Corridor Truck Parking Availability System (TPAS).

Truck parking information systems are described in Chapters 2 and 3. According to data in the Corridor database created for this project, sections of the I-10 corridor through the four states carry up to 26,000 large trucks per day. Although some vehicles in the corridor are moving goods a short distance, for example from a business to a railyard or from a distribution center to a store, many are traveling longer distances. While all these vehicles will require short-term parking at some point for food, fuel, or short rest breaks, overnight or long-term parking is needed to satisfy HOS requirements. In total, there are approximately 11,500 spaces in the corridor. Of those, approximately 907 spaces are available at 38 public rest areas. The I-10 Coalition's TPAS will focus on deploying technology at 38 public facilities to identify unused spaces and making this information available to drivers through several dissemination tools including DMS, mobile smartphone applications, and web applications such as state 511 systems.

At a high level, this concept will focus on two categories of technology: identification of space utilization and information dissemination, which are directly linked. The technology that identifies space utilization determines the number of available spaces and feeds the data to the information dissemination technology, which broadcasts that information to stakeholders.

Space Utilization

Two broad approaches can determine the number of available truck parking spaces: site volume measurement and parking space-based vehicle occupancy detection.

Site Volume Measurement. The first approach measures site volume, or the number of vehicles entering and leaving the public parking facility. By comparing this volume to the overall number of spaces, an occupancy rate can be calculated. Several potential technologies can be deployed to measure site volume.

The most commonly deployed technology uses pavement-embedded loop sensors at a truck parking facility's entrance and exit to determine the number of vehicles that enter and leave a site. This technology is well-tested and used by state DOTs to measure traffic volumes in many different settings. This approach works best at sites where truck and car parking areas are separated and trucks have single ingress and egress points, which are simpler to measure.

For sites with the appropriate layout and operating characteristics, this approach can be very cost-effective (especially for larger sites with several parking spaces). However, accuracy can be an issue with this approach. Ingress/egress counting technology alone cannot determine whether trucks are actually parking in designated spaces as opposed to open ground elsewhere in the lot. In addition, this technology is not able to gather detailed data such as the average length of stay, which allow for predictive analytics of truck parking needs. The addition of a closed-circuit television feed can be used to check for accuracy, but this raises the cost, requires additional human resources to operate, and could raise privacy concerns.

Other technological approaches include laser detection and radio-frequency identification device (RFID) transponder technology. Laser systems can be mounted at the entrance and exit of a facility and can track volume by counting the number of times the laser beam is broken. The main issue with this approach is accuracy. Adverse weather conditions including snow, rain, fog, or dust can disrupt the laser beam and lead to a false count. An RFID reader at a public truck parking site could track entries and exits of a vehicle with a transponder, and from that derive site volume and the number of spaces available. However, only a subset of the national trucking fleet currently has transponders, so obtaining an accurate count would not be possible until the technology is more widely adopted.

Vehicle Occupancy Detection. The second approach, vehicle occupancy detection, determines occupancy by detecting whether a vehicle is actually parked at each space. Several technologies are available, each with their own strengths and weaknesses (North Carolina Department of Transportation, 2017):

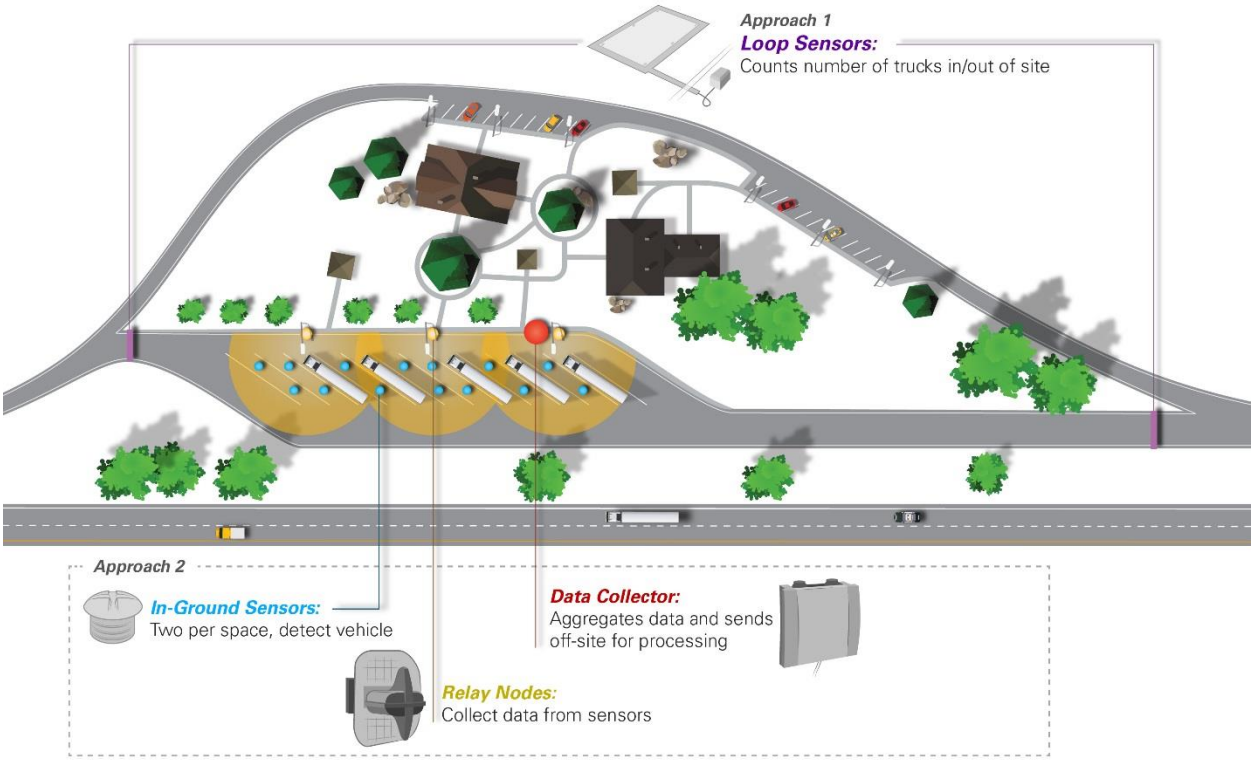
- In-pavement sensors
- Video detection
- Light and laser detection

Of these three systems, in-pavement sensors (commonly referred to as pucks, given their shape) are well-tested and currently used in deployments throughout the country. Compared to the other vehicle occupancy detection approaches, the installation costs are relatively low. This approach can provide detailed data to the DOTs, including average length of occupancy and peak hours, that can be used to develop predictive analytics.

This technology can be deployed at every public rest area in the corridor regardless of site design or ramp configuration. At smaller sites (less than approximately 15 spaces), the in-pavement sensors are cheaper overall than a loop detection system because only a small number of pucks are required, At larger sites, the loop sensor/site volume approach may be more cost-effective.

Because of the wide variety of layouts in the 38 public parking locations in the I-10 corridor, the detection technology that would be deployed at each site has not yet been determined. It is anticipated that the two primary approaches would be in-pavement sensors to detect vehicles in parking spaces or loop sensors to measure site volume.

Figure 29 shows a conceptual deployment of the two approaches to collecting data on parking space availability. Both approaches (Approach 1 using loop sensors to measure site volume and Approach 2 using in-pavement sensors to detect vehicle occupancy) are shown in this diagram, although only one would be deployed at any particular site.



Source: I-10 Corridor Coalition

Figure 29. Truck Parking Space Utilization Technology Approaches

Information Dissemination

Once data on the number of available spaces are collected, that information would be combined system-wide and provided to drivers and fleet management staff. The two main paths for this information dissemination are DMSs and smartphone/web-based applications.

The first approach would place DMSs upstream from the parking areas. Multiple surveys by ATRI have identified DMSs as the preferred communication method for drivers. The exact location of these signs depends on several factors, including distance between interchanges, distance between rest areas, and the presence of private parking options. Placement of the DMSs on I-10 has yet to be determined, but common practice around the country is to locate them approximately 20 miles or more before a site, and again as the site is approached. Each sign would include information on two to four upcoming public parking sites and display the site name and the distance to each site. The number of spaces available at each location would be updated as information is provided from the system.

The second approach would provide information to drivers and dispatchers via a smartphone app and web-based services such as a 511 system. This approach has several benefits:

- Relatively low cost to implement and minimal marginal cost to add more users
- Ability to base information on driver-defined preferences, location, and direction of travel
- Potential to integrate the smartphone app with ELDs and truck fleet management systems
- Ease of integration with private-sector information as it becomes available, or ease of making public-sector data available for third-party apps to consume (thus drastically reducing implementation costs)
- Potential to include a parking reservation function in the future

In practice, from a driver's perspective, the smartphone application could work as follows:

- Prior to departure, the driver downloads the truck parking mobile application to a smartphone.
- Once downloaded and accessed, the application automatically displays any truck parking spots open in the locations along the corridor.
- The application pulls GPS coordinates from the smartphone and generates a web service request that includes geo-coding data (latitude, longitude, and bearing).
- The request is sent to the TPAS.
- The mobile application then calculates the estimated distance to each identified facility and displays this information along with location and number of available spaces.

The service could be expanded in the future to include third-party truck stops. Drivers could use a touch screen on a smartphone to select a truck stop name/icon. Once the third-party truck stop has been selected, the driver would log in to a separate application to reserve a parking spot from the parking provider.

The application may also allow for future integration with ELDs and common fleet management systems to include parking as part of a driver's route guidance. In addition, the application can be designed to allow for future inclusion of a parking reservation function.

Figure 30 depicts the integration of the DMSs, smartphone/web applications, and the I-10 TPAS.

Source: I-10 Corridor Coalition

Figure 30. Truck Parking Site Information Dissemination Conceptual Framework

Benefits

Stakeholders may realize a number of benefits associated with truck parking information and reservation systems:

- Better utilization of truck parking may reduce fatigue-related crashes involving trucks, improving overall roadway efficiency and travel time reliability in the corridor.
- Parking in appropriate locations could reduce the pavement maintenance costs associated with illegal parking along ramps and frontage roads.
- Drivers and carriers can increase productivity by spending less time looking for parking, and they are less likely to violate HOS regulations.
- Parking in appropriate, protected locations would increase driver safety.

Implementation Barriers

Stakeholders may face challenges to implementing this technology concept:

- Funding to expand some public rest areas to accommodate more truck parking may be difficult to secure.
- State-to-state communication may need to improved to share information related to parking availability and the public and private parking inventory.
- Working with the different flexibility and communication capabilities of multiple information system technologies can be complicated, particularly across a multistate corridor.
- Private-sector stakeholders (drivers, carriers, truck stop operators) will expect parking-related technologies (to measure capacity and disseminate information) to be openly accessible for different kinds of trucking firms across different information platforms.
- The reliability of new truck parking information systems may affect the pace of their adoption by drivers and carriers.
- The interest and cooperation levels of truck stop operators and other private-sector parking providers (shippers and distribution centers) may also affect the expansion of truck parking information systems to include privately owned parking spaces.

Institutional Issues

Public-sector stakeholders may be required to cooperate with the private sector when developing and implementing a truck parking availability information and reservation system:

- It may be necessary to involve third parties to reduce unfair competitive advantages for some private-sector partners.
- Public-sector entities may want to ensure that the public information disseminated as part of this system can be easily used by the private sector. Data development and data sharing between both public- and private-sector stakeholders may increase the chances for successful implementation.
- Consistent and flexible data sharing across various platforms can be coupled with agreements to protect data and ensure the safety and security of system users.

HIGHWAY ENVIRONMENT CONDUCIVE TO THE NEXT GENERATION OF ADVANCED TECHNOLOGIES

Framing the Operational Strategy

The four state DOTs supporting the I-10 Corridor Coalition can begin to develop a blueprint for future actions that will support the trucking industry's possible adoption of semi-automated operations (truck platooning) in the next five years, and of autonomous truck deployments on a large scale by perhaps as

soon as the mid-2020s. An initial corridor concept could be developed for initial planning of operations and infrastructure.

To prepare for developments in automated vehicles (AVs), connected vehicles (CVs), and their combination (CAVs), agencies will need to consider how to build infrastructure to support and facilitate V2I communications. The following technology considerations will be critical:

- Determining the corridor infrastructure necessary to support V2I communications over the corridor. High-speed fiber can provide robust, real-time, reliable communications from the roadside to state DOT traffic management centers, regional traffic management centers, the I-10 AFTIS, and other systems. A build-out over the next decade to provide a continuous fiber infrastructure on the I-10 corridor could help prepare the corridor for multiple potential CAV applications of interest to the public-sector agencies.
- Determining the corridor infrastructure necessary to facilitate V2I communications over the corridor. A mix of technologies would most likely be used. Dedicated short-range communications (DSRC) 5.9-GHz roadside readers can be used, provided the market penetration of DSRC radios on trucks and automobiles accelerates significantly in the coming decade; however, deploying DSRC could present a significant risk if another communications technology becomes a market standard. Cellular technology can also support some CV applications and has the advantage of not requiring new infrastructure. Disadvantages of cellular technology are a lack of public-sector control, coverage issues in remote areas, and concerns over bandwidth. Current 4G LTE technology can support many CV non-safety applications. Future 5G technology is expected to be competitive with DSRC on many types of CV applications, but the rollout of 5G in the United States could take a decade or more.

From the private-sector side, as detailed in Chapter 3, most of the commercial fleet operators interviewed indicated that they would expect national standards and requirements for CAV systems and equipment. Any CAV equipment or application would need to work in every state—not just the four western I-10 states—because tractors and trailers must be able to move freely where business takes them. Most commercial fleet operators interviewed believe that significant regulatory, insurance, privacy, proprietary, and liability issues must be resolved before CAV technologies can be widely adopted in commercial fleets. Other issues identified by stakeholders include the following:

- What are the business models for connected freight information systems along the corridor? What are the roles and obligations of the public and private sectors, and how will each sector fund and operate its respective functions?
- When should the states own the advanced infrastructure information and travel information systems, and how would public data feed into private-sector systems?
- What kinds of public-private partnership opportunities would be appropriate (from a business standpoint) and allowed (from a statutory standpoint)?

Many motor carriers are working with technology providers that enable platooning in various real-world, revenue service demonstrations and pilot tests. Operational and institutional issues for public agencies to consider in relation to the use of platooning and autonomous trucks include the following:

- How could truck platoons and/or autonomous trucks operate across state lines?
- Should platoons and/or autonomous trucks be operated with escorts?
- Should platooned and/or autonomous trucks be limited to operate in specific lanes or on certain roadways only?
- Should platooned and/or autonomous trucks have a feature where other drivers can easily identify them (perhaps electronically) as being in platoon or autonomous operations?
- Should platooned and/or autonomous trucks have a feature where state mobile enforcement personnel on the interstate can easily identify them (perhaps electronically) as being in platoon or autonomous?
- What effects, if any, do platooned or automated trucks have on bridge condition (e.g., due to closer spacing) versus traditional, wider-spaced trucks?
- What will be the allowed, safe minimal spacing distances between platooned trucks and autonomous trucks? What about during mixed traffic? What is the maximum allowable platoon size (number of platooning trucks)?
- What is the procedure for handling incidents and crashes involving autonomous trucks?
- When automated trucks (and automobiles) become the predominant vehicles on the road (perhaps during the 2030s), can interstate signage be reduced (e.g., due to vehicle automated operation and CV applications providing roadway alerts in the vehicle)?
- As automated trucks (and automobiles) become the predominant vehicles on the road (perhaps during the 2030s), can lane width be reduced (e.g., because automated vehicle operation is more precise than human operation)?

Building the Operational Strategy

The following steps are recommended to fully develop each element of the strategy:

- Identify the existing corridor infrastructure and operations strategy elements that can be affected by emerging AV and CAV technologies.
- Identify new corridor infrastructure and operations strategy elements that may need to be implemented to respond to emerging AV and CAV technologies.
- Document potential technical, operational, and safety issues that must be addressed to support deployment.
- Develop operational procedures and infrastructure that support implementation of AV and CAV technologies (e.g., technology, maintenance, special striping, roadside V2I units, back-office systems, messaging to vehicles, and alerts).
- Conduct testing and pilot programs in partnership with truck manufacturers to validate the strategy elements.

- Define the appropriate timeline and schedule to implement the infrastructure and operations strategy option.
- Estimate the costs and benefits of each strategy option.
- Determine areas where harmonization of regulations across the four states will support the concept. For example, today, truck platooning regulations and approaches differ across the four states on the corridor:
  - Texas passed a following-distance law and an AV testing law.
  - Arizona has limited commercial deployment. Legislation was passed that allows the reasonable following-distance standard to be adjusted (https://www.azleg.gov/ars/28/00730.htm).
  - California allows operational testing of commercial systems. Legislation was passed that allows operations, focuses on a 100-ft following standard, and only allows Level 1 automation.
  - New Mexico is considering applications from platooning vendors/fleets on a case-by-case basis.
- Specify any educational components needed for the public to understand the purpose of the strategy and the plan to prepare for these technologies.

Benefits

AV and CAV technologies and semi-automated applications, such as long-haul truck platooning, have the potential to benefit both the public and private sectors within the I-10 corridor states in the following ways:

- Public agencies and communities might see an increase in economic development associated with more efficient trucking operations along I-10.
- DOTs might experience increased efficiency in highway operations and improved optimization of infrastructure capacity, as autonomous and connected vehicles may operate with shorter following distances and fewer crashes.
- Safety benefits may be realized through technologies that prevent crashes.
- Autonomous vehicles might operate at consistent speeds, which could lead to a reduction in vehicle emissions.
- The private sector might benefit from fuel savings, time savings, fewer crashes, and increased reliability in estimating travel time.

Implementation Barriers

The following barriers may present challenges to the implementation of long-haul truck platooning and AV/CAV technologies for both the public and private sectors:

- DOTs may have to rely on simulations and modeling (in the absence of extensive testing and research) to determine the possible impacts of these new options on the infrastructure, such as bridges and pavements (more computer-controlled truck movement may concentrate truck weights in narrower bands on pavements and concentrate loads on bridges).
- Platooning operations may require information exchange with public-sector agencies, requiring DOTs or other public agencies to incur capital and operating expenses associated with these information systems.
- Consistent signage and messaging standards for platooning and AV/CAV trucks would need to be developed to provide information to drivers of nearby vehicles, such as guidance on how to merge onto roadways in the presence of automated vehicles.
- Motor carriers would depend on interoperability of the various platooning technologies and systems in order to purchase new trucks with compatible platooning capabilities.
- Motor carriers and truck manufacturers would need to set standards for onboard equipment (sensors, braking, vehicle communications) that enables platooning and autonomous operation; they would also need to mitigate cyber-security risks of such onboard systems.

Institutional Issues

Institutional issues can present the following challenges to successful implementation of innovative operational strategies within the roadway environment:

- Motor carriers will expect uniformity of long-haul truck platooning regulations and authorities across state lines, and corridor states will need to coordinate to establish a consistent regulatory framework that supports of AV and CAV operations.
- The private sector might hesitate to fully implement long-haul track platooning and other AV/CAV operations, depending on the resolution of liability and insurance issues.
- Unanticipated operator negligence and technology system failures can affect public acceptance of the technology and hinder its broader adoption.
- The general driving public may need to be educated about what to expect when encountering platooning or automated trucks in the roadway environment.

ROADSIDE SAFETY COMMUNICATION

User Needs Summary

A total of 3,986 people died in large-truck crashes in 2016 in the United States (US Department of Transportation, 2017). Seventeen percent of those killed were truck occupants, 66 percent were occupants of cars and other passenger vehicles, and 16 percent were pedestrians, bicyclists, or motorcyclists. The number of people who died in large-truck crashes was 27 percent higher in 2016 than in 2009, which was the year with the lowest number of fatalities since data collection began in 1975

(US Department of Transportation, 2017). Emerging safety-related technology programs such as the US Department of Transportation's (USDOT's) Smart Roadside Initiative (SRI) have an opportunity to reduce large-truck fatalities.

Corridor stakeholders identified a need for improved safety-related roadside communications to support enforcement, vehicle inspection, and driver safety monitoring for trucks operating on the I-10 corridor. Cellular technologies and DSRC 5.9-GHz technologies, as discussed in the previous section, could potentially support roadside safety communication needs. The following new safety applications have been defined by USDOT's SRI (US Department of Transportation, undated). (The SRI program also includes a truck parking element. That element was not included here because truck parking isa distinct strategy in this Volume 1.):

- **Electronic screening (e-screening).** E-screening involves automatic identification and safety assessment of a commercial vehicle in motion. With e-screening, safe and legal vehicles are allowed to continue on their route. Enforcement resources can be used to target unsafe vehicles and carriers. Currently, e-screening occurs at fixed stations and on-demand verification sites.
- **Virtual weigh stations/electronic permitting**. Virtual weigh stations and electronic permitting (discussed in Chapter 2) are intended to improve truck size and weight enforcement. USDOT progress to date includes the development of a virtual weigh station/electronic permitting architecture and a current pilot test of a system in Kentucky and Tennessee.
- **Wireless Roadside Inspection (WRI) Program.** The WRI program's goal is to increase the number and frequency of roadside safety inspections and to obtain data about the commercial vehicle and its driver. The program is examining technologies that can transmit safety data directly from the vehicle to the roadside and from a carrier system to a government system. The safety data being considered for transmission include basic identification data (for the driver, vehicle, and carrier); the driver's HOS record; and sensor data that provide information on weight, tire status, and brake status. Specifically, these technologies will encompass:
    - E-screening for fixed safety inspection stations, including third-party applications such as HELP/PrePass and DriveWyze
    - Truck safety condition detection, such as infrared detection of brakes and tires
    - Weigh-in-motion to identify trucks that should stop at a weigh station

If WRI is deployed, enforcement systems and staff can use WRI data to support e-screening and inspections at various locations including staffed roadside sites, virtual weigh stations, and on-demand verification sites. The SRI program pre-dates the USDOT Connected Vehicle Program (discussed in Chapter 2), but CV roadside communications technology in the form of V2I DSRC 5.9 GHz has emerged as the leading approach to facilitate communications between these applications and trucks in federally funded field tests of the three SRI applications detailed above.

If these technologies are to be implemented, the following steps would be required:

- DOTs would prepare a data repository to store, integrate, and share this information, and to facilitate sending consistent messages to motor carriers across all four states.
- Vehicles in motor carrier fleets would need the functionality to send messages with the necessary information and format for communication with state CV applications (e.g., V2I communications as discussed in the previous section).
- Trucks would need to be manufactured with connectivity and additional sensors (e.g., brake and tire monitoring) to support WRI. For this system to function, it was assumed that trucks would use DSRC radios to communicate with roadside units that will support the state/corridor SRI safety applications.

User Roles

Table 18 summarizes key stakeholders and their roles for this concept. The two primary classes of end users for this technology concept are state truck enforcement/inspection personnel in one class; and truck drivers, trucking dispatchers, and fleet operations personnel in the other class.

Table 18. Primary Users and Stakeholders of Roadside Safety Communication

Primary Users/Stakeholders	Roles
State enforcement/ inspection personnel	• Primary system users. • Target vehicles for inspection, implement inspections, provide citations, monitor driver and vehicle safety, and monitor truck and driver safety remotely (mainline screening, weight, brakes, tire pressure, and driver HOS)
Truck drivers	• System users. • Receive real-time safety information on brakes, tire pressure, and HOS
Trucking company operations and maintenance staff	• System users. • Receive real-time safety information on brakes, tire pressure, and HOS

User Needs and Concept Functions

Table 19 lists the essential functions of this integrated SRI technology concept based on the set of specific user needs that have been derived from the stakeholder workshops, interviews, and working sessions with the participating DOT representatives.

Table 19. Roadside Safety Communication—Function Development

User Need Description	Essential Technology Concept Function(s)
Automated mainline screening of trucks independent from fixed inspection facilities	• SRI virtual weigh station architecture implementation • Wireless monitoring of driver HOS through ELDs • Connectivity to FMCSA systems • V2I Roadside communications CV architecture
Rapid inspection of truck safety independent of a fixed inspection station bay	• SRI Wireless Roadside Inspection architecture implementation • Truck onboard safety monitoring technology (brakes and tire pressure) • Wireless monitoring of driver HOS through ELDs • V2I Roadside communications CV architecture

Framing the Technology Concept

The primary focus of the I-10 roadside safety communication concept would be the development of the CV V2I infrastructure necessary to (1) improve the efficiency of state enforcement personnel monitoring and screening trucks, and (2) facilitate a new type of wireless, rapid truck safety inspection that would cover truck brake wear, tire pressure, and driver HOS.

The current national framework for the CV environment envisions the use of DSRC, cellular communication (e.g., 3G and 4G), or other future means of radio communication between vehicles and the surrounding infrastructure. USDOT has established DSRC as a specifically allocated set of channels and frequencies for use in the anticipated CV world. DSRC is also central to a continuing series of field evaluations and pilots sponsored by USDOT.

In-vehicle DSRC technology is now beginning to appear on some new vehicles and trucks, but not at a significant level. Significant market penetration of DSRC radios would need to begin now, at current rates of development, to support widespread use of this technology in the 2020s. Although other technologies for truck connectivity could be considered, those in the USDOT-sponsored CV program are the only ones that are being prepared for national coordinated standards and non-proprietary (open) solutions.

The proposed system envisions that for trucks traveling the I-10 corridor, onboard DSRC radios would be integrated with equipment and processors that would implement the onboard safety monitoring application packages (e.g., brake monitoring, tire pressure monitoring, and HOS ELDs). Enabling technology might reside in the truck itself and would ultimately include a wide variety of onboard vehicle systems. This onboard equipment and technology would communicate with various operation centers and remotely situated application servers.

The public sector enforcement-deployed or DOT-deployed DSRC radio at each roadside installation site (referred to here as the "DSRC roadside unit") would be capable of communicating over relatively short distances to ensure timely communication with state enforcement systems on the corridor. A dedicated

DSRC infrastructure installation could include a DSRC radio, pole, and cabinet. Control cabinets used for intelligent transportation systems or tolling systems can also house equipment for the CV system.

While other systems and equipment, such as back-room servers, would be necessary to realize the functionality of the envisioned CV system, the following specialized V2I components would be needed:

- DSRC radio systems
- DSRC poles and mounting structures
- DSRC roadside cabinets and equipment
- Communications and power conduit and cabling
- Closed circuit television or other video monitoring systems
- Fiber trunk lines

In further developing this technology concept, the following information may also be considered:

- Sharing data across states to support safety inspections and weight enforcement would help streamline these often manual processes.
- Sharing data ahead of vehicle movements and across state borders allows transportation and enforcement agencies, as well as trucking companies, to be proactive in their response.
- Conducting random spot checks during the implementation of these new technologies may validate the reliability of sharing enforcement results among the states and reduce duplicative vehicle inspections (enforcement agencies have contended that truck weight or safety data could change between checkpoints).
- AV/CAV/CV policy and operational guidelines in coordination among the four states are needed.
- Best practices to address motor carrier concerns (described in Chapter 2) about the reliability of roadside technologies that extract vehicle-based information or that result in automated enforcement are needed.
- Tracking progress of 5G CV technology compared to DSRC-based CV technology will inform selection of the most appropriate V2I technology.

Benefits

Roadside safety communication technology has the following potential benefits for private- and public-sector stakeholders:

- Comprehensive safety inspection information throughout the corridor could improve commercial vehicle safety enforcement and result in removing unsafe drivers and trucks from the road.
- These systems could expand safety enforcement with cost-effective automated detection, improving public agencies' efficient delivery of services and use of resources.

- More effective enforcement of safety standards may reduce the frequency and severity of crashes involving larger trucks, which can lead to more cost-efficient shipping along the corridor.

Implementation Barriers

The implementation of roadside safety communication faces potential barriers:

- As with many advanced operational strategies desired by public-sector partners, funding for development, implementation, and ongoing operations can be difficult to secure and sustain.
- New technology needs to be adopted, and the needed interoperability of that technology may require the extraction of vehicle-based information and present implementation challenges. Differences in operating policies and procedures between fleets and independent operators can present implementation challenges; independent operators may lack resources to participate in pre-screening programs.
- Ensuring accessibility to data being produced by the public sector for consumption by the private sector can be a hurdle.

Institutional Issues

Any concept that requires coordination across state lines can present institutional issues for public-sector stakeholders:

- Roadside safety communication will require the cooperation of both the state DOTs and state law enforcement agencies to ensure all agencies' needs are met. This involves interstate cooperation and information sharing, which are subject to specific state statutes and policies that will need to be addressed.
- Consistency across state lines in the adjudication process will affect whether private-sector stakeholders adopt these strategies.
- Private-sector stakeholders will need to have confidence in the FMCSA safety assessment criteria or other screening processes that are likely to be incorporated into this operational strategy.

PERMITTING STANDARDIZATION

Framing the Operational Strategy

As detailed in Chapter 3, when carriers and shippers need to move oversized goods on specialty vehicles through more than one state along the I-10 corridor, they are often required to duplicate shipment information in multiple permitting systems. Each state may have a different timeline for processing and approving oversize and overweight (OS/OW) vehicle permits. Stakeholders might reasonably believe

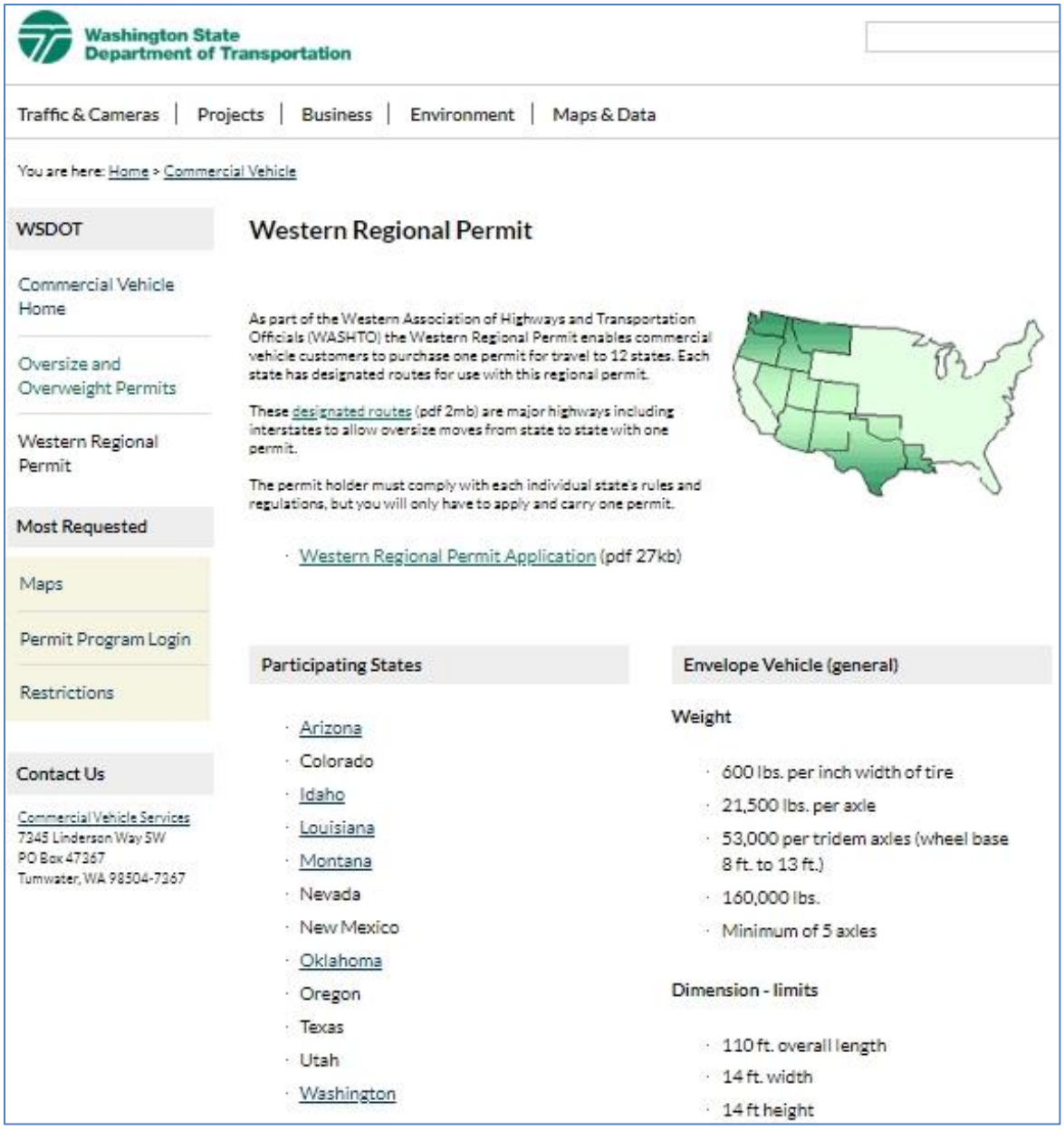
that common data elements in the OS/OW permits of all four states could be shared across each state's permitting platforms. With each state OS/OW permitting agency having its own set of requirements (California regulations pose distinct requirements for carriers), specialty OS/OW trucking brokers have emerged that are well versed in the process of securing permits for those loads. The following issues are also of concern to motor carriers operating on the I-10 corridor:

- Some states do not allow triple trailers (Arizona and California).
- Some restrictions (construction related) are temporary and could be state-specific.
- State law enforcement agencies in the four states may have different opinions about each state's unique OS/OW permitting requirements, links, escort vehicles, and signage.

According to stakeholders on the I-10 corridor, a single OS/OW move can take six to eight weeks to plan, involving coordination across multiple permitting systems. It would help these shippers and carriers to receive dynamic updates on changing traffic circumstances on routes associated with planned and permitted moves. This information could be shared between state DOTs and related OS/OW permitting entities so that real-time adjustments to OS/OW moves could be coordinated among state permitting systems.

The American Association of State Highway and Transportation Officials (AASHTO) is taking the lead at the national level to achieve something close to standardization of the regulations for OS/OW permitting across the United States. AASHTO's harmonization of truck permitting has attempted to develop standard guidance that covers 23 different areas related to truck OS/OW permitting, encompassing guidance documents/planning; general regulations; and warning, following, and flagging standards. The intent of a website and the supporting stakeholder engagement for the AASHTO harmonization effort is to promote the creation of an eventual national standard for OS/OW permitting. AASHTO's harmonization efforts intend to create an environment in which baseline information about OS/OW permits can be shared among states, while each state is responsible for adopting rules and standards that conform to these baseline expectations.

An approach to similar to the AASHTO initiative has been sponsored by the Western Association of State Highway and Transportation Officials (WASHTO) and had been used for over a decade (Figure 31). The WASHTO approach could be applied under current statutes to western regional OS/OW permits across the I-10 corridor in Texas, New Mexico, and Arizona (California has a distinctive regulatory structure). Under this process, OS/OW routing and operations would be approved by participating states, within certain regulatory parameters that match the states' individual regulations. WASHTO has been involved in AASHTO-sponsored efforts to establish baseline conditions for operational rules (escorts, time-of-day restrictions, and placarding/signage) and permit information sharing.



Source: Washington State Department of Transportation (2018)

Figure 31. WASHTO Regional Permit Standardization System Overview

The WASHTO regional permit approach could provide a starting point for the four I-10 corridor states to begin negotiations for additional standardization. The four states could also invite discussion with leaders of state trucking associations to focus on establishing a minimum acceptable baseline for interstate OS/OW permitting standards and identifying common parameters so that applicants enter information only once.

This process could also take a systems approach to provide some basic automation to a standardized permitting process. This could result in development of a centralized back-office system for information integration across the four states. This approach would reduce errors in data entry. This back-office system will depend on the legislative authority of the four states to share permit information outside each state's permitting applications.

Building the Operational Strategy

To fully develop this strategy, the following actions can be considered:

- Establish a joint working group of OS/OW permitting leaders/champions across the four states, including state enforcement personnel and state DOT personnel.
- Create a matching private-sector engagement group, consisting of leadership from the four state trucking associations and industry leaders in OS/OW moves on I-10.
- Document the commonalities, differences, and gaps between states' OS/OW permitting regulations.
- Assess the critical differences in regulations and procedures between the WASHTO regional permit standard and California's OS/OW permitting approach.
- Develop a time-phased implementation plan that supports development of a common framework for OS/OW standardized permitting within a defined time frame.

Benefits

As with the other operational strategies, permitting standardization can benefit both public- and private-sector stakeholders in various ways:

- Roadway safety would be improved because carriers and drivers would make fewer stops and better comply with state regulations.
- Permitting efficiency of applicable state agencies would be improved
- The private sector could benefit from improvements in cross-border permitting that would lead to fewer discrepancies, greater efficiency, and reduced costs

Implementation Barriers

Implementation of standardized permitting can be a challenge for participating stakeholders:

- State-to-state communications among permitting systems need to be harmonized, even though preexisting systems may be incompatible.
- Common communication systems, needs, and timelines need to be identified.
- Differences in the business requirements of motor carriers and brokers may slow the identification and adoption of compatible systems.

- Vehicle-based permit communication technology requirements need to be identified and agreed upon.
- The security of electronically transmitted permitting information needs to be addressed.

Institutional Issues

Institutional challenges will also need to be faced as part of the development and deployment of standardized permitting:

- Differences in regulatory policies and agency authority from one state to another would require resolution.
- Each state and its agencies (DOT and law enforcement) have different responsibilities in OS/OW permitting.
- Better and more rigorous standards and enforcement may be needed, and international vehicle conditions and permitting will need to be considered.
- Private-sector stakeholders will want to consider their business needs for intrastate and interstate OS/OW operations and the potential impacts of standardized permitting.

CHAPTER 5. PLANNING FRAMEWORK

This chapter explains the functions and relationships required for the effective implementation of technologies and systems associated with five strategies:

- Truck Parking Availability Systems
- Advanced Freight Traveler Information Systems
- Highway Environment Conducive to Delivery of the Next Generation of Advanced Technologies
- Roadside Safety Communication
- Permitting Standardization

IMPLEMENTATION IMPACTS

This section examines the implications of implementing the five strategies, including potential impacts on public and private resources and the interactions with other implementation issues discussed in Chapter 4.

Impacts of the Five Strategies

Deploying the corridor strategies would impact several elements of the freight operating environment—facilities, equipment (in the field and on the trucks), software, personnel, and procedures—as described below:

- Facilities (centers): Facilities where public and private entities monitor information about traffic conditions, construction zones, weather information, parking availability, vehicle movements, shipments, truck condition, and driver status. These include public traffic management centers and private dispatching operations of motor carriers.
- Equipment (field): Sensors, cameras, detectors, and other equipment found along the roadside or in the pavement, designed to measure performance, detect conditions, and diagnose problems. This could also include similar kinds of equipment in private truck parking lots or shipping and receiving yards.
- Equipment (trucks): Devices similar to field equipment (sensors, cameras, detectors) but found on the truck itself. These devices or on-board units can be outward-facing to improve operations (lane departure warnings, automated braking, and cruise control) or can be oriented toward the driver (alertness, time keeping) or the vehicle (condition of engine, brakes, axles).
- Software: Computer-based systems to integrate information to, from, and among vehicles, infrastructure, motor carriers, shippers, and facility owners.
- Personnel: People involved in direct operations, maintenance, information technology, and other systems associated with vehicles and infrastructure along the corridor.

- Procedures: Formal and informal practices, rules, and policies that define the relationships among public and private agencies and individuals who own and use the I-10 corridor and the facilities along it.

Table 20 describes high-level impacts of each of the five strategies on the elements above.

Table 20. Impacts of Deploying Connected Freight Strategies on the Interstate 10 Western Corridor

	Truck Parking Availability Systems	Advanced Freight Traveler Information Systems	Highway Environment Conducive to Next-Generation Technologies	Roadside Safety Communication	Permitting Standardization
Facilities (Centers)	Use existing centers and integrate systems with public and private parking information.	Use existing urban-based centers and integrate and expand systems into rural areas.	Use new center(s) with new stakeholders (CAV operators).	Use existing law enforcement centers and systems but with broader integration, requiring inter-agency coordination.	Use existing permitting agency platforms and integrate systems, with more permit information shared among state systems.
Equipment (Field)	New field equipment and communications will be needed at parking sites.	Expand detection systems (congestion, construction, weather) and roadside communication (DMSs).	Enhanced roadway maintenance (striping, lane markers, signs) needed for onboard CAV cameras and sensors.	Roadside detection device functions may include infrared sensors (brakes) and vehicle-based information transmission.	Most permitting systems are centralized, not distributed in the field.
Equipment (Trucks)	Parking information can be sent to smartphones and other onboard devices.	Real-time incident information needs to be available to dispatchers and onboard devices.	Expanded instrumentation of trucks. Communications from trucks to roadway.	Onboard diagnostics on vehicle condition and driver HOS are needed.	Vehicle-based permit information available for law enforcement across state lines.
Software	Support deployment of field equipment and services; share information with multiple systems.	Support integration of data from relevant centers into communication platforms.	Enable new applications and technologies as they develop and deploy along the corridor.	Integrate inspection records and preclearance across state lines.	Share and distribute baseline permit details in all states.
Personnel	Modest resources needed for parking information centers, detection installation, and maintenance.	May require additional staff to monitor rural conditions and incidents in traffic management centers.	Incorporate freight corridor needs within other DOT technology initiatives.	Streamline operations while improving effectiveness among existing staffing levels.	Permit staff will need to be trained to adjust multistate permit applications to individual state requirements.

Table 20. Impacts of Deploying Connected Freight Strategies on the Operating Environment (Continued)

	Truck Parking Availability Systems	Advanced Freight Traveler Information Systems	Highway Environment Conducive to Next-Generation Technologies	Roadside Safety Communication	Permitting Standardization
Procedures	Drivers, dispatchers, and truck stops may need to add truck parking reservation procedures as reserved parking expands to more facilities.	DOTs and law enforcement agencies may need scripts and procedures for a range of incident and weather management scenarios.	Carriers, shippers, law enforcement agencies, and insurers may need to adopt protocols for new technologies.	Federal and state carrier safety information data used in enforcement screening may need improvement and acceptance.	State permit agencies may need to adopt agreements to share data and permit information.

Truck Parking Availability Systems

Truck parking availability systems provide timely information about truck parking opportunities. While the focus of implementing this strategy is on integrating existing systems, states may also need to increase the deployment of field equipment to track and manage parking in public rest areas. When deploying corridor strategies, the two most affected elements would be:

- Equipment (field): DOTs seeking to connect public rest areas to truck parking information systems may consider what kinds of devices will measure parking space occupancy and availability (a variety of devices and systems are discussed in Chapter 4).
- Equipment (truck): Drivers have different kinds of in-cab communications devices that connect to dispatchers, traffic information systems, HOS logging systems, and business and personal smartphones. Truck parking information systems must provide information on availability (and ultimately on reservations) to drivers and dispatchers already using different kinds of devices.

Advanced Freight Traveler Information Systems

The private and public sectors offer various forms of traveler information along most roadways, including I-10. The private sector provides this information through software-enabled services such as mapping applications (Google and Apple), Waze, and HERE. The public sector provides the information through web services and applications, such as ADOT Traveler Information System AZ511.gov, and roadside DMSs that post roadway conditions. When deploying corridor strategies, two affected elements would be:

- Facilities: State DOTs and metropolitan planning organizations with urban traffic information centers may plan how to enable communication among statewide traffic centers to cover the hundreds of miles of rural highway. To collect the construction lane closure information

stakeholders have requested, DOTs may consider requiring more detailed and frequent information (such as real-time lane closures) from highway construction contractors and then sharing that information with multiple carrier systems, across state lines, and in both rural and urban areas.

- Procedures: DOT traffic information centers often have procedures for responding to incidents based on how many first responders are called to the scene of a crash. DOTs may want to consider how to connect with the multiple law enforcement agencies along the corridor to get information on incident severity (one of the major needs heard in stakeholder outreach) and communicate the relative congestion impacts of traffic incidents.

Highway Environment Conducive to Next-Generation Technologies

Carriers have indicated that they would expect standards and requirements for connected and automated vehicle (CAV) systems and equipment to be developed at a national level, not state-by-state. States might seek to accommodate new technologies through incremental improvements of existing systems and operations centers. New in-vehicle hardware could have significant impacts on public infrastructure and roadside communications as private-sector automation and new communications technologies roll out. When deploying corridor strategies, two affected elements would be:

- Equipment (field): Roadway information from pavement markings, retroreflective markers, and regulatory/advisory signs will need to be readable by cameras and sensors of autonomous vehicles. States can ensure that markings and signage offer high contrast for cameras, or that signs are embedded with infrared or non-visible markings that convey information to sensors.
- Procedures: National and state regulations may require amendments or adjustments to respond to increasing automated capabilities of new equipment. States may consider pursuing special-purpose legislation that allows platooning vehicles to follow more closely than allowed by standard traffic rules, or instituting regulations that allow or encourage autonomous vehicle operations.

Roadside Safety Communication

States may consider pursuing the development of the V2I communications infrastructure to enable state enforcement personnel to more efficiently inspect trucks for compliance with safety requirements. With new infrastructure in place, inspections of truck brake wear, tire pressure, and HOS could be conducted rapidly and wirelessly. The infrastructure would also put new demands on truck fleets for added onboard hardware and communications. When deploying corridor strategies, two affected elements would be:

- Equipment (field): As trucks are equipped with more onboard monitoring systems, the public sector will be interested in discovering the right mix of sensors and communications devices to communicate directly with the trucks rather than with a transponder or smartphone.

- Procedures: The public and private sectors will face the challenge of agreeing on how to share private onboard truck data with public law enforcement agencies, both remotely (at driving speeds) and during roadside inspections.

Permitting Standardization

The standardization of OS/OW truck permitting requirements across multiple states would require the states to analyze laws and regulations, clarify permitting processes, and engage in intergovernmental negotiations. The OS/OW permitting agencies in New Mexico and Texas are not signatories to the I-10 corridor charter, and while they eventually may be sympathetic to the goals of this strategy, more outreach and communication may be necessary to achieve permit standardization across state lines. When deploying corridor strategies, two affected elements would be:

- Facilities (centers): Each permitting agency can expect to develop processes to share information on multistate permit moves with all agencies across state lines so that applicants do not duplicate effort and commerce can move freely along the corridor.
- Procedures: The permitting agencies may need to identify baseline information necessary for coordination, understanding that each state has unique regulations.

Coalition Implementation Priorities

Considering these implementation issues along with the benefits of and barriers to implementation discussed in Chapter 4, the coalition states have selected two of the five strategies—truck parking availability systems and advanced freight traveler information systems—for the near-term focus of planning and deployment.

Table 21 lists the coalition's priorities for the five strategies in light of the following practical elements affecting the strategies:

Available resources: What public and private resources are available to support implementation of the strategies? Current federal discretionary grants have been awarded to states for truck parking availability systems and advanced freight traveler information systems. Private venture capital is also fueling multiple freight technology ventures in truck automation and platooning. Funding for Priorities 4 and 5 shown in

- Table 21 is less extensive and may require state-level funding.
- Strategy readiness: How soon could the strategies be deployed? Priorities 1 and 2 in Table 21 are well defined but would require planning and additional field assets. Although freight technologies (Priority 3) are being tested, the regulatory and legal requirements are unclear. The trucking fleet is not adopting onboard screening and diagnostic systems uniformly (Priority 4),

and public access to this onboard screening data is not mandated. Finally, OS/OW permit standardization (Priority 5) would require revisions to state laws.

- Public-sector and private-sector roles: How does the relative ownership and responsibility for these strategies fall among the public and private sectors? At first, truck parking information systems will focus on public assets, but the ultimate goal is to include private truck stops, which control many more spaces. The deployment of new freight technologies will likely be driven by companies creating the technologies and the carriers adopting them. Roadside safety communication and permitting standardization primarily involve the public-sector, since public agencies own the assets or are responsible for the regulations.
- Implementation outlook: All things considered, what are the overall prospects for strategy implementation?

Table 21. Interstate 10 Western Freight Corridor Strategy Priorities

	Truck Parking Availability Systems	Advanced Freight Traveler Information Systems	Highway Environment Conducive to Next-Generation Technologies	Roadside Safety Communication	Permitting Standardization
Coalition Priority	1	2	3	4	5
Time Horizon	Short	Mid-term	Long term	Long term	Long term
Available Resources	Robust public funding	Robust public funding	Robust private funding	Limited funding	Limited funding
Strategy Readiness	Public systems in deployment; private apps available	Data collection in place; incident severity metrics less defined	Multiple systems being tested; institutional relationships to be determined	E-screening not universal among fleets; unclear public access to levels of onboard data	Some permit information sharing could be possible given state laws
Public/Private-Sector Roles	Early: 80%/20%; Ultimate: 30%/70%	70%/30%	20%/80%	70%/30%	80%/20%
Implementation Outlook	Coalition applied for grant for public parking; high priority for industry	Need expansion to rural areas, connection to carrier systems; could create competitive advantage	Extensive private deployments underway; public roles to be clarified	Need common public standards among agencies; issues of private data sharing are unclear	Regulatory regimes vary among coalition states; harmonization is needed

HOW WOULD THE STRATEGIES WORK?

What would be the practical impacts for state agencies, freight shippers, and carriers if all five corridor strategies were to be deployed? This chapter presents two conceptual scenarios of events that involve interactions of the roadway environment, the freight movements associated with a driver and carrier, and the agencies and procedures that guide that movement. The scenarios show the interactions that allow the corridor strategies and functions to achieve their collective missions. These scenarios provide a picture of the corridor operating in its built-out configuration and supplying the services that the coalition has identified in the five strategies included in this planning framework.

Scenario 1: Automated Truck Movement from El Paso, Texas, to Riverside, California

This scenario is suggested by and expanded upon from current shipments of white goods (refrigerators and washing machines manufactured in maquiladoras in Mexico) from El Paso to California along I-10 using driver-assisted autonomous truck operations (Embark is an autonomous truck company that is currently shipping Electrolux/Frigidaire goods from El Paso to the Los Angeles area.) In this scenario, the driver hopes to make the entire journey within the allowed 11-hour HOS window. This scenario is described in more detail in the step-by-step elements in Figure 32, which shows the location of each step by number, as then detailed in Table 22.

The envisioned trip begins at a yard in El Paso, Texas, as a driver in a standard tractor picks up a trailer filled with refrigerators and drives it to a transition point along I-10. Once there, the driver unhooks the trailer, and the trailer is then connected to an autonomous tractor with partial driver control. That truck carries the load 650 miles along I-10, handing it off to a driver at a transition point somewhere between Indio and Palm Springs, California, where the trailer is switched to a standard tractor for operations in the urban area with more traffic and more complicated street networks. That standard tractor and trailer is driven to an Electrolux distribution center in Riverside, California.

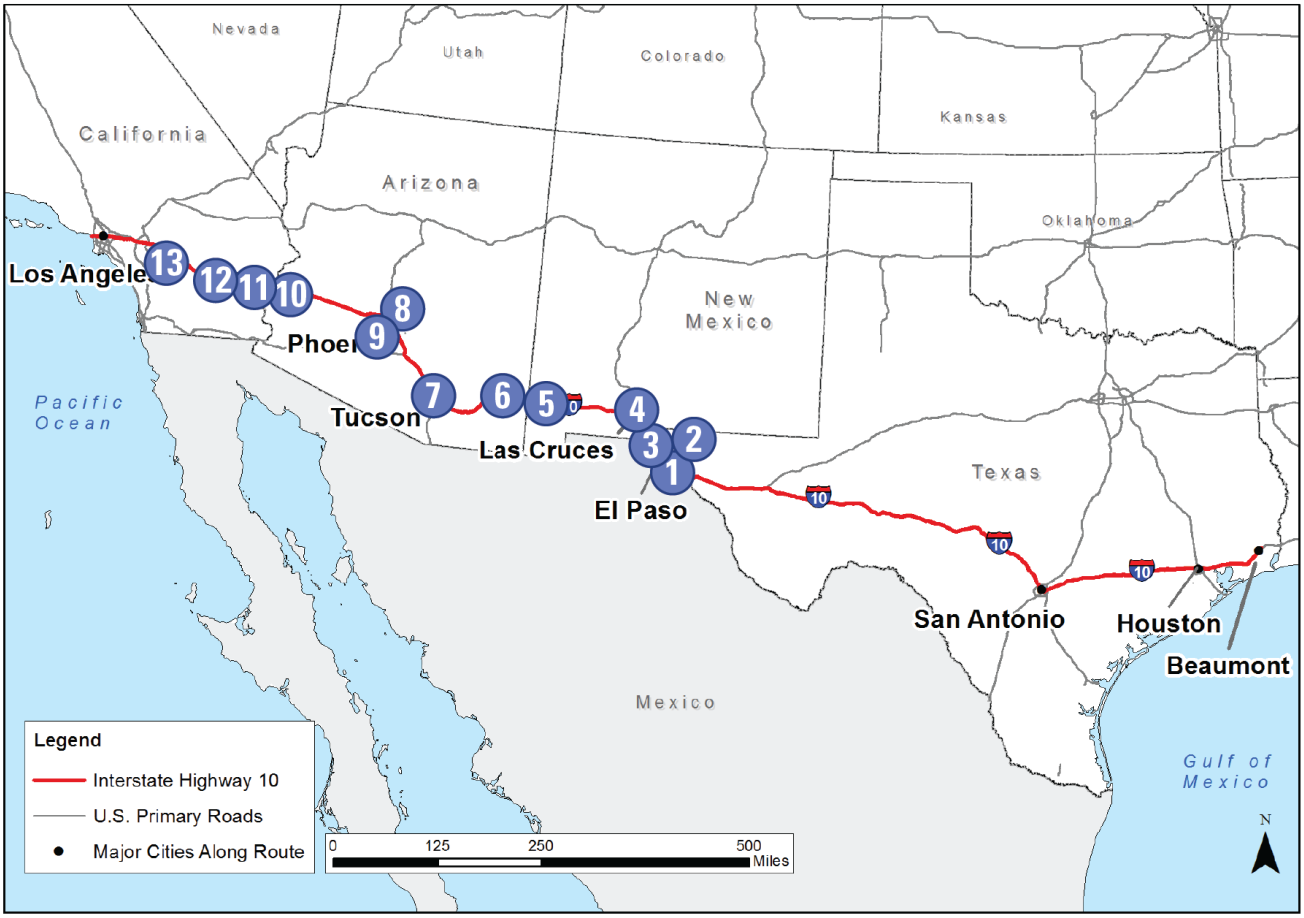


Figure 32. Interstate 10 Scenario 1 Conceptual Representation:
Automated Truck Movement from El Paso, Texas, to Riverside, California

Table 22. Scenario 1 Detailed Steps

1	**6:00 a.m.**, Mountain Daylight Time (MDT), Socorro, Texas, warehouse. Trailer of white goods leaves warehouse with conventional tractor and travels to I-10/Horizon Blvd Flying J Truck Stop in Sparks, Texas, southeast of El Paso.
2	**6:15 a.m.**, Flying J Truck Stop. The driver of an automated, instrumented Embark tractor exchanges the Electrolux trailer. The driver of the autonomous tractor enters change-of-duty status into the electronic log and begins the trip by driving the truck onto westbound (WB) I-10 and then enabling autonomous operation of the vehicle. Across the planned initial route and potential alternative routes, roadway curves and grades must be compatible with AV systems, and each corridor state has authorized the AV truck trip. The driver follows instructions for autonomous operation of the tractor as set by the Embark dispatchers and systems analysts. In areas of heavy traffic or work zones where there may be many curves through the zone, off-ramps or on-ramps, or off-interstate travel, the driver keeps full control of the vehicle. Elsewhere and where appropriate (i.e., steady traffic on interstate roads that are relatively straight), the driver enables autonomous vehicle operation.
3	**6:30 a.m.**, El Paso, Texas. Driver receives information from the Automated Freight Traveler Information System (AFTIS) on work zones and congestion in El Paso in advance of early morning rush hour. The dispatcher and driver discuss traffic conditions, construction, or weather information to determine final routing. Detecting no expected en-route delays, the trip is routed according to original plans. Had there been delays of sufficient duration or posing risks for the AV (congested driving conditions), then alternative routes would either be calculated at the dispatch center or in the vehicle or be suggested by the AFTIS. Alternatively, if traffic incidents of extended delay were to occur, the driver could, based on parking availability, park the vehicle and conserve HOS and fuel by waiting until normal traffic conditions are restored. Although no delays are expected through the El Paso area, as a precaution, the driver takes manual control of the vehicle until traffic thins out west of El Paso, at which time the driver reengages autonomous operation of the vehicle.
4	**7:30 a.m.**, Anthony, New Mexico. The driver approaches the Anthony Port of Entry (POE) (24-hour operations) and CMV safety inspection/weigh station. The vehicle's transponder conveys vehicle/driver/carrier information through the Pre-Pass/Drivewyze system, and the truck is cleared to move along without stopping. Based on proximity to a weigh/inspection station, as the truck approaches, an automated check and verification of the driver, vehicle, and motor carrier unique identifiers is launched. The vehicle's weight is also verified via a weigh-in-motion (WIM) scale upstream of the station. If the credentials check, the carrier is known to be low risk in terms of safety compliance, and if the vehicle weights are in compliance, then the driver/vehicle receives a green light in advance of inspection/weigh station via mobile app.
5	**9:30 a.m.**, Lordsburg, New Mexico. The driver pulls into a truck stop for a 15-minute bathroom break and snack. The driver checks AFTIS information systems for construction, weather, and congestion information about Tucson and Phoenix coming up to the west. The driver works with the dispatcher to check traffic conditions, construction, or weather information and to determine final routing. Expecting no en-route delays, the trip is routed according to original plans.

Table 22. Scenario 1 Detailed Steps (Continued)

6	**9:15 a.m.**, Mountain Standard Time (MST), San Simon, Arizona (where Daylight Savings Time is not observed). Driver approaches San Simon POE and CMV safety inspection/weigh station past the Arizona state line. The vehicle transponder conveys vehicle/driver/carrier information through the Pre-Pass/Drivewyze system, and the truck is cleared to move along without stopping. Arizona law enforcement is aware of the truck passing the earlier New Mexico checkpoint (Step 4) without incident. The preclearance process is executed with the same process detailed in Step 4 above.
7	**10:45 a.m.**, Tucson, Arizona. Driver enters urban section of I-10 in Tucson and receives any updated AFTIS information. ADOT crews have maintained the interstate section to remove debris and tire carcasses and kept clear pavement markings and reflectivity on all signage so that onboard cameras and sensors can uphold lane integrity in higher traffic areas. Based on the truck's location, traffic information is relayed to the truck indicating near free-flow road conditions. Driver maintains the automated status of the vehicle.
8	**12:30 p.m.**, Phoenix, Arizona. Driver pulls off interstate into truck stop for a 15-minute break and to access lunch stored in his/her onboard cooler (cumulative driving hours: 6:30). Driver takes control of the truck and pulls into the truck stop. Driver checks messages and AFTIS information. He/she sees that conditions are clear going forward.
9	**12:45 p.m.**, Phoenix, Arizona. Driver pulls back onto I-10 westbound. Driver reengages autonomous operation once safely on the interstate.
10	**2:45 p.m.**, Ehrenberg, Arizona. Driver approaches Ehrenberg POE and is cleared through preclearance lanes. Arizona law enforcement has records of preclearance events from earlier in the day. The preclearance process is executed with the same process as in Steps 4 and 6 above.
11	**3:15 p.m.**, Pacific Daylight Time (PDT, same as MST), Blythe, California. Driver approaches the WB Blythe California Highway Patrol (CHP) weigh station and is cleared through preclearance lanes. California law enforcement has records of preclearance events from earlier in the day in other states. The preclearance process is executed with the same process as in Steps 4, 6, and 10 above.
12	**3:45 p.m.**, Desert Center, California. At this point, without any delays, the driver is at nine hours and 30 minutes of cumulative driving time. If the driver had experienced any delays along the route due to construction, congestion, or weather, or from stopping at POEs, or if WB traffic en route to Riverside had been congested, then the driver and dispatcher would have identified a safe place to park somewhere between Indio and Palm Springs (suitably safe for the expensive automated tractor). The driver and dispatcher would have accessed the I-10 truck parking availability system to find public and private truck parking availability. If en-route traffic advisories warned of severe weather or incidents ahead on the truck's route that would exhaust the driver's available HOS, and if no reasonable alternate route were available, the trucking dispatch center would approve the driver's layover at an approved truck stop just inside the state line. Parking availability at truck stops would be checked and a reservation would be made by the dispatch center or by the driver via a mobile application. The application would connect the driver to a corridor-wide truck parking availability/reservation system and allow the driver to see predicted availability at upcoming truck stops and to reserve a parking space. A conventional tractor would then be dispatched to pick up the trailer at the truck stop to continue its trip to final destination.

Table 22. Scenario 1 Detailed Steps (Continued)

13	**5:30 p.m.**, Banning, California. Without any other delays and with the application of all other I-10 corridor functions, the driver reaches the CHP weigh and inspection station at Banning and exchanges the trailer with a conventional tractor. The conventional tractor (and new driver) takes the trailer 30 miles into the Riverside, California, warehouse. The conventional tractor may have pulled a trailer for the autonomous tractor to make a return trip the following day. The driver of the autonomous vehicle, having exhausted his/her available HOS, goes off duty until the next day when he/she makes the return trip with a trailer brought to him/her or as a bobtail run (without a trailer).

Scenario 2: OS/OW Movement from Long Beach, California, to Fort Stockton, Texas

This scenario envisions a permitted OS/OW load for specialty oil and gas drilling equipment manufactured in Asia, shipped through the Port of Long Beach, and destined for wells outside Fort Stockton, Texas. This scenario is described in more detail in the step-by-step elements in Figure 33, which shows the location of each step by number as then detailed in Table 23.

In advance of the OS/OW shipment, the specialty carrier could be expected to use a newly standardized permitting system, and by entering shipment information and manifests into the California permit agency, the baseline permit information for this shipment would be shared among the permit systems for Arizona, New Mexico, and Texas. This information sharing among the I-10 corridor states would make the OS/OW permit process much more streamlined.

Once the information is processed, the states return their OS/OW approvals (including routing instructions and/or route restrictions), and fees are electronically paid by the carrier; a multistate OS/OW permit is then issued via fax, e-mail, or mobile device.

Figure 33. Interstate 10 Scenario 2 Conceptual Representation:
OS/OW Movement from Long Beach, California, to Fort Stockton, Texas

Table 23. Scenario 2 Detailed Steps

Day One	
1	**7:00 a.m.,** Pacific Standard Time (PST), Port of Long Beach Terminal, California. The specialty motor carrier arrives at the terminal, and the specialty drilling equipment is loaded and secured on an OS/OW tractor trailer. The driver continues 90 miles along I-710, I-605, and CA-60 to I-10 in Beaumont, California. The driver makes use of AFTIS information on road conditions, congestion, and weather. The driver and dispatcher consult traffic condition, construction, or weather information from the AFTIS system for final routing, assuming approved alternate routes are available and are forecast to improve the trip according to carrier parameters (such as on-time or least-miles routing decisions). In this example, since no expected en-route delays are revealed, the OS/OW trip is routed according to the original plans. The carrier and shipper/receiver can determine the location of the truck/load through onboard satellite tracking systems.
2	**10:00 a.m.,** Beaumont, California. The driver enters I-10 eastbound (EB).
3	**10:15 a.m.,** Banning, California. The driver approaches the Desert Hills EB weigh station. Based on proximity to a weigh/inspection station, as the truck approaches, roadside communication systems begin an automated check and verification of the driver, vehicle, and motor carrier unique identifiers. The vehicle's weight is also verified via a WIM scale upstream from the station. The driver enters the POE. Even though the carrier participates in preclearance programs, today this OS/OW load is randomly checked to make sure the proper permits are in place and the load is secured properly. This process takes no more than 15 minutes. The driver takes a short break during this permit check. Following clearance through the POE, the driver pulls the truck back onto EB I-10.
4	**12:30 p.m.** MST, Ehrenberg, Arizona. The driver approaches the EB Ehrenberg POE weigh station and is waved through preclearance lanes. This is possible because Arizona law enforcement has records of the permit check from earlier the same morning in Banning.
5	**2:30 p.m.,** Avondale, Arizona. The driver exits I-10 for the Pilot Truck Stop and takes a short break, buying lunch for the road. The driver checks the AFTIS system for congestion and traffic information ahead in Phoenix and Tucson and sees that conditions are clear going forward.
6	**4:30 p.m.,** Tucson, Arizona. Without any other delays, the driver is now at nine hours cumulative driving time and needs to find truck parking sometime in the next two hours. The driver can communicate with the dispatcher to check the truck parking availability system for available parking in the section of rural Arizona ahead. The dispatcher finds parking available at a truck stop at Exit 340 in Willcox, Arizona.
7	**5:45 p.m.**, Willcox, Arizona. Driver exits I-10 and enters the truck stop to park for the night.

Table 23. Scenario 2 Detailed Steps (Continued)

Day Two	
	6:00 a.m., Arizona Time, Willcox, Arizona. Driver re-enters EB I-10.
9	**10:00 a.m.** MST, Anthony, New Mexico. The driver comes up to the Anthony POE (24-hour operations) and CMV safety inspection/weigh station. The truck's transponder conveys vehicle/driver/carrier information through the Pre-Pass/Drivewyze system, and the truck is cleared to move along without stopping. New Mexico law enforcement has information on permit checks in California from the previous day. The preclearance process is executed with the same process detailed in Step 4 above.
10	**1:00 p.m.**, Central Standard Time (CST), Van Horn, Texas. The driver comes up on a Texas Department of Public Safety weigh station. The vehicle transponder conveys vehicle/driver/carrier information through the Pre-Pass/Drivewyze system, and the truck is cleared to move along without stopping. Texas law enforcement has information on permit checks in other states from this trip. The preclearance process is executed with the same process detailed in Steps 4 and 9 above.
11	**1:15 p.m.**, Van Horn, Texas. The driver stops at a Pilot Truck Stop in Van Horn for a short break and to pick up lunch for the road.
12	**1:30 p.m.**, Van Horn, Texas. Driver returns to EB I-10.
13	**3:15 p.m.**, Fort Stockton, Texas. The driver exits I-10 and continues north on US 285 to deliver the load to a well site 20 miles northwest of Fort Stockton.

NEXT STEPS

This planning framework equips the four states in the pooled fund study to move ahead with strategy implementation. This section describes corridor needs, high-priority strategies, stakeholders, and the role of the stakeholders. Funding opportunities, contracting mechanisms, public-sector input, legislation, and other factors will guide the implementation of these strategies. The sequence and scope of implementation projects will drive the next steps, such as developing system requirements and design.

General Implementation Process

Each strategy will require a different path to implementation, but generally, they involve transportation technologies that are put into practice through a standard systems engineering process familiar to the state DOTs. That process involves the following steps:

- System requirements: In the requirements step, stakeholder needs are reviewed, analyzed, and transformed into verifiable requirements that define what each corridor strategy system will do

for a specific project but not necessarily how the system will do it. Working closely with stakeholders, the requirements are gathered, analyzed, confirmed, documented, and baselined. Developing the system requirements involves integrating existing systems and deployments in the corridor. The coalition states may consider contracting with a systems integrator that can represent the states as the strategies are designed and installed.

- Design: This step describes how the requirements will be met, how interfaces are detailed, how requirements are distributed to systems components, and how final off-the-shelf products are selected. As the states work on specific systems along the corridor, the agencies explore the types of services and products that may be available through existing contracts. For instance, it may be possible to obtain a specific device or service through a current contract with a partnering state DOT. Taking advantage of such collaborations could help speed the build process and provide more consistency in products and services along the corridor.
- Software/hardware development and installation: The next step is to obtain the systems that will drive the implementation of the strategies. The agencies again examine their existing contracts to identify those that overlap among multiple agencies, that can be awarded most effectively, and that are consistent with the statutes in each jurisdiction. The states determine how to share development of software and equipment in common or pooled-fund contracts and decide whether cooperative purchasing of equipment and hardware can provide consistency and lower-unit costs. The four states may need to handle field installation in their own jurisdictions, given the limitations of state transportation fund sources.
- Integration and verification: Software and hardware components are individually verified and then integrated to produce higher-level application subsystems. These components are also individually verified before being integrated with others until the complete system has been created and confirmed. These tests are typically performed by contractors and sent to the contracting agencies as evidence of successful work.
- System validation: System owners/operators run their own set of tests to make sure that the deployed system meets the original needs identified in the initial system requirements process.
- Operations and maintenance: Each strategy may be operated and maintained through a different method and protocol. For example, if the four states receive grant funding for a truck parking availability system, part of the corridor-wide grant funding may be used to develop common standards and equipment for monitoring parking availability, standards, and designs for roadside DMSs, as well as data architecture and information sharing systems. Each state might then use grant funding to install necessary equipment at each parking facility, along with systems for sharing availability information. Other strategies may need tailored plans for operations and maintenance. The four states will need to determine the best legally authorized opportunities for engaging directly with the private-sector users and/or beneficiaries of these five strategies. The states may decide that the mix of large and small trucking firms is better served in a freight traveler information system that pushes congestion, incident, work zone, and weather restrictions to third-party mapping/routing services and individual company routing

systems. States may also decide that the pace of vehicle technological change is so swift that they want to interact directly with individual firms demonstrating new platooning and vehicle automation systems before creating a corridor-wide V2I specification or strategy.

Institutional Next Steps

This report completes Transportation Pooled Fund Study 5-348, the *Interstate-10 Western Connected Freight Corridor, Volume 1: Improvement Strategies*, and identifies strategies to enhance freight operations along the corridor. In addition to fostering the technical advances necessary to develop the strategies, the states along the corridor may need to address a range of institutional issues.

Following the execution of the coalition charter in 2016, the member states developed and executed an operating agreement for the I-10 Corridor Coalition in 2017. This planning framework will enable the states to determine how to collaboratively execute the truck parking information availability system and other strategies. The coalition can identify roles for agency staff, I-10 coalition teams, and contractors. Figure 34 illustrates a possible structure for deploying the strategies. The structure distributes the tasks by three general organization types: state DOTs, technical consultants, and system integrators. In addition to these institutional issues, strategy implementation is likely to take place in phases over time, with more detailed plans being developed in each phase. The phases, illustrated in Figure 34, are:

- Phase 1—Today: This phase refers to the near-term future, with the completion of the planning framework and the set of strategies. At the same time, the coalition can consider business models by which the four DOTs bring about strategy execution. These address how project funding would be shared, how professional services would be obtained, and how the states may work together in planning and monitoring strategy development.
- Phase 2—Readiness: Once the business model is developed and the coalition governance processes are defined, the DOTs can obtain the services of the systems integrator (SI) described above, along with other technical consultants, to develop plans and specifications for necessary systems. Once the SI is engaged, that firm may proceed with the technical steps necessary to more fully plan for implementing the strategy.
- Phase 3—Build-Out: Once the plans are in place for strategy implementation, the DOTs can work with designers to acquire and install the equipment and software, both in the field along the highway infrastructure and in central facilities and control centers. The SI can be expected to work with the DOTs to ensure that local- and regional-level designs and contracts effectively synchronize and communicate as strategies are completed.
- Phase 4—Operations: Once the strategies have been implemented through procedures, systems, communication links, software, and roadside equipment, the DOTs may shift to an operational orientation, ensuring that necessary data are updated and connected. Each DOT may be responsible for ongoing systems support and maintenance.

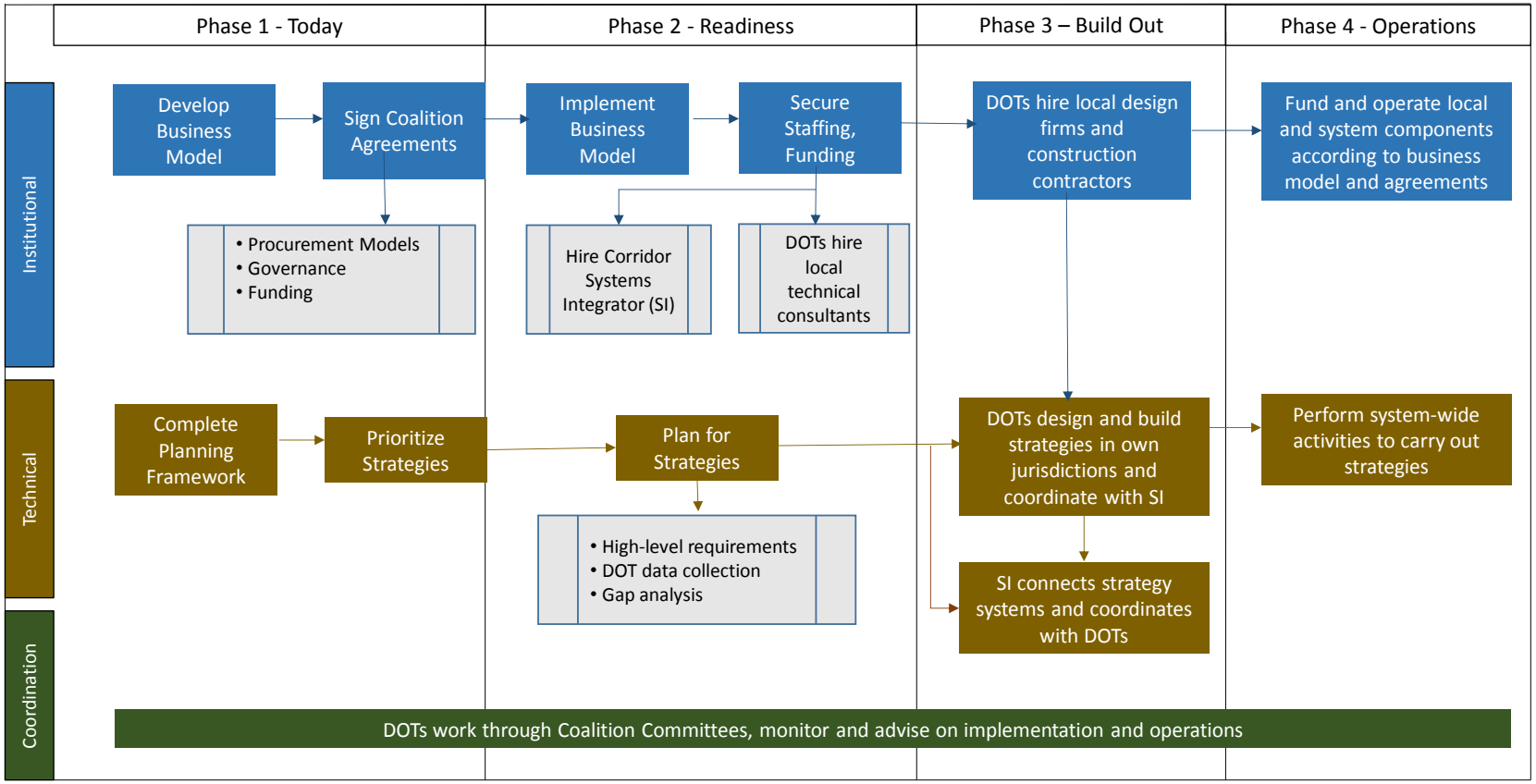


Figure 34. Strategy Implementation Process for Interstate 10 Western Freight Corridor

The I-10 Corridor Coalition member states will determine the pace and means by which these five strategies are deployed, as suggested in Table 21 above. That process will be set up through plans and agreements yet to come, building on the information used to complete this planning framework.

An illustration of this implementation process can be found in the truck parking grant application filed by the coalition states for funding under the federal Advanced Transportation and Congestion Management Technologies Deployment program. The application is attached as Appendix B and is the next phase of collaborative planning and execution among the coalition states.

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APPENDIX A. ISSUE IDENTIFICATION QUESTIONS AND INTERVIEW PROTOCOLS

Workshop Questions

Reminder from the presentation: "connected freight corridor" could refer to connecting public data for easier permitting among all four states; connecting carriers and shippers to real-time data on weather, congestion, and other incidents along the corridor; allowing faster information sharing from vehicles to roadsides to convey safety information; and equipping trucks to share information to each other for platooning and other systems to communicate vehicle to vehicle.

Considering that description:

1. What kinds of connected technologies matter to you and your industry/community right now? What sounds like the most promising improvement that may be coming in the future? What functions of a connected corridor are most effectively carried out by the public sector? By the private sector?

2. New technologies communicating information from trucks to law enforcement could help focus enforcement resources on carriers that need the most attention in terms of safe equipment, drivers, and legal loads. What kinds of systems should be in place to increase overall truck safety—weigh in motion, pre-clearance, or shared inspection records across all four states?

3. What kinds of traveler information—incidents, weather conditions, or congestion levels—would be most helpful for freight operators/corridor users? How can the states provide data that can be used by shippers and carriers in multiple systems and apps? For motor carriers large and small?

4. What can state agencies do to enable technologies that increase trucking efficiency, such as truck parking capacity information, vehicle/container/trailer tracking, load matching, or other systems? What can states do to make OS/OW permitted movements more efficient? Operation of newer technologies and operations (onboard systems or truck platooning)?

5. What kinds of capabilities/efficiencies across all four states would have the greatest effect on economic development? For logistics-related businesses and those that depend on good logistics? How important is it to businesses and communities in your state that all four states have consistent capabilities, compatible systems, and reciprocal and consistent regulations?

6. How important is it for your state that goods movement/freight operations along the I-10 corridor be improved? How much attention should freight improvements receive in transportation planning across all four states, in each state, and at the MPO and regional level?

Interview Protocol

Purpose of Study

I am [interviewer name] with the Texas A&M Transportation Institute. TTI is a research arm of The Texas A&M University System specializing in transportation research. We are working on a multi-state project sponsored by the state departments of transportation in Texas, New Mexico, Arizona, and California to examine the use of advanced vehicle and infrastructure technologies to improve the freight movement

experience for safe carriers, reduce friction for goods movement, and expand economic development. We are conducting this study for the Arizona Department of Transportation on behalf of the four-state I-10 Corridor Coalition, which also includes the departments of transportation from California, New Mexico, and Texas, which are also involved in this study. While this study focuses on the I-10 corridor in these four western states, the lessons learned here could be applied elsewhere.

Role of Stakeholder Interviews in Study

We are seeking input on the kinds of systems and improvements that can be added to improve interstate freight mobility in the western section of the I-10 corridor. We are interviewing a small number of stakeholders identified by each of the four state departments of transportation to solicit feedback from stakeholders that have an interest in freight mobility on I-10. Information from these interviews will be collected and summarized to create an overall needs assessment for the corridor. Ultimately, this stakeholder involvement will inform the development of new operational and technology solutions to enhance truck movement on I-10.

How This Information Will Be Collected and Used

I have a list of 11 questions that I would like to ask related to freight operations and mobility in the I-10 corridor. Your participation in this interview will be approximately 30–45 minutes and will consist solely of this interview by phone. I am going to take notes of our conversation, as I will for the others interviewed in this phase of our study. These notes will not include your name or company and will be treated as anonymous input.

Your Rights and Consent

Participation in this interview will involve no cost to you, nor will you be paid for participating in our study. You are not likely to have any direct benefit from participating in our study, but as a freight stakeholder in your state, you may contribute to future improvements in freight movements along I-10.

Your participation in this study is voluntary. You do not have to answer any question you do not want to answer. If at any time and for any reason you would prefer not to participate in this study, please feel free not to. If at any time you would like to stop participating, please tell me. We can take a break, stop and continue at a later date, or stop altogether. You may withdraw from this study at any time, and you will not be penalized in any way for deciding to stop participation. If you have any questions about this study, you can ask them now. If you have questions later, I will send you contact information for our principal investigator in a follow-up e-mail.

If you understand what you are being asked to do in the conduct of this study and consent to participate in this interview, please let me know by saying, “I agree to participate.”

Interview Questions

1. From your perspective as a freight operator, freight manager, or public agency, what is the most significant issue/factor/condition that hampers freight movement in the corridor?

2. Have you heard to the term “connected freight corridor” or “connected technologies” before? If so, what types of services/operations does a connected freight corridor need to support?

3. Is there a need to coordinate the operations of I-10 across multiple states? If so, under what circumstances/situation does the coordination need to occur?
    - Weather
    - Incidents
    - Construction
    - Oversized/overweight loads and permits
    - Points of entry/preclearance
    - Traveler/freight information

4. To make freight flow effective within the I-10 corridor, what do freight operators and public agencies need to know about operations in other states? When, where, and how does this information need to be provided? How do information needs change depending on how far or close an operator is to an event?

5. Are data about freight movements already being collected and shared in the I-10 corridor? If so, what kinds of data and with whom? What is the purpose of sharing data? How are these data being shared?

6. How would you prefer to receive shared data and information? For example, would you prefer to receive data via email, on a website, or by some other method? Does the data format matter?

7. How do you currently get information on major incidents or closures on I-10? What information would you like to receive on incidents and closures in the future? How would you like to receive this information?

8. Does a forum currently exist that allows stakeholder to discuss their freight mobility issues? Do you have a freight management task force or other freight advisory committee? How often do they meet? Have they been involved in these discussions?

9. What measures should be used to gauge the successfulness of a connected corridor? Can you currently collect these performance measures?

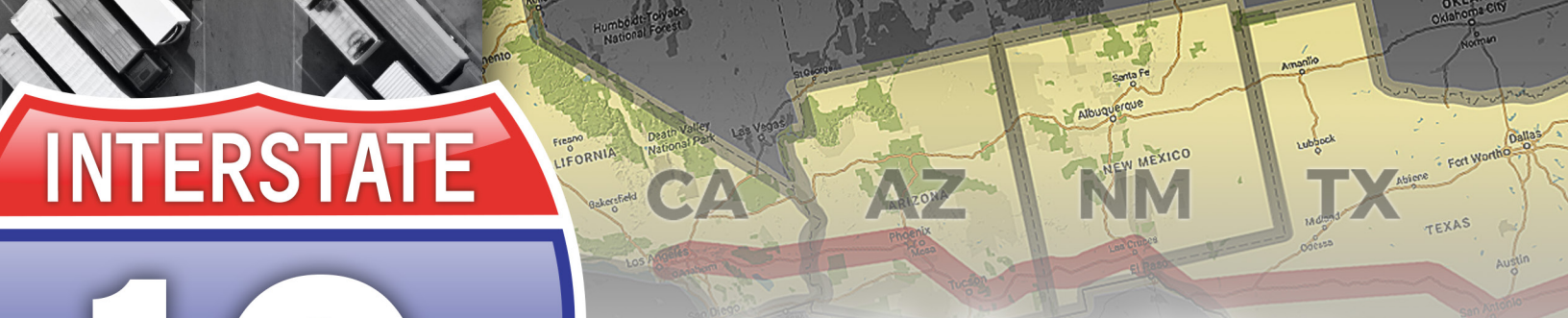
10. How consistent are the rules and regulations that govern freight mobility across jurisdictions—locally and across state boundaries? Is there a need to harmonize rules and regulations governing freight movement?

11. Do you have anything that you would like to add or any additional comments you would like to provide?

Interview Conclusion

We thank you for your time and valuable input into this needs assessment. We will be preparing a final report summarizing the needs assessment for the corridor stakeholders. If you have any other information that you would like to contribute or want to provide additional information to me at a later date, please do not hesitate to contact me by phone or email.

APPENDIX B. I-10 CORRIDOR COALITION TRUCK PARKING AVAILABILITY SYSTEM ATCMTD GRANT APPLICATION



I-10 Corridor Coalition Truck Parking Availability System

ATCMTD Grant

volume 1 – technical approach

submitted to

U.S. Department of Transportation – Federal Highway Administration

submitted by

Texas Department of Transportation

Advanced Transportation and Congestion Management Technologies Development (ATCMTD) Initiative

Applicant
Texas Department of Transportation

Type of Eligible Applicant
State Agency

ATCMTD Grant Request
$6,850,000

Location
California, New Mexico, Arizona, Texas

Congressional Districts
California (CA 08, CA 27, CA 31, CA 32, CA 33, CA 34, CA 35, CA 36, CA 37, CA 39, CA 40)**; Arizona** (AZ 1, AZ 2, AZ 3, AZ 4, AZ 7, AZ 8, AZ 9)**; New Mexico** (NM 2)**; Texas** (TX 02, TX 07, TX 10, TX 11, TX 14, TX 15, TX 16, TX 18, TX 21, TX 23, TX 27, TX 28, TX 29, TX 36)

NOFO Number
693JJ318NF00010

JUNE 2018

I-10 CONNECTS
I-10 CORRIDOR COALITION

Texas Department of Transportation
Caltrans
ADOT
NMDOT

SECTION I—COVER PAGE

Project Name	I-10 Corridor Coalition Truck Parking Availability System (I-10 Corridor Coalition TPAS)
Eligible Entity Applying to Receive Federal Funding	Texas Department of Transportation (TxDOT)
Total Project Cost (from all sources)	$ 13,700,000
ATCMTD Request	$ 6,850,000
Are matching funds restricted to a specific project component? If so, which one?	No
State(s) in which the project is located	California, New Mexico, Arizona, Texas
Is the project currently programmed in the • Transportation Improvement Program (TIP) • Statewide Transportation Improvement Program (STIP) • MPO Long-Range Transportation Plan • State Long-Range Transportation Plan	 No No No No
Technologies Proposed to Be Deployed (briefly list)	i. Advanced traveler information systems ii. Advanced transportation management technologies iii. Infrastructure maintenance, monitoring, and condition assessment v. Transportation system performance data collection, analysis, and dissemination systems

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SECTION II—PROJECT NARRATIVE

1. INTRODUCTION

The I-10 Corridor Coalition, whose members comprise the departments of transportation (DOT) of California, Arizona, New Mexico, and Texas and which is supported by the trucking associations of each State, are pleased to submit this application to partner with U.S. DOT on the I-10 Corridor Coalition Truck Parking Availability System (I-10 Corridor Coalition TPAS). Texas Department of Transportation (TxDOT) is the lead applicant and is seeking $6.85 million in 2018 ATCMTD grant funding to implement a truck parking availability detection and information dissemination system at 37 public truck parking locations along the I-10 Corridor from California to the Texas. The objective of this system is to make available to truck drivers and dispatchers in real time truck parking information to assist them in making informed parking decisions. The four States have committed to match the grant 1:1 with other available non-Federal funds or in-kind match to maximize safety, mobility, operational, environmental, and state-of-good-repair elements along the Corridor. These benefits are detailed in this application, and laid out in the Benefit/Cost Analysis (BCA).

Who: The I-10 Corridor Coalition.

What: A **Truck Parking Availability System** (TPAS) including truck parking space utilization and information dissemination technology

Where: 37 public truck parking facilities on I-10 in California, Arizona, New Mexico, and Texas

When: Fully **deployed within 4 years** of Notice to Proceed.

Why: This project has a **benefit/cost ratio** of 5.6 at a 3% discount and 4.7 at a 7% discount. Providing truck parking availability information **increases public safety** by reducing fatigue-related crashes with associated **reductions in congestion and delay**, reduced time searching for parking, **reduced emissions and fuel use,** and limits **damage to public highway infrastructure.**

Knowing the number of truck parking spaces that are available at any given time and communicating that information to drivers is the key objective of this project.

Interstate 10 is part of the National Primary Highway Freight System (PHFS). This is a network of highways identified as the most critical highway portions of the U.S. freight transportation system determined by measurable and objective national data. I-10 Corridor is a critical national trade Corridor and the segment from California to Texas connects 4 of the 10 largest U.S. sea ports by tonnage (Los Angeles, Long Beach, Houston, and Beaumont). Under current conditions, drivers frequently waste significant amounts of time looking for a place to park and rest for a required break or at the end of their work day. Drivers who have not found parking before exceeding their Hours of Service (HOS) are often forced to park in unauthorized, unsafe locations such as those shown in Figure 1—highway shoulders, on and off ramps, or on local streets. This lack of adequate, safe truck parking is a national issue that has gained widespread attention in the years following the death of Jason Rivenburg and the subsequent passing of Jason's Law.

The Federal Highway Administration (FHWA) in 2012 noted that 36 State departments of transportation (DOT) reported a lack of commercial vehicle parking. All four States in the I-10 Corridor Coalition—California (Caltrans), Arizona (ADOT), New Mexico (NMDOT), and Texas (TxDOT)—indicated multiple issues, including not enough capacity at public and private rest areas and trucks parking on highway shoulders, interchanges, and on local roads near the highway.

Figure 1: Truck Parking on Ramp,
Texas Canyon Rest Area, AZ

The inclusion of truck parking technology as a funding area in the United States Department of Transportation's (U.S. DOT) 2018 Notice of Funding Opportunity (NOFO) for the Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) grant program provides a great opportunity to address parking needs in the Corridor through the deployment of an I-10 Corridor Coalition Truck Parking Availability System (I-10 Corridor Coalition TPAS). Utilizing proven technology being deployed in Florida and the Mid-America Association of State Transportation Officials (MAASTO) Regional Truck Parking Information Management System (TPIMS). This system will improve mobility and safety along this critical freight Corridor, reduce infrastructure damage and diesel emissions, as well as save commercial truck drivers thousands of dollars a year in lost earnings.[1] The initial deployment described in this grant also can serve as the foundation for future technology implementation in the Corridor, including integration of weather or other alert systems, a truck parking reservation system, and automated and connected vehicle and infrastructure technology.

The I-10 Corridor Coalition is the multijurisdictional group that will oversee this project under the coordination of TxDOT. This Coalition includes four State DOTs (CA, AZ, NM, and TX) that are organized under a charter and operating agreement. The primary objectives of the Coalition are to:

- Explore the technical and operational feasibility of a multijurisdictional I-10 Corridor.
- Develop a model for regional cooperation and interoperability that can be expanded to other States in the southwest U.S. and across the remainder of the I-10 Corridor (Louisiana, Mississippi, Alabama, Florida).
- Support development of technology standards to improve movement of people and freight along the Corridor.

The Coalition is focused on the reconfiguration, expansion, utilization, and integration of intelligent transportation systems (ITS) and connected and autonomous vehicle (CAV) and infrastructure technologies to better accommodate future demand, while increasing efficiency and reliability along the I-10 Corridor.

2. GEOGRAPHIC SCOPE

Through the I-10 Corridor Coalition States, Interstate 10 runs approximately 1,700 miles from the Pacific Ocean and California State Route 1 in Santa Monica, CA to Texas. It is the main east-west link between the Ports of Los Angeles and Long Beach (and the greater Los Angeles region)

[1] American Transportation Research Institute's diary research, released in December 2016, documented the amount revenue lost by drivers who stop driving early in order to find and secure a parking space. With an average of 56 minutes of revenue drive time sacrificed by drivers per day, the parking shortage effectively reduces an individual driver's productivity by 9,300 revenue-earning miles a year, which equates to lost wages of $4,600 annually.

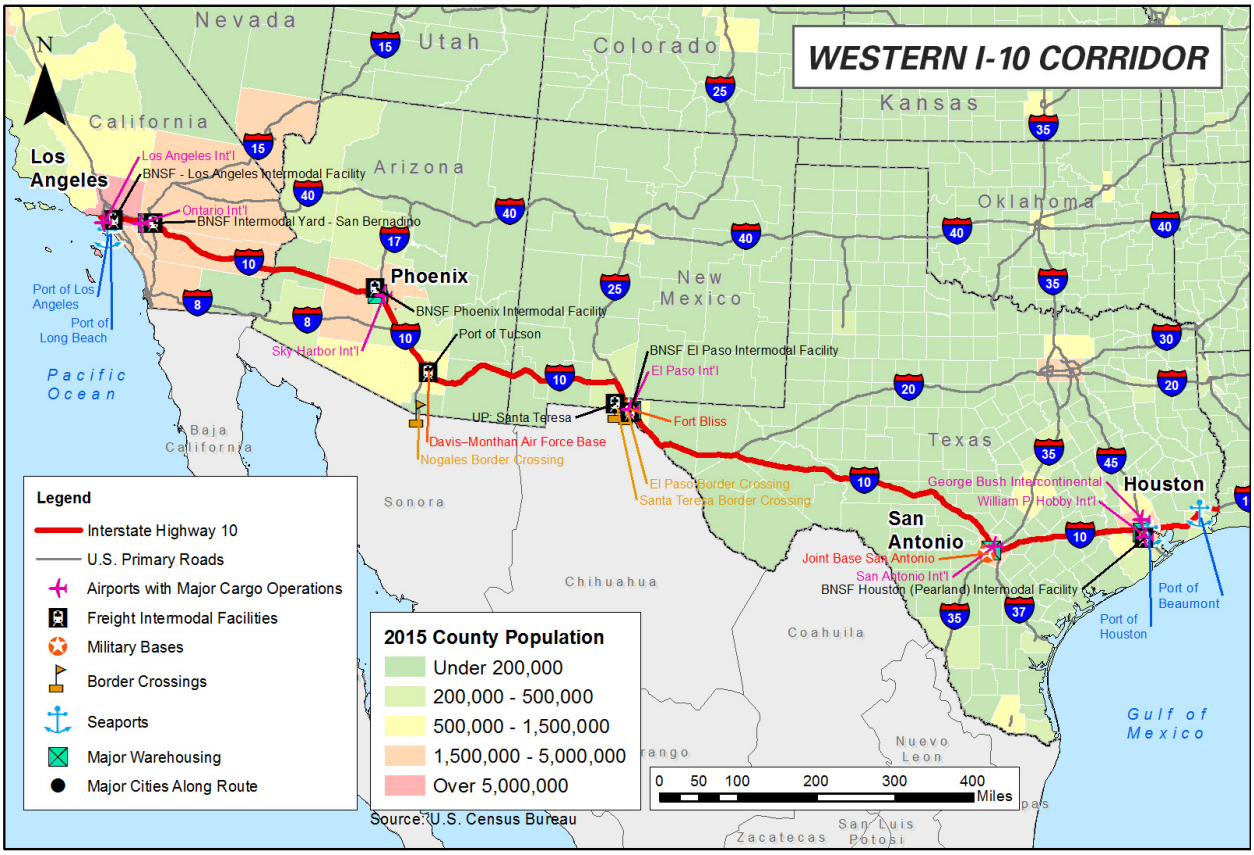
to the Ports of Houston and Beaumont, passing through major metropolitan areas, including Phoenix, Tucson, El Paso, San Antonio, Houston, and Beaumont, and ultimately linking much of the southeastern United States. The Corridor is shown in Figure 2 along with key freight and transportation facilities and intersecting highways.

Table 1: I-10 Mileage by State

California	Arizona	New Mexico	Texas
243 miles	392 miles	164 miles	881 miles

Source: FHWA Route Log and Finder List, 2017. Accessed May 24, 2018.

Figure 2: Project Geography and Key Transportation Facilities



3. ISSUES AND CHALLENGES ADDRESSED

The I-10 Corridor is one of the key economic arteries in the United States, stretching approximately 1,700 miles through the 4 I-10 Corridor Coalition States. On its western end, the Ports of Los Angeles and Long Beach (San Pedro Bay Ports) via Interstate-710 and Interstate-110 are the busiest container ports in the Nation,[2] transferring goods between ships and trucks bound to destinations throughout the country. In Texas, the Port of Houston is the 6th busiest container port in the Nation and the busiest U.S. port by foreign waterborne tonnage and Port of Beaumont, Texas is the 5th largest in the U.S. in terms of annual tonnage and is the #1 military cargo port in the country.[3] Between them, I-10 serves:

[2] https://www.portoflosangeles.org/about/facts.asp. Accessed May 24, 2018.
[3] https://www.portofbeaumont.com/. Accessed May 24, 2018.

- Major metropolitan areas, including Los Angeles, Riverside-San Bernardino, Phoenix, Tucson, Las Cruces, El Paso, San Antonio, and Houston.
- Critical military bases, including Davis-Monthan Air Force Base, Fort Bliss, and Joint Base San Antonio.
- The El Paso International Border Crossing which processed nearly 780,000 inbound trucks in 2017.[4] For numerous other U.S.-Mexico border crossings, I-10 is the first east-west Interstate north of the border.
- Large rail-truck intermodal facilities in each State which provide an alternate option for long-distance shipments.
- Major international airports, including Los Angeles International Airport, Sky Harbor International Airport (Phoenix), and George Bush Intercontinental Airport (Houston).

The communities along the I-10 Corridor are home to businesses that produce and ship goods as well as millions of consumers who depend on stores being stocked with everything from groceries to building supplies to clothes—or want those same items delivered directly to their door.

> The National I-10 Freight Corridor Study estimated the economic impact of freight moving along the I-10 Corridor at $1.38 trillion annually.

The National I-10 Freight Corridor Study examined the economic impact of the entire I-10 Corridor on the economies of California, Arizona, New Mexico, Texas, Louisiana, Mississippi, Alabama, and Florida. The report estimated that freight movement in the Corridor would grow by twice the rate of passenger traffic by 2025. Keeping these trucks moving is critical to support the $1.38 trillion in economic impact the Corridor generates.[5] The 4 States in the I-10 Corridor Coalition greatly benefit from that economic activity, but it comes with a number of challenges.

Freight flows between these States are heavily reliant on trucks to safely and efficiently move goods. Sections of the I-10 Corridor in these 4 States carry more than 26,000 large commercial trucks per day with statewide averages ranging from more than 5,300 combination trucks in New Mexico to nearly 10,400 trucks in California (see Table 2 below). These combination trucks are more likely to be involved in long-distance trade. With longer hours on the road, the need to take rest breaks to meet HOS requirements increases.

Table 2: Combination Truck Average Annual Daily Traffic (AADT), ***2015***

State	Average Truck AADT	Maximum Truck AADT
California	10,398	26,078
Arizona	5,900	8,426
New Mexico	5,382	18,572
Texas	6,358	17,048

Source: Highway Performance Management System (HPMS), 2015.

Approximately 1,270 miles or 75 percent[6] of the total length among the 4 Coalition States are in rural areas. Uncertainty about available spaces is compounded on these long stretches of road with limited amenities and safe places to park where the next stop may be a hundred miles away. The lower truck volumes in these areas combined with sparse population make the business

[4] U.S. Bureau of Transportation Statistics, Border Crossing/Entry Data. Accessed May 24, 2018.
[5] Includes Louisiana, Mississippi, Alabama, and Florida. http://www.firstcoastvision.com/I-10_Freight_Corridor_Study.pdf. Accessed May 24, 2018.
[6] Estimate based on GIS analysis of 2015 National Highway Planning Network data using U.S. Census Urbanized Areas and Urban Clusters.

case for building private truck parking difficult, often leaving the public sector to fill in the gaps and provide this critical amenity. Of the 37 public rest areas selected for I-10 Corridor Coalition TPAS deployment, 33 are in rural areas.[7]

> By making the commercial driver and the truck more productive during their Hours of Service, this project will result in improved benefits to the private-sector freight community, thus enhancing economic competiveness along the I-10 Corridor.

Driving through urban areas in the I-10 Corridor comes with its own set of challenges. Approximately 430 miles (25 percent) of I-10 in the 4 States passes through an urbanized area or urban cluster. Congestion in the Los Angeles-Long Beach-Anaheim, CA metropolitan area cost truck drivers more than $1.25 trillion in 2015 (7th highest in the U.S.) and congestion in the Houston-The Woodlands-Sugar Land, TX metropolitan area cost truck drivers more than $1.15 trillion in 2015 (8th highest in the U.S.).[8] Moreover, interchanges with I-10 are among the worst truck bottlenecks in the country, including interchanges with I-45, U.S. 59, I-610 (west), and I-610 (east) in Houston, TX (#11, #13, #33, and #38 respectively), with I-15 in San Bernardino, CA (#26) and with I-17 in Phoenix (#40) in the top 100.[9] Congestion can force truck drivers to max out their HOS without gaining much distance. In turn, the lack of truck parking in and around urban areas can contribute to congestion by forcing trucks to stay on the road and search for available truck parking spaces.

The combination of long stretches of rural road and high truck volumes in urban areas also increases the potential for crashes. Crashes involving fatigued truck drivers are a particular problem that the I-10 Corridor Coalition TPAS project aims to improve. Data from the 4 States shows an average of nearly 206 truck-involved, fatigue-related crashes a year resulting in 4 fatalities and nearly 70 injuries on I-10.[10]

Figure 3: Truck Parking on Ramp,
Texas Canyon Rest Area, AZ

All of these issues and challenges reinforce the need to provide adequate and safe truck parking for drivers in the Corridor.

Truck parking needs are divided into two categories: **1) A lack of information;** and **2) A lack of supply**. Arizona, New Mexico, and Texas have all recently finished, or are in the process of conducting, truck parking studies to better

[7] Wildwood Safety Roadside Rest Area (EB) in Redlands, CA and Anthony Welcome Center (WB) in Anthony, NM are in urban areas.

[8] http://atri-online.org/wp-content/uploads/2017/05/ATRI Cost-of-Congestion-05-2017.pdf. Accessed May 24, 2018.

[9] http://atri-online.org/wp-content/uploads/2017/01/2017-ATRI Bottleneck-Brochure.pdf. Accessed May 24, 2018.

[10] For Texas, crashes in state database with fatigue as a contributing factor were included. For California, New Mexico, and Arizona, a fatigue-related factor of 13 percent was used consistent with FMCSA statistics. See: https://www.fmcsa.dot.gov/safety/driver-safety/cmv-driving-tips-driver-fatigue. Accessed May 23, 2018.

understand these needs and develop plans to address them within their States. The I-10 Corridor Coalition TPAS directly addresses the first of these needs: a lack of information. Even when truck parking spaces are available in the I-10 Corridor, drivers often do not know where to find them. If a parking area is full, drivers need to know this before arrival in order to develop alternative plans. Knowing the number of available spaces at any given time and communicating that information to drivers is the key objective of this project. In addition, this information can help make informed decisions regarding the need for additional capacity.

The inability for truck drivers to find safe truck parking can result in a number of negative consequences for both public and private-sector stakeholders, including but not limited to:

1. Tired truck drivers and those approaching their HOS limits may continue to drive over their limit, increasing risks to public safety. Nationwide, it is estimated that 13 percent of commercial vehicle-related crashes involve a fatigued driver.[11]
2. Truck drivers may choose to park at unsafe locations, such as the shoulder of the road and exit ramps. In addition to the safety risk of parking in these locations, this causes damage to publicly owned infrastructure that is not designed to accommodate heavy trucks.
3. Drivers searching for parking incur costs associated with increased trip miles, vehicle wear, and fuel consumption. This additional driving has negative and costly impacts on highway infrastructure and increases vehicle emissions.
4. Truck drivers may stop driving before reaching their HOS limits in order to secure a space to park. This has a negative impact on productivity with resulting cost penalties to companies and, ultimately, consumers. The American Transportation Research Institute (ATRI) recently estimated that drivers lose an average of 56 minutes a day in driving time due to the need to find parking. This results in a cumulative opportunity cost of approximately $4,600 per driver annually,[12] a figure that may go up as HOS are more actively enforced due to the mandated use of ELDs.

> There are an average of 206 truck-involved, fatigue-related crashes each year on the I-10 Corridor.

Collecting and disseminating truck parking availability information to drivers will help mitigate these challenges.

Although this project does not directly address the second issue—**truck parking supply**—by providing better information to dispatches and drivers, the project will allow for a more efficient use of existing supply. In addition, a nominal number of spaces may be added during site preparation (e.g., through re-striping or pavement maintenance) associated with the installation of truck parking space utilization technology (discussed further below).

The initial deployment of the I-10 Corridor Coalition TPAS will focus on collecting and publishing truck parking information for public facilities. This will be accomplished through the use of Dynamic Parking Capacity Signs (DPCS), existing State 511 and road information system platforms, and the development of an I-10 Corridor truck parking smartphone application. This application will serve as the base for anticipated future technology deployments in the Corridor (see Section 10) and ensure that information is available to drivers regardless of private-sector involvement. However, as requested, data also will be made available to 3rd party applications and websites to promote widespread use of truck parking availability information.

[11] https://www.fmcsa.dot.gov/safety/driver-safety/cmv-driving-tips-driver-fatigue Accessed May 23, 2018.
[12] American Trucking Associations presentation to I-95 Corridor Coalition (5/2/18).

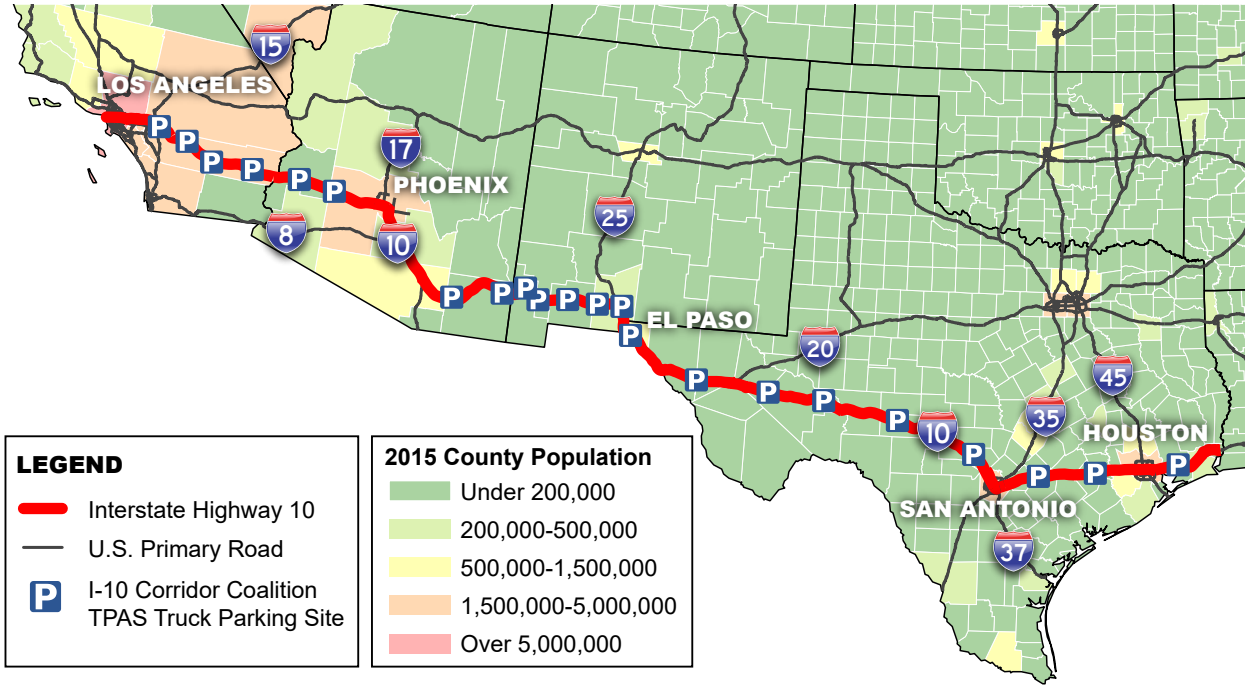
4. TRANSPORTATION SYSTEMS AND SERVICES

The project has an estimated Benefit-Cost Ratio of 5.6 at a 3 percent discount and 4.7 at a 7 percent discount.

As previously described, the I-10 Corridor through California, Arizona, New Mexico, and Texas is a key strategic artery for commerce in the United States. With some segments of the Corridor carrying more than 26,000 combination trucks a day, providing parking for those vehicles is a critical need. Although some of these vehicles are moving goods a short distance (i.e., from a business to a rail yard or from a distribution center to a store), many are traveling longer distances. While most truck drivers require short-term parking at some point during their trips for food, fuel, or short rest breaks, the larger need for trucks is long-term parking to allow drivers to adhere to HOS rest requirements.[13]

This project is focused on deploying technology to identify truck parking space availability at 37 public truck parking facilities with a total of more than 550 truck parking spaces on the I-10 Corridor (see Figure 4), and disseminating that data to drivers, dispatchers, and public-sector stakeholders through roadside message signs, smartphone applications, and online.

Figure 4: I-10 Corridor Coalition TPAS Truck Parking Sites



This grant application supports deployment of three categories of technology: truck parking space utilization, availability, and information dissemination. Although the following sections describe these separately, the technologies are directly linked. The parking space utilization technology determines the number of available parking spaces and feeds that data to the information dissemination technology, which is then provided to truck drivers and dispatchers.

Truck Parking Space Utilization and Availability

The I-10 Corridor Coalition TPAS project anticipates utilizing two key systems to determine truck parking space utilization and availability—1) a site volume approach using in-ground loop sensors

[13] This parking is usually to meet the 10 consecutive hours off duty requirement. See: https://www.fmcsa.dot.gov/regulations/hours-service/summary-hours-service-regulations. Accessed May 24, 2018.

to measure truck volume entering and leaving a site and 2) a vehicle occupancy detection approach using in-ground magnetic sensors to detect if a space is occupied. The choice of deployment between these two technologies at each truck parking site will be determined through further study conducted after award of grant funding.

Figure 5: Truck Parking in San Antonio, TX with Lined Spaces

Site Volume Approach

The first approach to determining truck parking availability measures site volume, or the number of vehicles entering and leaving the site. By comparing this to the overall number of spaces, an occupancy rate can be calculated.

At sites with the appropriate layout and operating characteristics, this project will utilize loop sensors at the entrance and exit to a truck parking facility to determine the number of vehicles that enter and leave a site. This approach works best at sites with a single truck ingress point and a single truck egress point to avoid counting other vehicles. Loop sensors are a proven technology used by State DOTs to measure traffic volumes in a number of different settings. By comparing the number of trucks that enter and leave the site to the total number of spaces, a utilization rate can be calculated.

This approach can be very cost effective, especially at larger sites where the cost to install a vehicle detection system rises in proportion to the number of truck parking spaces. However, accuracy can be an issue with this approach as there is no way to verify if trucks are actually parking in spaces as opposed to open ground elsewhere in the lot. Additionally, there is limited ability to gather more detailed data, such as the average length of stay, that allows for predictive analytics of truck parking needs. A closed-circuit television (CCTV) feed can be used to baseline the system and check for accuracy but this raises the cost and requires additional human resources to operate.

Other site volume approaches considered include laser detection, Radio-frequency identification (RFID) transponders, and Commercial Mobile Radio Services (CMRS) wireless communication technology. Laser systems are mounted at the entrance and exit to a facility and track volume by counting the number of times the laser beam is broken. The main issue with this approach is accuracy. Adverse weather conditions, including snow, rain, fog, or dust can disrupt the laser beam and lead to a false count. RFID transponders are highly accurate, but only a subset (between 10 and 20 percent) of the national trucking fleet has transponders as of 2018, so obtaining a reliable count is difficult unless the technology is more widely adopted.

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Figure 6: ELD Mandate Timeline

However, electronic logging devices (ELD) which will be mandatory as of December 2019 in most long-haul trucks (see Figure 6), operate using CMRS and have a screen that could display truck parking-related information.[14,15] Future partnerships between ELD manufacturers and the transponder and truck parking application markets could make this technology viable for dual use for both tracking HOS and providing truck parking information.

Parking Space Vehicle Occupancy Detection Approach

The second approach to determining truck parking availability determines occupancy by detecting if a space is occupied. Within this approach there are a number of available technologies, each with their own strengths and weaknesses, as shown in Table 3.

Table 3: Vehicle Occupancy Detection Systems, *Strengths and Weaknesses*

System Name	Strengths	Weaknesses
In-Ground Sensors	• Widely tested and deployed. • Relatively low cost.	• Accuracy concerns. • Requires facility closure for installation and maintenance.
Video-Detection	• Flexible. • Easy to configure or reprogram remotely. • Low installation and maintenance costs.	• Accuracy issues in inclement weather (snow, rain) and vulnerable to the elements (wind, sun, etc.). • Require interpretation to be effective.
Light and Laser Detection	• Highly accurate.	• Do not classify vehicle types. • High cost to install and maintain. • Vandalism and theft concerns. • Require controlled entry/exit points for the parking area.

Source: North Carolina Truck Parking Study, 2017.

The in-ground sensor node vehicle detection method is well tested and used in deployments throughout the country. Compared to the other vehicle occupancy detection methods, the costs are relatively low. Reliability concerns can be minimized with the deployment of multiple sensors per space (for accuracy weakness) and with planning and public information campaigns (for facility closure). Resulting information, including average length of truck parking occupancy and peak hours, can be used to develop predictive analytics. For these reasons, the in-ground sensor method is one of two specific truck parking space utilization technologies that will be deployed as part of the I-10 Corridor Coalition TPAS project.

[14] Automatic On Board Recording Devices (AOBRD) satisfy the requirement for the December 2017 deadline. These devices do not have the same display capabilities as an ELD. AOBRD will not meet the requirements after December 2019. See: https://www.fmcsa.dot.gov/hours-service/elds/implementation-timeline. Accessed May 24, 2018.

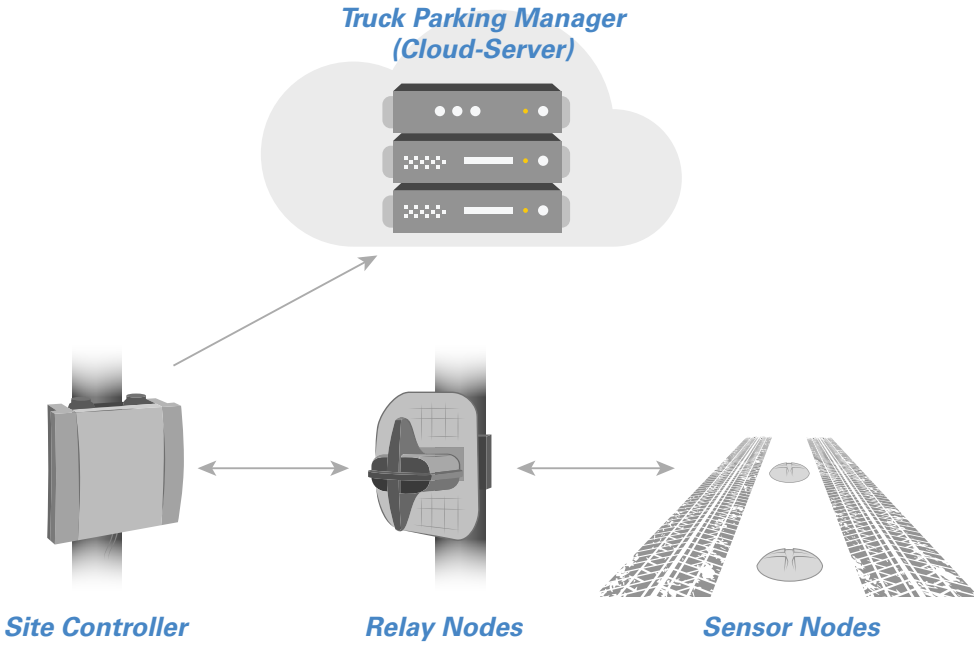
[15] Unlike current transponders used in commercial vehicle bypass systems or electronic tolling which display bypass/pull-in instructions using green and red lights.

This in-ground sensor method requires four key pieces of technology:

- **In-Ground Sensor Nodes:** Wireless, lithium battery (with a life of 7 to 10 years) powered in-ground sensors to determine space occupancy. Two deployed per truck parking space to improve accuracy in detecting smaller trucks.
- **Relay Nodes:** Wireless, lithium battery powered. Attached to poles at site to collect data from sensors. The number required depends onsite layout.
- **Data Collector:** Powered, one per site. Aggregates all data from relay nodes and transmits to a central location for processing.
- **Truck Parking Management System:** Off site. Data processing, performance and system management, and connection to information dissemination system.

The links between these component pieces are shown in Figure 7.

Figure 7: In-Ground Sensor Node Truck Detection System



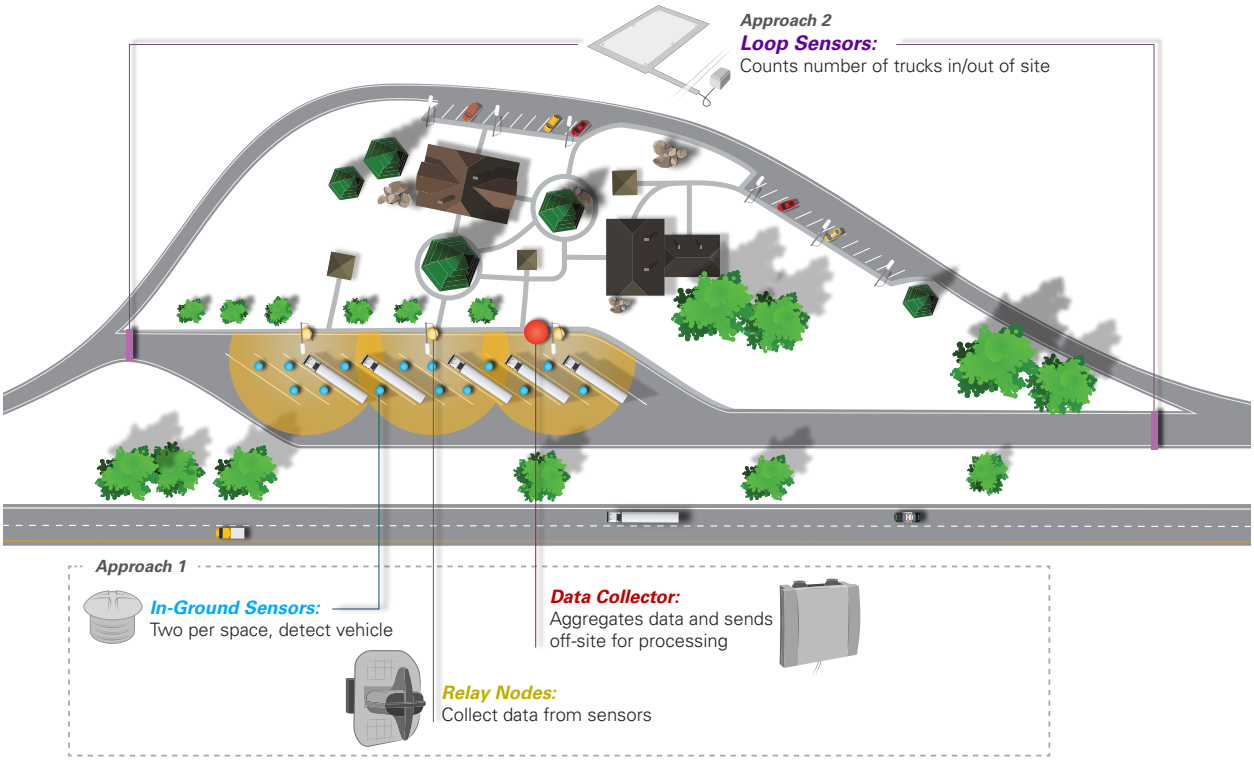
Due to the variety of layouts in the 37 public truck parking locations selected for the I-10 Corridor Coalition TPAS, the two primary approaches will be in-ground magnetic sensors and, where allowed by site layout and operational circumstances, loop sensors. System design will define the appropriate technologies for each of the parking sites.

For the purposes of this application and the benefit/cost analysis, the cost to install in-ground sensors at every truck parking location is used to provide a conservative benefit/cost ratio. For smaller sites (less than 15 spaces), in-ground sensors would be the preferred approach due to lower overall cost than loop detectors, higher accuracy of the system, and ability to deploy at any location, regardless of site geometry or ramp configuration. At larger sites, the loop sensor site volume approach may be more cost effective, but successful deployment is reliant onsite design. Due to this uncertainty, using the more expensive in-ground sensors as the cost baseline for all sites produces a higher cost and a more conservative estimate.

The Benefit/Cost Analysis assumes the use of in-ground sensors “pucks” at all truck parking sites. This produces a higher overall cost and a more conservative Benefit/Cost Ratio.

Figure 8 below shows a conceptual deployment of the two approaches. Both approaches—Vehicle Occupancy Detection using in-ground sensors (Approach 1) and Site Volume using loop sensors (Approach 2)—are shown in this diagram although.

Figure 8: Space Utilization Technology Approaches



Information Dissemination

Information on the number of available spaces must be combined systemwide and provided to drivers and fleet management staff. There are two main paths for this information dissemination—Dynamic Parking Capacity Signs (DPCS) and smartphone or web-based applications.

Dynamic Parking Capacity Signs

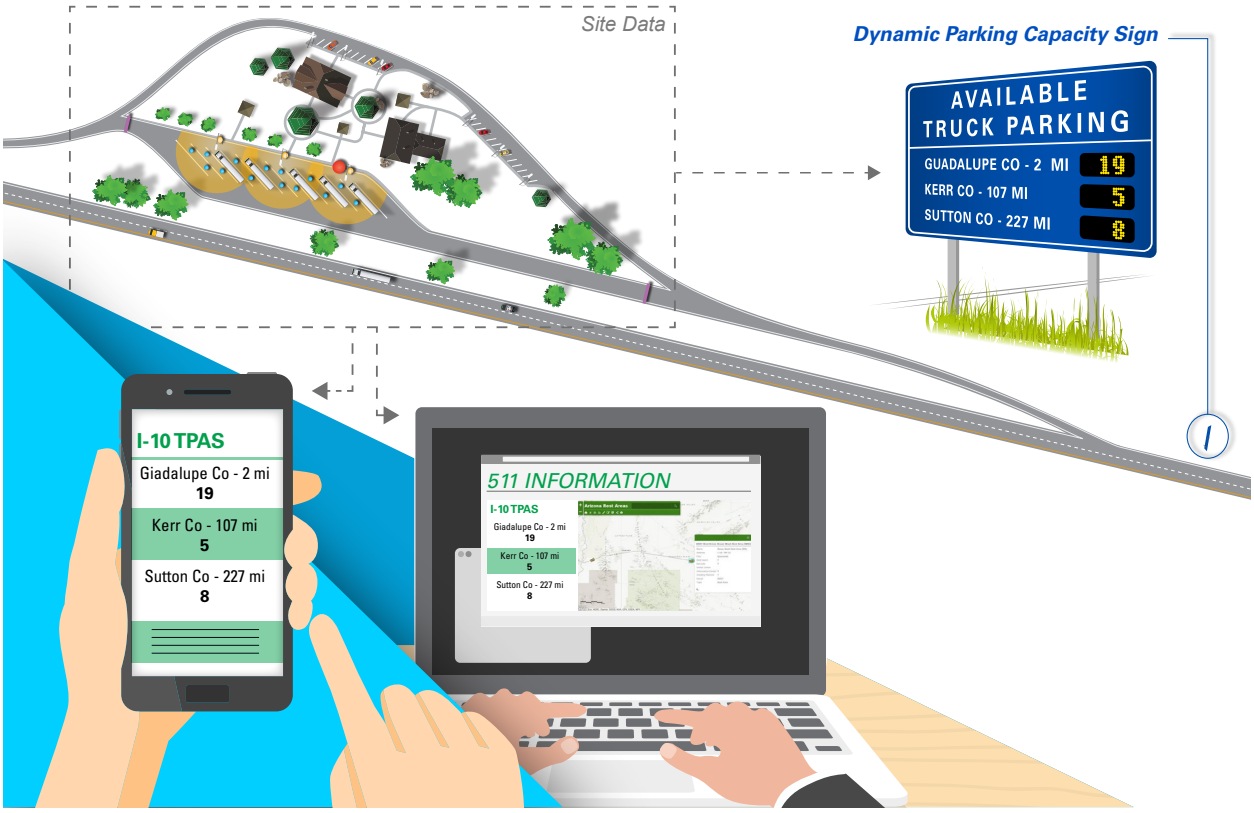
The first approach will place DPCS, shown in Figure 9, upstream from the parking areas. Multiple surveys by ATRI have identified DPCS as the preferred communication method for drivers. The initial grant request would fund two DPCSs approaching each parking location, for those locations serving both eastbound and westbound.[16] The exact location of these signs varies depending on a number of factors, including distance between interchanges, distance between rest areas, and the presence of private parking options. Exact placement will be

Figure 9: Example Dynamic Parking Capacity Sign

[16] There are 37 facilities in the Corridor being considered for this grant. Some serve a single direction of traffic and some have a separate space for eastbound and westbound traffic but are named as a single facility. In total, there are 18 sites eastbound, 17 sites westbound, and 2 sites that serve both eastbound and westbound traffic. This creates a need for 78 DPCS.

determined during the planning and design phase of this project, but best practice around the country is to locate one DPCS within 3 miles of the site and one approximately 20 to 30 miles prior to a site. This provides drivers with an advanced warning of space availability with enough time to consider alternative plans if a location is full and an updated count of space availability as the driver gets closer to the site. The DPCS are anticipated to be similar to that shown in Figure 10. Each sign will include static information showing upcoming truck parking location site names and distance to the site. The number of available spaces displayed on each DPCS will be dynamic and change as information is provided from the space utilization technology.

Figure 10: I-10 Corridor Coalition TPAS Site Information Dissemination Concept of Operations



Smartphone Application and Websites

The second information dissemination approach will provide data to drivers and dispatchers via a smartphone application and web-based services. Benefits of this approach include:

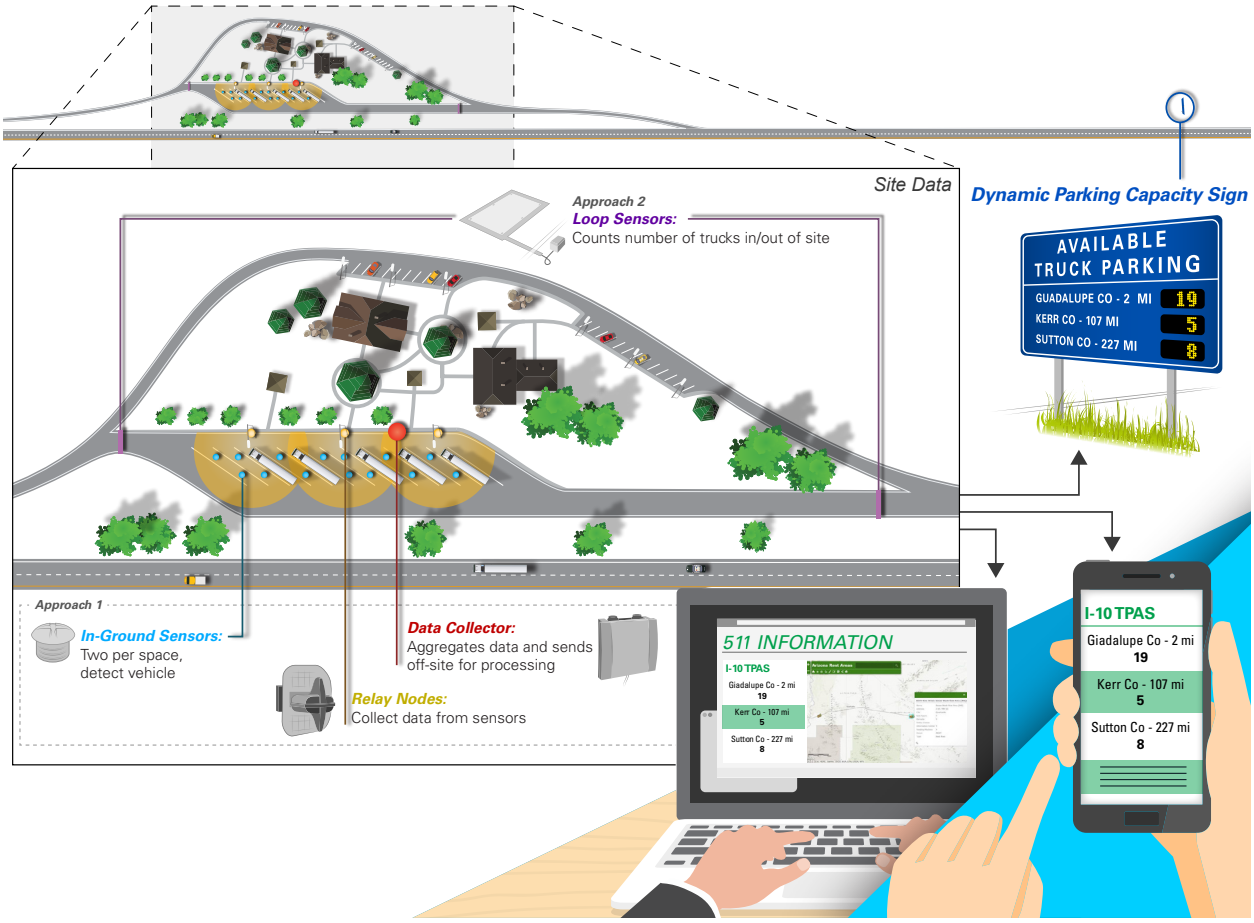
- Relatively low cost to implement and minimal marginal cost to add additional users.
- Developing a new smartphone application for truck parking in the I-10 Corridor provides a base for future technology deployments (see Section 10).
- Providing information based on driver-defined preferences, location, and direction of travel.
- Potential integration with ELDs, truck fleet management systems, and privately owned truck parking site information, as well as potential to include a truck parking reservation function.

If developed as a new application by the I-10 Corridor Coalition, the service could be expanded in the future to include privately owned truck stops and serve as the base for additional technology deployments in the I-10 Corridor. Alternatively, the four States could coordinate with existing truck parking applications developers to push truck parking availability to the cloud,

for 3rd party applications to acquire. However, this approach requires cooperation from 3rd party vendors which has not yet been obtained. This approach will be explored in further detail in Phase I and Phase II of the Deployment Work Plan (see Section 5).

Combined, the I-10 Corridor Coalition TPAS will collect, analyze, and provide truck parking information to stakeholders as shown in Figure 11.

Figure 11: I-10 Truck Parking Availability System Concept of Operations



5. DEPLOYMENT PLAN STATEMENT OF WORK

A Deployment Work Plan for he ATCMTD I-10 Corridor Coalition TPAS project will be developed upon award of funding but will generally include the following phases and subtasks:

- **Phase I—Planning and High-Level Design**
  - » *Task I-1—Program/Project Management*. The project team will develop a detailed Work Plan, stakeholder engagement plan, and other necessary documents and procedures to guide communications, deliverables, and resolution of issues. This task also includes periodic meetings throughout the period of performance between project team members to ensure the successful deployment of the project.
  - » *Task I-2—Stakeholder Engagement*. The project team will build on the I-10 Corridor Coalition's successful momentum by engaging regional goods movement stakeholders, and signing up additional participants, concentrating on the State trucking associations for the four States. Although placed in Phase I, this subtask will feed other tasks and be ongoing throughout the course of the project.

  - » *Task I-3—Define a Concept of Operations (ConOps), Conduct Business Process Mapping, and Refine Data Sources*. Building off of the I-10 Corridor Coalition ConOps now under development (estimated date of delivery: November 30, 2018), the I-10 Corridor Coalition TPAS-specific ConOps will define specific truck parking availability technologies such as sensors at facilities, back office processing, and dissemination of information applications. In parallel, the project team will conduct interviews with trucking association representatives, State agency representatives, and private-sector facilities operators to gather the necessary data to develop a business process map incorporating information and knowledge captured from the new participants.
- **Phase II—Detailed Design and Deployment**
  - » *Task II-1—Define I-10 Corridor Coalition TPAS Requirements.* The project team will develop new user needs Functional Requirements, qualifications for Functional Certification for truck parking information applications, and system requirements to guide the integration between the four State's systems. The project team will capture new requirements from the trucking representatives so that the tool can be customized to maximize usefulness to drivers, trucking companies, and parking facility operators.
  - » *Task II-2—Complete Application Development and Deployment Planning.* The elements of the I-10 Corridor Coalition TPAS overall application will be developed, integrated, coded, and beta tested at a software level under this task. As part of the integration effort, where applicable, the project team will focus on the necessary information exchange with the existing legacy systems that will ensure the I-10 Corridor Coalition TPAS system can be accessed as seamlessly as possible by users as part of their daily business environment (truck drivers, trucking companies, parking facility operators, and State DOTs). The software will be flexibly designed to integrate with a variety of systems and Information Technology (IT) environments, through the use of a cloud-based framework. Additionally, the project team, in consultation with key stakeholders and users, will develop a Deployment Plan which will carefully outline a phased deployment of the system elements, and plans for user training and technical support, system operations, and data collection to support performance measurement.
  - » *Task II-3—System Integration and Deployment.* The project team will instrument 37 truck parking facilities with truck occupancy sensors or loop sensors to measure volume and data processing support, deploy 78 DPCS, integrate the system with each State's transportation management center (TMC) and create an IT platform that will support information exchange with traffic operations centers and their systems (such as 511 and web-based exchange forums), and develop and support a smartphone application to allow drivers to access truck parking availability information. A project team member will be available during the test and deployment periods to assist users in system use, troubleshooting, and requested follow-up training.
- **Phase III—System Performance, Operation, and Maintenance**
  - » *Task III-1—Continuous System Performance Evaluation.* The project team, in collaboration with key stakeholders and users, will develop key performance goals (and supporting measurement metrics) for the system early on, and will continuously measure actual performance of the system during the deployment phase. The project team is prepared to work closely with (and provide data to) an Independent Evaluator, if FHWA decides to provide one.
  - » *Task III-2—Long-Term Operations and Maintenance.* As covered in previous sections of this grant application, this deployment project will enable the I-10 Corridor Coalition

TPAS to be scaled beyond the immediate deployment and may include increased truck parking sources, weather advisories, route guidance, and inputs from regional IT initiatives that could impact trucking operations in the Corridor such as the LA Metro FRATIS project and regional connected and autonomous vehicle deployments.

Annual O&M costs for the I-10 Corridor Coalition TPAS are estimated to be $672,000.

In relation to this longer-term deployment strategy, there are two key operations and maintenance factors: 1) this project will result in the development of a long-term deployment and systems maintenance approach by the State DOT stakeholders; and 2) the anticipated lifespan of the I-10 Corridor Coalition TPAS technology (hardware and software) elements is estimated to be between 10 and 20 years, depending on the equipment. This allows time beyond this 4-year project for the technology to be increasingly well managed and potentially expanded by the stakeholder agencies. An O&M plan will be created to enable the I-10 Corridor Coalition member States in supporting operations and maintenance of the cloud-based I-10 Corridor Coalition TPAS system, including covering costs for hardware and software updates, and replacement of defective units.

As appropriate, these tasks will be guided by the National ITS Reference Architecture (ARC-IT). For ITS projects, the recently released Version 8.1 provides a common basis for planners and engineers with differing concerns to conceive, design, and implement systems using a common language as a basis for delivering ITS projects. It also updated tools such as the Regional Architecture Development for Intelligent Transportation (RAD-IT) which focuses on regional planning and the development of Operations Concepts, and Systems Engineering Tool for Intelligent Transportation (SET-IT) which is a graphical tool for project-focused development.[17]

Throughout the above tasks, the project team will apply rigorous systems engineering principles consistent with Institute of Electrical and Electronics Engineers (IEEE) and FHWA guidance, including, but not limited to the following:

- FHWA Systems Engineering Guidance.
- IEEE Standard 29148-2011—Systems and Software Engineering—Life-Cycle Processes—Requirements Engineering.

6. REGULATORY, LEGISLATIVE, AND INSTITUTIONAL DEPLOYMENT CHALLENGES

There are limited anticipated regulatory, legislative, and institutional deployment challenges associated with deployment of these technologies in the four States. Of note here are three potential challenges that will be addressed:

- **Driver Distraction with In-Vehicle Devices.** Federal Motor Carrier Safety Administration, 49 CFR Parts 383, 384, 390, 391, and 392 [Docket No. FMCSA-2009-0370] RIN 2126-AB22, "Limiting the Use of Wireless Communication Devices" restricts the use of all hand-held mobile devices by drivers of commercial motor vehicles (CMV). This rulemaking restricts a CMV driver from holding a mobile device to make a call or text, or dialing by pressing more than a single button. CMV drivers who use a mobile phone while driving can only use a hands-free phone located in close proximity. This rule impacts how the I-10

[17] Note that Arizona will complete a RAD-IT in Summer 2018 (https://azdot.gov/docs/default-source/transportation-studies/its_architecture_information_brief.pdf?sfvrsn=2). For further information, see: https://local.iteris.com/arc-it/index.html.

Corridor Coalition TPAS mobile application will be designed to minimize driver distraction.

- **Prohibition on Commercialization of Rest Areas on Interstates.**[18] The States of California, Arizona, New Mexico, and Texas recognize that some privately operated truck stops provide a similar service which could in the future be incorporated into an integrated Corridor-wide truck parking information system. However, the initial focus of the I-10 Corridor Coalition TPAS is on the currently noninstrumented public parking locations. This scope will maximize initial benefits and avoid any competitive issues that might arise by inclusion of some private truck-stop operations and not others or by publicly sharing capacity and pricing information.
- **System Design Standards and Technical Specifications.** States may need to adopt or develop design specifications for the associated hardware and software systems that are part of the I-10 Corridor Coalition TPAS to ensure consistency of deployment throughout the I-10 Corridor Coalition. Example specifications for some systems already may be available within the Coalition States. Other specifications can be drawn from other deployments that the I-10 Corridor Coalition TPAS is similar to, including projects in Florida, Michigan, and the MAASTO Regional TPIMS.

7. QUANTIFIABLE SYSTEM PERFORMANCE IMPROVEMENTS

The envisioned I-10 Corridor Coalition TPAS project is anticipated to provide benefits in the areas of safety (crash reduction from searching for parking while fatigued and/or beyond their HOS and parking in unsafe conditions), mobility (reduced travel time savings due to reduced crashes and truck driver time searching for parking), environmental (reduced truck emissions and fuel use), other cost savings (nonfuel vehicle operating costs from reduced miles searching for parking), and state of good repair (reduced wear and tear on roadway ramps and shoulders from illegal truck parking). A quantitative benefit/cost analysis was conducted of the I-10 Corridor Coalition TPAS project to evaluate system performance utilizing the FHWA Tool for Operations Benefit Cost Analysis (TOPS-BC) and other spreadsheet methods. It provides estimates for benefits of the project in terms of travel-time savings, accident cost savings, environmental (emissions and fuel) cost savings, and other cost savings (vehicle operating costs). The Excel Worksheet containing the benefit/cost analysis can be provided to the U.S. DOT upon request and is summarized in Appendix C.

Table 4 presents the expected annualized monetary benefits from the benefit/cost analysis results.

Table 4: Summary of I-10 Corridor Coalition TPAS Project Average Annual Benefits, *$ Millions*

System Name	Safety	Travel Time	Environmental	Operating	Total
Annual Monetary Benefit	$4.7	$1.0	$1.1	$1.3	$8.1

It is important to note that there are other expected system benefits from the I-10 Corridor Coalition TPAS project which were not quantitatively assessed as part of the analysis. For example, reducing crashes associated with fatigued drivers will improve travel-time reliability and overall economic competitiveness for the freight industry along the Corridor. Safety and state-of-good-repair (pavement) benefits from trucks utilizing available parking at rest areas instead of ramps, neighborhood streets, or other potentially unsafe locations. Finally, providing a better truck parking environment frees enforcement personnel to focus efforts on other issues.

[18] https://www.federalregister.gov/documents/2016/09/27/2016-23269/commercial-activities-on-interstate-rest-areas.

Based on an average annual cost of $1.27 million, **the benefit/cost for the I-10 Corridor Coalition TPAS project is estimated to be 6.3 undiscounted, 5.6 at a 3 percent discount, and 4.7 at a 7 percent discount.**

8. QUANTIFIABLE SAFETY, MOBILITY, AND ENVIRONMENTAL BENEFITS

Based on the benefit/cost analysis performed and summarized in Section 7, Table 5 presented the quantified safety, mobility, and environmental benefits estimated for the project.

Table 5: Summary of I-10 Corridor Coalition TPAS Project Safety, Mobility, and Environmental Benefits

Benefit Type	Estimated Benefits
Safety	• Implementation of the I-10 Corridor Coalition TPAS is estimated to reduce the number of fatigue-related commercial vehicle crashes by 10 percent resulting in approximately 21 fewer fatalities, injuries, and PDO crashes annually which corresponds to a $4.7 million annual savings.
Mobility	• The estimated delay saved from the fatigue-related crashes above and subsequent lane closures is 20,000 hours annually, resulting in $278,000 in annual savings. • Over 27,000 hours are estimated to be saved annually by truck drivers from the truck parking availability information via the truck parking capacity signs and the web application. This equates to approximately $740,000 in annual mobility savings.
Environmental	• Emissions and fuel use savings will result from the reduced number of miles trucks will drive from searching for parking. The benefit/cost analysis approach assumed a 15-minute savings which corresponds to 12 miles and 2 gallons saved per parking space utilized. CO_2 savings is estimated to be nearly 2,500 tons or $90,000 annual savings. Other emissions savings are estimated to be nearly $300,000 annually from CO, NOx, VOC, $PM_{2.5}$, and PM_{10}. Fuel savings from the truck parking information is estimated to be 221,000 gallons annually, $672,000 annually. An additional $36,000 is saved annually associated with CO_2, fuel use, and other emissions from savings associated with the fatigue-related crashes.

9. DEPLOYMENT VISION, GOALS, AND OBJECTIVES

Interstate 10 and is a critical artery for the movement of freight that drives economic activity in California, Arizona, New Mexico, and Texas. Recognizing the importance of collaborating on activities that impact I-10, these four States formed the I-10 Corridor Coalition in 2016 with the goal of working together to create safer and more efficient travel, both commercial and personal, along the Corridor. The vision, goals, and objectives of the I-10 Corridor Coalition TPAS, shown in Table 6 below, align with and will support the overarching I-10 Corridor Coalition goal.

Table 6: I-10 Corridor Coalition TPAS Vision, Goals, and Objectives

Vision: Truck drivers, dispatchers, and public officials in the I-10 Corridor will have real-time access to accurate and reliable information about public truck parking availability through an advanced, coordinated, and intelligent transportation information system.	
Goals	**Objective**
Reduce fatigue-related truck-involved crashes in the I-10 Corridor.	The I-10 Corridor Coalition TPAS will enable commercial vehicle drivers to readily identify parking spaces and reduce the chances of operating while fatigued.
Reduce emissions associated with excess driving while searching for parking.	The I-10 Corridor Coalition TPAS will enable commercial vehicle drivers to readily identify parking spaces and reduce travel searching for parking.
Reduce public infrastructure degradation from vehicles parking in unauthorized locations.	The I-10 Corridor Coalition TPAS will enable commercial vehicle drivers to readily identify parking spaces and reduce parking along highway shoulders, ramps, or other unauthorized locations.
Create an information technology platform that can be expanded in future deployments to serve other Corridors within the four States, other States along I-10, and/or other ITS needs in the I-10 Corridor.	The I-10 Corridor Coalition TPAS will create a system that can be expanded elsewhere in the member States, possibly expanded to adjacent States, and could be leveraged to deliver other truck-related travel information such as forecasted truck availability or weather advisories.

A successful deployment of the I-10 Corridor Coalition TPAS project will identify vacant truck parking spaces and communicate that information in real time to drivers, dispatchers, public officials, and other stakeholder in I-10 Corridor using a variety of information dissemination systems. The information systems developed during this project such as a smartphone application, could be expanded both within the I-10 Corridor Coalition member States to other important Corridors (or even statewide) and to other States I-10 passes through (Louisiana, Mississippi, Alabama, and Florida).

10. LEVERAGING LOCAL AND REGIONAL TRANSPORTATION TECHNOLOGY INVESTMENTS

There are a number of local and regional ITS projects that will provide a structure or input for the I-10 Corridor Coalition TPAS. The key systems are described in the sections below.

I-10 Western Connected Freight Corridor Concept of Operations (Pooled Fund Study)

For the State DOTs for California, Arizona, New Mexico, and Texas, Texas A&M Transportation Institute (TTI) and a team of consultants is leading the development a ConOps report for an I-10 western connected freight Corridor, to be completed by December 2018. Through the ConOps, this project is creating a framework for future improvements in technology, governmental policies, and procedures that will create a better environment for shippers and carriers doing business along the I-10 Corridor. This project's objectives include harmonizing transportation standards across State lines and facilitating successful deployment of technologies and applications for commercial vehicle movement along the Corridor. The ConOps is focusing on the following five technical areas:

- Advanced Freight Traveler Information System.
- Truck Parking Availability Systems (TPAS).
- Roadside Safety Communication.
- Permitting Standardization.
- Truck platooning.

It is important to note that the TPAS element of the ConOps is fully consistent with the approach to the I-10 Corridor Coalition TPAS being presented in this proposal.

Texas Connected Freight Corridors Project

Texas Department of Transportation is leading the Texas Connected Freight Corridors Project to create a sustainable connected vehicle deployment in Texas using I-35, I-10, and I-45 to showcase connected vehicle applications applicable to TxDOT and its partners throughout the "Texas Triangle." The project, partially funded through a $6.09 million 2017 ATCMTD grant to Texas DOT. TxDOT and the project partners will match the grant with at least $6.1 million making the total project cost over $12 million.

The project will utilize a combination of technologies, including cellular, Dedicated Short-Range Communications (DSRC), and smart infrastructure to implement a suite of vehicle-to vehicle (V2V) and vehicle-to-infrastructure (V2I), collectively called V2X applications. These technologies are expected to enable a sustainable deployment where TxDOT will be able to acquire a rich set of traffic conditions data and in turn provide better information to its freight partners and the traveling public. For example, the I-35 Connected Work Zone (CWZ) pilot provides congestion and construction information directly to cellular communication equipment in long-haul trucks. Another element of the model deployment effort will accommodate Truck Parking Reservations.

The Texas Connected Freight Corridors Project provides opportunity to support the goals of the proposed I-10 Corridor Coalition TPAS by potentially exchanging information related to parking availability along I-10, I-35 and I-45 in the "Texas Triangle."

New FRATIS—Port of Los Angeles/Long Beach

In the future, I-10 Corridor Coalition TPAS and the Freight Advanced Traveler Information System (FRATIS) program in Los Angeles will be able to exchange information so that intermodal trucks could stage parking out of the Los Angeles area overnight to better manage the flow of trucks into the ports of Los Angeles and Long Beach. With significantly expanding levels of imports and exports through the ports, this would represent a regional approach to managing not only current, but future congestion at the west coast ports and along the I-10 Corridor connecting the ports.

State and Regional Traveler Information Systems

State 511 Deployment

511 is described by the U.S. DOT as "America's Traveler Information Telephone Number."[19] This free phone service provides access to travel information that varies by State or region but, at a minimum, includes traffic and road conditions. Many States or regions also have deployed a companion website to support the 511 service. State-level 511 deployment as of July 2016 in the I-10 Corridor Coalition States is summarized in Table 7.

Table 7: Online State 511 System Overview

System Name	Safety	Travel Time	Environmental	Operating
Deployed Statewide	Regional deployment, overseen by Caltrans	Yes	Yes	On State highways[b]
Traffic	Yes	Yes	Yes	Yes
Events/Construction	Yes	Yes	Yes	Yes
Weather	No	Yes	Yes	Yes
Road Work	Yes	Yes	Yes	Yes
Truck-Specific Information[a]	No	No	No	No
Transit	Yes	No	No	No

[19] https://www.fhwa.dot.gov/trafficinfo/511what.htm.

System Name	Safety	Travel Time	Environmental	Operating
Website	https://go511.com/ http://www.ie511.org	http://www.az511.gov	http://nmroads.com	https://drivetexas.org

[a] Includes truck size and weight restrictions, information about weigh stations, parking, etc.
[b] Dallas-Ft. Worth has a regional 511.

Regional Traffic Management Center (TMC) Deployment

Additional resources are available at the local and regional level through Traffic Management Centers (TMC). TMC use ITS to collect data and provide information to motorists in key locations along I-10, including San Antonio (TransGuide), Houston (TranStar), and Los Angeles (RIITS).

Connected and Autonomous Vehicle Testing

Connected and Autonomous Vehicle (CAV) testing on the I-10 Corridor already is underway. Embark began a pilot test between El Paso, TX and Palm Springs, CA in October 2017 using CAV with a human in the cab. Human drivers bring a trailer from the shipper to a rest stop off I-10 where the CAV takes over and delivers the trailer to another rest stop for final delivery by another human driver. Although there is no in-ground infrastructure associated with this test as of writing this report, the existence of a pilot CAV program in the Corridor may provide future synergies with the I-10 Corridor Coalition TPAS deployment.[20]

11. PROJECT SCHEDULE AND DELIVERABLES

The proposed I-10 Corridor Coalition TPAS Project can be completed within four years from notice to proceed. Since the proposed project is an ITS project, it will follow the Systems Engineering process. Once the software development is completed and equipment has been purchased construction of the proposed project can begin. There will be no right-of-way acquisition required for the proposed project. The project schedule is provided in Table 8.

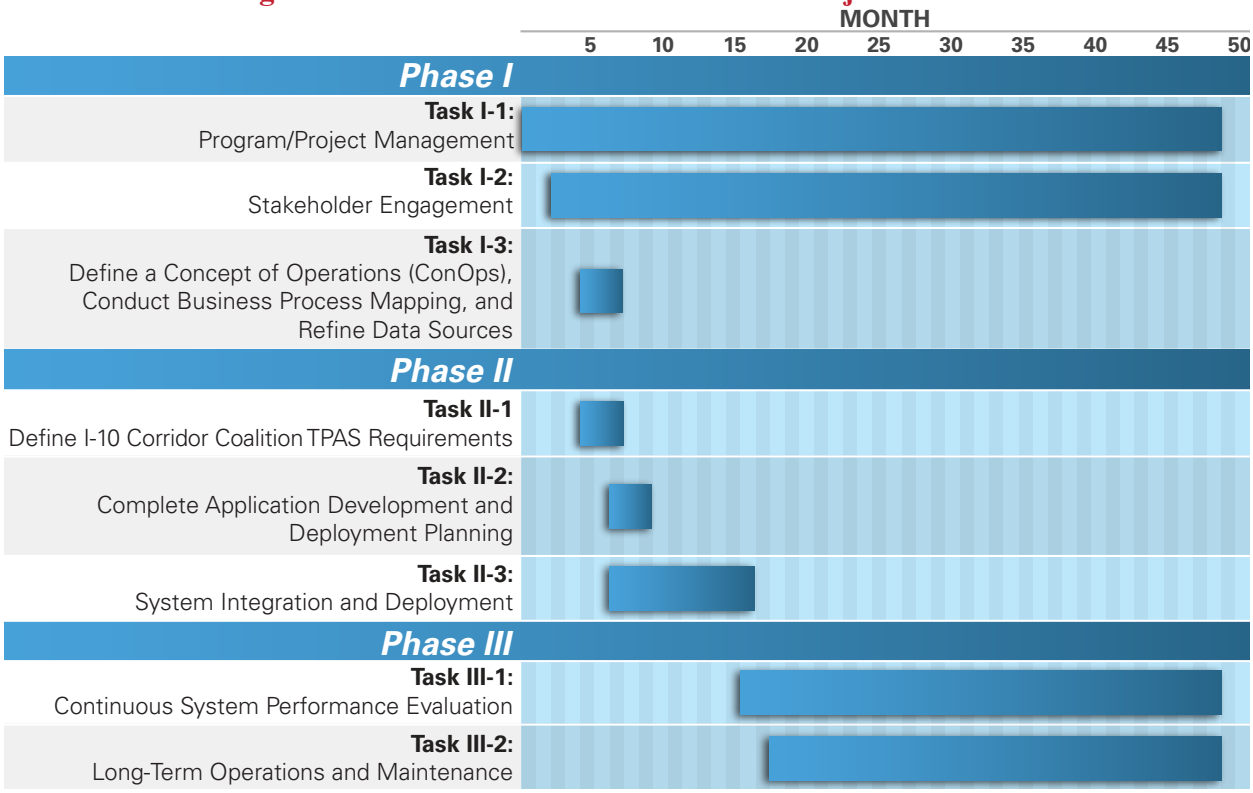
Table 8: I-10 Corridor Coalition TPAS Project Schedule

Activity or Milestone	Duration	Completion Date—Months after NTP
Kickoff Meeting	**1 day**	**1 month**
Procurement	3 months	3 months
Concept of Operations and Stakeholder Outreach	3 months	6 months
User Needs, Functional and System Requirements	2 months	7 months
Design	2 months	9 months
Year 1 Report to the Secretary	**2 weeks**	**12 months**
Software Development	5 months	14 months
Equipment, Communication, Field Installation	2 months	16 months
Testing, Integration, Validation	2 months	18 months
System Operations	14 months	48 months
Year 2 Report to the Secretary	**2 weeks**	**24 months**
Year 3 Report to the Secretary	**2 weeks**	**36 months**
Year 4 Report to the Secretary	**2 weeks**	**48 months**
Monthly Progress Reports	**1 day**	**Every month**

The Gantt chart in Figure 12 presents the project tasks detailed in Section 5 and their timeline.

[20] https://www.wired.com/story/embark-self-driving-truck-deliveries/. Accessed May 29, 2018.

Figure 12: I-10 Corridor Coalition TPAS Project Timeline



12. LEVERAGING U.S. DOT ITS AND TECHNOLOGY PROGRAMS

U.S. DOT has deployed a number of Intelligent Transportation Systems (ITS) and technology programs that can help guide the deployment of the I-10 Corridor Coalition TPAS or be included in the I-10 Corridor Coalition TPAS system in the future once the base system is complete. These systems and their interaction with the I-10 Corridor Coalition TPAS elements are shown in Table 9 below.

Table 9: I-10 Corridor Coalition TPAS and U.S. DOT ITS and Technology Programs

I-10 Corridor Coalition TPAS Element	U.S. DOT Program	Leverage Point
Truck Parking Space Utilization Detection Technology	• SmartPark	• FMCSA program demonstrated technology to provide truck parking availability information in real time. Lessons learned have influenced development of private-sector technology and choice of detection systems in this grant.
Information Dissemination (website/ smartphone application)	• Freight Advanced Traveler Information System (FRATIS) • ITS Joint Programs Office (ITS-JPO) Emerging Capabilities (Private-Sector Coordination) • ITS Joint Programs Office (ITS-JPO) Enterprise Data	• The real-time traveler information and dynamic route guidance pieces of the FRATIS program are commonly included in vehicle navigation and traffic routing software today. • ITS-JPO Emerging Capabilities examines and ensures the safe adoption of new and advanced technologies in the transportation field. » Includes close interaction with private sector and academia to identify promising new technologies. • ITS-JPO Enterprise Data develops mechanisms to capture, house, share, analyze, transport, and apply operational data to improve safety and mobility across all modes of transportation.

I-10 Corridor Coalition TPAS Element	U.S. DOT Program	Leverage Point
All technology components	• Smart Roadside Initiative (SRI)	• One of the key research goals of the SRI program is to ensure that the necessary standards, protocols, and architecture are developed to support both interoperable operations across the country and appropriate data privacy requirements.
Funding	• Innovative Technology Deployment (ITD) Program	• FMCSA program focused on improving commercial motor vehicle safety. 2018 NOFO includes truck parking as a funding area. » "Projects associated with this priority should demonstrate real-time dissemination to a CMV driver of truck parking space availability information based on using: DPCS, interactive voice recognition, smartphone app, or other proven technology."
Future Information Dissemination	• Wyoming I-80 CV Pilot	• Potential to leverage I-80 technology deployments once the initial I-10 Corridor Coalition TPAS deployment is complete. » Weather Information: Dust storms and occasional severe flooding are weather conditions that impact travel on the I-10 Corridor. » Process to develop a standard set of practices and a shared agreement about roles and responsibilities for deployment and managing the CV program for I-80 will be applicable for future deployment on I-10.

13. PROGRAM TECHNOLOGIES, GOALS, FOCUS AREAS, AND OBJECTIVES ADDRESSED

The overall goal of the proposed project is to improve safety, reduce emissions from trucks searching for parking and mitigate impacts on roadway infrastructure from trucks parking in unauthorized locations on the I-10 Corridor. This is done by gathering accurate and reliable information about public truck parking availability and providing real-time access to such information via Dynamic Parking Capacity Signs and/or other applications.

The I-10 Corridor Coalition TPAS project furthers four program technologies, 10 U.S. DOT goals, one focus area, and four departmental objectives defined in the NOFO as shown in Table 10.

Table 10: I-10 Corridor Coalition TPAS Technologies, Goals, Areas, and Objectives Addressed

Topics Addressed	I-10 Corridor Coalition TPAS Project Explanation
Technology	
i. Advanced traveler information systems	• Utilizing proven technology, this project will provide real-time truck parking information at public rest stops based on data from sensors allowing truckers to make informed decisions. This information will be publicly available on agency websites, via an app, and on roadside DPCS.
ii. Advanced transportation management technologies	• With four States in the I-10 Corridor Coalition, this project will use advanced data collection and processing from sensors to assist transportation agencies with interjurisdictional coordination to provide real-time, dynamic parking availability information to improve mobility and safety along this critical freight artery.

Topics Addressed	I-10 Corridor Coalition TPAS Project Explanation
iii. Infrastructure maintenance, monitoring, and condition assessment	• The technologies proposed for this project will aid the transportation agencies in the four States to better monitor and manage truck parking at public rest areas and prioritize areas where additional resource allocation may be needed (e.g., additional paved areas for marked truck parking, future truck parking reservation needs, etc.).
iv. Transportation system performance data collection, analysis, and dissemination systems	• This initial project deployment is intended to set the foundation for future technology implementation in the Corridor. Information and data obtained from these technologies can be used to conduct analyses, research and identify and prioritize other improvements in the Corridor.
U.S. DOT Goals	
Enhanced use to existing capacity	• Providing information on available parking spaces will increase utilization of existing truck parking capacity at the public rest stops.
Delivery of environmental benefits	• The I-10 Corridor Coalition TPAS project is estimated to reduce CO_2 emissions by nearly 2,600 tons annually, equating to $93,000 saved annually. Other emissions savings are estimated to be $307,000 annually from CO, NOx, VOC, $PM_{2.5}$, and PM_{10}. Fuel savings from the truck parking information is estimated to be 228,000 gallons annually, $694,000 annually.
Improvement in operational performance	• As discussed previously, this system will improve both mobility and safety. Truck drivers searching for parking incur costs associated with increased trip miles, vehicle wear, and fuel consumption. Reducing fatigue-related truck crashes will improve the operational performance and reliability of the transportation networks.
Reduction in number and severity of traffic crashes	• The project will enhance safety by reducing the number of fatigue-related incidents, smoothing traffic flow, and reducing queue lengths resulting in an estimated savings of $4.7 million annually from reduced crashes.
Collection, dissemination, and use of real-time transportation-related information	• Traveler information from CMSs and the I-10 Corridor Coalition TPAS app will provide truckers with easier access to improved and expanded truck parking information in real time or for travel planning improving mobility, more efficient truck travel, reduced infrastructure damage, and improved safety.
Monitoring transportation assets to improve and prioritize investment decisions	• The truck parking availability technologies will provide the four DOTs with added ability to monitor their investments and prioritize truck parking investments in the Corridor as they will have better information on utilization and demand. In addition, if truck drivers are unable to find available parking, they may choose to park at unsafe locations, such as the shoulder of the road and exit ramps causing additional damage to publicly owned infrastructure not designed to accommodate heavy trucks. This project would reduce these impacts.
Delivery of economic benefits	• The estimated Benefit/Cost ratio for the I-10 Corridor Coalition TPAS project is 6.3 undiscounted, 5.6 at a 3 percent discount, and 4.7 at a 7 percent discount. The improved safety, mobility, and reliability benefits from improved traveler information will improve goods movement operational efficiencies and shipping costs, thereby providing economic benefit. Without this information, truck drivers may stop driving before reaching their Hours of Service (HOS) limits in order to secure a parking space because of the uncertainty of available spaces further along their route. Knowing the availability of parking can improve productivity.

Topics Addressed	I-10 Corridor Coalition TPAS Project Explanation
Integration of technologies into TSM&O	• A Concept of Operations report is being developed for the I-10 Western Connected Corridor Coalition, to be completed by December 2018. This project would serve as the foundation for future technology implementation by the Coalition in this high-priority connected freight Corridor. Other technologies under consideration include integration of weather or other alert systems, a parking reservation system, long-haul truck platooning, connected vehicle roadside safety infrastructure, and autonomous trucks to improve transportation system management and operations in the Corridor.
Evaluation of the impacts of project technologies	• The I-10 Corridor Coalition TPAS improvements would reduce the amount of time truckers drive around looking for parking and illegal parking on freeway ramps, shoulders, or neighborhoods along the Corridor resulting in reduced emissions, fuel use, and noise impacts.
Reproducibility and knowledge transfer	• Data and information obtained from this project could be used to assess the applicability of truck parking availability technology in other locations or Corridors.
Focus Areas	
Rural technology deployments	• The I-10 Corridor Coalition TPAS technology is mostly a rural deployment as the majority of the public rest areas through the four States are located in rural areas.
Objectives	
Supporting economic vitality	• Improving goods movement efficiencies and productivity from improved truck parking information along the four State high-priority freight Corridor will promote economic vitality at both the national and regional level.
Leveraging Federal funding to attract other, non-Federal infrastructure investment	• Leveraging Federal funding for advanced technologies in the Corridor provides the opportunity to utilize State funds for other investments in the Corridor. In this case, to also help identify where additional resources should be used to increase parking capacity at rest areas that show need based on real data.
Using innovative approaches to improve safety	• The project represents an innovative approach to providing real-time truck parking information both on DPCSs and an app which will reduce fatigue-related truck crashes thus improving safety in the Corridor, as well as improving goods movement productivity.
Performance accountability and achieving measurable outcomes	• The I-10 Corridor Coalition will monitor and evaluate the effectiveness of the I-10 Corridor Coalition TPAS to ensure the project is achieving the goals and outcomes identified.

SECTION III—MANAGEMENT STRUCTURE

1. PROJECT ORGANIZATION DESCRIPTION

The Texas Department of Transportation is the designated recipient that will enter into this agreement with FHWA and is the organization that will receive the federal funding. The department was established in 1917 by the Thirty-fifth Texas Legislature. The department, headquartered in Austin, maintains eighteen functional divisions, twenty-five district offices, and has approximately 25,000 employees. The chief duties of the department are to delineate, build, and maintain all state highway and public transportation systems.

This program will be managed by TxDOT's Freight and International Trade Section within the Transportation Planning and Programming Division. Mr. George J. Villarreal, P.E., TxDOT, will be the overall Program Manager for this project and will be the single point-of-contact for U.S. DOT for this grant. As detailed in Section IV (Staffing Description), Mr. Villarreal is a seasoned manager of major programs at TxDOT.

As presented in the Organizational Chart in Section IV, each state DOT (CA, AZ, NM, and TX) will provide a "State Project Lead" that will be responsible for managing development and deployment elements of the TPAS for their respective states. Each State Project Lead (including a State Project Lead for TxDOT as well) will report directly to Mr. Villarreal.

Coordination among the four State Project Leads to develop and deploy the ATCMTD technologies under the overall direction of Mr. Villarreal will be conducted in an organized manner that will be seamless to U.S. DOT – U.S. DOT staff will only need to coordinate grant management activities with Ms. Mays at TxDOT. To facilitate this streamlined management approach, a charter and operating agreement have been signed and implemented by the four states:

- The four states recently completed and signed an ATCMTD TPAS Joint Project Agreement that specifically outlines the financial, operational and management responsibilities of the each state to support the successful deployment of this project for U.S. DOT; it may be reviewed online here:
- The I-10 Corridor Coalition Organizational Charter may be reviewed online here: https://i10connects.com/sites/default/files/documents/files/organizational-charter-i10-Corridor-coalition.pdf.
- The I-10 Corridor Coalition Operating Agreement may be reviewed online here: https://i10connects.com/sites/default/files/documents/files/I-10_Corridor_Coalition_Operating_Agreement_AZ-NM-CA-TX_FINAL-12-19-2017.pdf.

As detailed in Section IV, a Systems Engineering Team contractor is already in place to support development of the Year 1 activities of stakeholder outreach, development of the Concept of Operations, System Requirements, and High-Level System Design. This activity will support TxDOT in proceeding early in Year 2 with the procurement of the System Implementation Team Contractors, who will proceed with Final Design, Technology and Software Development, Beta Testing, Deployment, and two years of System Operations – across the four states, in coordination with the State Project Leads, but under the project-level management of Mr. Villarreal at TxDOT.

2. PARTNERSHIP PLAN

The trucking industry, particularly, truck drivers, but also secondary users who assist in truck trip planning (e.g. trucking dispatchers, fleet managers, shipping companies), are the primary end users of the TPAS system. To facilitate substantial trucking industry private sector involvement in this project, as detailed in the organizational chart (Section IV), leadership from the four state trucking associations (CA, AZ, NM, TX) will serve as valuable private sector advisors throughout this project, and will be providing access to trucking companies to help implement a User Advisory Group, which will be periodically engaged in this project to validate the deployed applications are delivering the intended benefits to truck drivers operating on I-10. Each of the four states trucking associations have pledged support to facilitate these activities; their Letters of Support are **provided in Appendix B**.

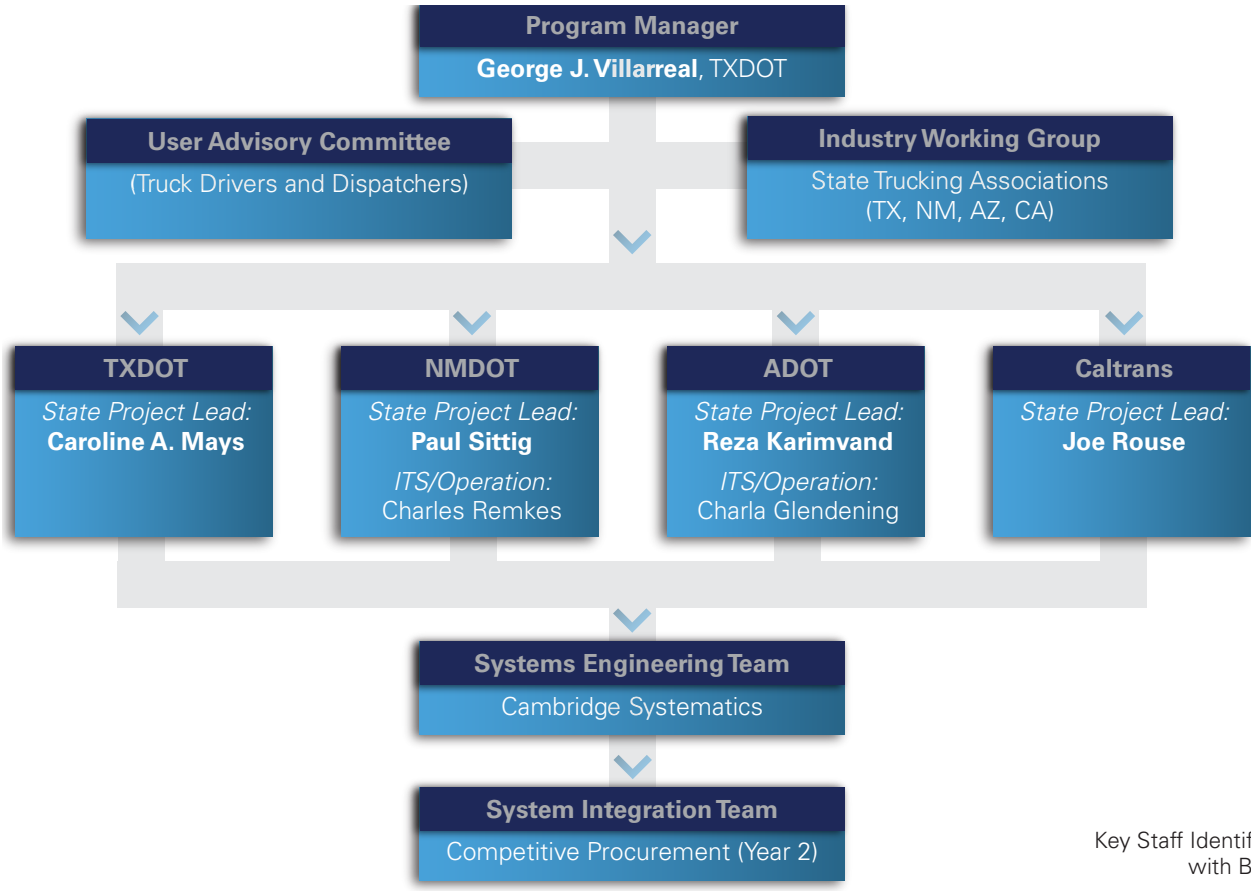
3. DESIGNATION OF SUB-RECIPIENTS

TxDOT is the only agency that will receive funding directly from U.S. DOT for this project. However, TxDOT will use the funds for procuring a contractor for deploying and operating the system in Texas and in the three other I-10 Corridor Coalition states: California, Arizona, and New Mexico.

4. ORGANIZATIONAL CHART

Figure 13 provides the organizational chart for this project. This organizational approach has been developed based on best practices derived from TxDOT's and the three partnering state DOT's history of successfully delivering hundreds of millions of dollars of ITS and operations projects in the Southwestern United States. Unique features of this approach include continuous stakeholder involvement and use of a project delivery approach where a systems engineering contractor that is already under contract with TxDOT will provide key technology design, implementation, and deployment advice to the TxDOT Program Manager and the four state DOT lead staff during project execution. Note that biographical information of the staff shown in this chart is presented in Section IV, with résumés and bios provided in Appendix A.

Figure 13: Organizational Chart



Key Staff Identif
with B

The specific organizational roles provided on the organizational chart are detailed here:

- **Program Manager (Key Staff).** The Program Manager will deliver all necessary reports and information required by U.S. DOT to successfully administer this grant – providing streamlined, "one-stop-shopping" to U.S. DOT ATCMTD program staff. The Program Manager will assure the commitment of the proposed team and support staff and will be responsible for implementing quality control procedures that will encompass TxDOT and contractor activities over the course of the project. The Program Manager will also manage the necessary contractor procurement activities, including the selection of a System Integration Team early in year two of the project.
- **State Project Leads (Four Key Staff) and ITS/Operations Staff.** Each state DOT (CA, AZ, NM, and TX) has a "State Project Lead" that will be responsible for managing and coordinating

all necessary planning and deployment activities within their states, rest stop access, coordination with state enforcement agencies, and operations staff activities related to the information technology systems connectivity that will be necessary in deploying the TPAS. They will also be responsible for coordination with their respective state trucking associations to facilitate trucking industry participation. Each State Project Lead will be supported by a senior staff member from the DOT's ITS or Operations department – these individuals will provide engineering- and operations-level guidance and advice in support of each state's ATCMTD deployment activities. Resumes for the state leads and bios for the ITS/Operations Staff are included in Appendix A.

- **Public-Private Stakeholder Advisory Groups.** The ***User Advisory Group*** is the motor carrier operational stakeholder group, made up of truck drivers and trucking company dispatchers who utilize the I-10 Corridor on a regular basis. This group will be accessed early on to validate requirements for the technology applications and will be leveraged later in the project to participate in providing feedback on initial operations of the I-10 Corridor Coalition TPAS (e.g. beta testing). In addition, an ***Industry Working Group***, consisting of one leadership member from each of the four state trucking associations, will support this project by providing key reviews of appropriate project deliverables, and will assist the team by recruiting motor carrier participants for the User Advisory Group.
- **Systems Engineering Team.** Cambridge Systematics is already under contract on a TxDOT task that is working with the I-10 Corridor Coalition to define the I-10 Corridor Coalition TPAS. Upon ATCMTD grant award, this contract will be leveraged by TxDOT to have Cambridge Systematics perform systems engineering, preliminary design activities, and deployment coordination of the I-10 Corridor Coalition TPAS. As a result, this team will be immediately able to work on the ATCMTD project activities, substantially reducing project and schedule risk for this deployment project. Cambridge Systematics will also assist TxDOT in developing an RFP for the System Integration Team contractor, as detailed below. Bios for the Systems Engineering Team are included in Appendix A.
- **System Integration Team Procurement.** Assuming an October 2018 award, the broader technology system implementation and vendor procurement activity will begin exactly one year later in October 2019, and will take no longer than three months to complete. This will result in the selection of a System Integration Team contractor who will finalize and deploy the integrated system of I-10 Corridor Coalition TPAS project technologies with completions of all deployments and integration activities by Quarter 4 of FY 2021, as outlined in the Project Schedule. The System Integration Team will include all necessary subcontractors and vendors to deploy all the TPAS technologies across the four states.

5. MULTIJURISDICTIONAL GROUP

This project will represent the first cooperative deployment of technology undertaken by the I-10 Corridor Coalition. The I-10 Corridor Coalition is a cooperative partnership in the Southwestern United States that covers membership from four state DOTs: California, Arizona, New Mexico, and Texas. The four state DOTs are united by the pursuit of freight technology enhancements on the I-10 Corridor in their respective states.

The three completed and signed agreements from this group that will facilitate this successful ATCMTD deployment (a Joint Project Agreement, a Charter and an Operating Agreement), are covered in Section 1 above.

SECTION IV—STAFFING DESCRIPTION

1. STAFFING

The following summarize the lead persons for the project and technical support staff (see Table 11, below). Résumés and bios are included in Appendix A

Program Manager

George J. Villarreal, P.E., TxDOT, will be the overall Program Manager for this project. At TxDOT he is responsible for overseeing the four sections within the traffic operations division: traffic management, traffic engineering, traffic safety, and crash data analysis. Through his supervision of the four sections he ensures the Traffic Operations Division (TRF) supports the 25 TxDOT districts in the managing and implementation of guidelines associated with design, placement, and use of traffic control devices. He also assists the division in supporting the districts in the deployment and research of advanced computer applications, electronics, and communication technologies. This includes traffic signal hardware systems and application of intelligent transportation systems.

State Project Leads

Texas Lead: Caroline A. Mays, AICP, TxDOT

Caroline Mays is responsible for overseeing TxDOT's comprehensive and multimodal Freight, International Trade and Border Planning Programs. Her specific responsibilities include: 1) implementation of FAST Act freight provisions; 2) developing and implementing a comprehensive Statewide Freight Mobility Plan and Texas-Mexico Border Transportation Master Plan; 3) convening and managing the statewide Freight Advisory Committee and the Border Trade Advisory Committee; 4) developing statewide freight policies and investment strategies; 5) developing and carrying out strategic plan for TxDOT's activities for addressing freight, international trade and border issues; and 6) communicating and coordinating with internal and external stakeholders. Her experience in transportation planning includes: Freight Transportation, International Trade and Border; Intelligent Transportation Systems (ITS); Systems Management and Operations and Incident Management; Transit Planning; and Long Range Transportation Planning. She has presented on freight, International trade, border, and ITS transportation issues at national, state, regional, local, and industry forums and provides on-going technical assistance on the subject.

Arizona Lead: Reza Karimvand, P. E., ADOT

Mr. Reza Karimvand joined ADOT in 1995, following a 10-year private-sector career in transportation engineering. He has served ADOT in multiple capacities, including leading a number of key projects, such as: redesign of the ADOT Traffic Operations Center, the detour plan for full freeway closure in the Phoenix region; the statewide DMS Master Plan, signal centralization in the Greater Phoenix region, and a sophisticated technology for dust monitoring system on I-10.Nationally, Mr. Karimvand is active member of Strategic Initiatives Working Group (formerly known as V2I Deployment Committee) for Cooperative Automated Transportation (CAT) Coalition. He currently is now leading Arizona's participation in the I-10 Corridor Coalition, and is overseeing the development of an I-10 Corridor Connected Freight Concept of Operations. He also is a member of Signal Phasing and Timing (SPaT) challenge and U.S. DOT Multi-Modal Intelligent Traffic Signal System (MMITSS) Group which is responsible for formulation of guidance to public agencies throughout the nation. Mr. Karimvand graduated from the Louisiana Tech University and is a Registered Professional Engineer in the State of Arizona.

New Mexico Lead: Paul A. Sittig, NMDOT

Paul Sittig, New Mexico DOT's lead freight planner, has been with NMDOT since November 2012, where he has overseen the development of the state's freight plan under MAP-21, and an update to the New Mexico Freight Plan under the FAST Act. In addition to freight planning, he manages the roadway classifications for the state, including the Functional System and National Highway System, and supervises technical and freight planning staff.

California Lead: Joe Rouse, Chief of the Office of System Operations for the Division of Traffic Operations at the California Department of Transportation (Caltrans). The Office of System Operations provides leadership in mobility management on the California State Highway System through operational strategies, incident management and traveler information. The office oversees managed lanes operations, traveler information programs, and the state's 12 Transportation Management Centers, which track and manage road conditions on the State Highway System. Joe is also the department's technical and policy expert on tolling and congestion pricing.

Table 11. Highlights of Technical Team Staff Qualifications

Staff Name	Org Chart Category(s)	Qualifications Summary
Charla A. Glendening, AICP	ADOT ITS/ Operations	• Statewide Planning Manager • Oversees Long Range Transportation Plan, Freight Plan, Bike/Ped Plan and the Tribal Program
Charles Remkes	NMDOT ITS/ Operations	• NMDOT's Chief of Intelligent Transportation Systems • ITS planning, design, construction, deployment, operations and maintenance as well as administering all ITS-related budgets and financial tracking
George J. Villarreal, P.E.	TxDOT ITS/ Operations	• Overall Program Manager for I-10 CC TPAS and state technical staff lead in traffic management, traffic engineering, traffic safety, and crash data analysis for TxDOT
Joe Rouse	Caltrans ITS/ Operations	• Caltrans state lead for I-10 CC TPAS and technical staff lead in systems operations/traffic operations
Mark Jensen	Systems Engineering Team	• 30 years advanced technology systems engineering experience • ConOps, Requirements, Design, Deployment of U.S. DOT CV applications
Daniel Stock	Systems Engineering Team	• 37 years of experience in quantitative/economic analysis • 24 years of experience in ITS deployment, testing and evaluation
Krista L. Jeannotte	Systems Engineering Team	• 25 years of experience specializing in ITS and freight technology applications, systems engineering, and the evaluation of technology deployments
Brian Stewart	Systems Engineering Team	• Specializes in freight and intermodal planning, logistics operations, and commercial vehicle operations

2. PRIMARY POINT-OF-CONTACT

George J. Villarreal, P.E.

Deputy Director Traffic Operations Division at Texas Department of Transportation

14555 Blanco Rd. San Antonio, TX 78216

Cell: 806-577-2305 | Email: gjuan.v@gmail.com

APPENDIX A: RÉSUMÉS
PART 1: KEY STAFF RÉSUMÉS

Program Manager

George J. Villarreal, P.E.
14555 Blanco Rd. San Antonio, TX 78216
Cell: 806-577-2305 | Email: gjuan.v@gmail.com

YEARS OF EXPERIENCE: 15

- Deputy Director Traffic Operations Division
- Texas Department of Transportation

BIOGRAPHICAL SUMMARY

George Villarreal is responsible for overseeing the four sections within the traffic operations division: traffic management, traffic engineering, traffic safety, and crash data analysis. Through his supervision of the four sections he ensures the Traffic Operations Division (TRF) supports the 25 TxDOT districts in the managing and implementation of guidelines associated with design, placement, and use of traffic control devices. He also assists the division in supporting the districts in the deployment and research of advanced computer applications, electronics, and communication technologies. This includes traffic signal hardware systems and application of intelligent transportation systems.

HIGHLIGHTS OF TRANSPORTATION ENGINEERING EXPERIENCE

Texas Department of Transportation (TxDOT)—Serves as a representative for TxDOT on an AASHTO Innovation Initiative that works collectively with representatives from the states of Rhode Island, Arizona, and North Carolina as lead states to develop a guidance document on the implementation of a wrong way driving program.

Texas Department of Transportation (Lubbock District)—Planned, designed, and oversaw construction of TxDOT Lubbock District first ITS system. The system included dynamic message signs, closed circuit cameras, and microwave vehicle detection system.

Kimley Horn & Assoc—Developed curriculum and instructed courses based on the PMP Transportation Learning Path certification which included courses in: Risk Based Construction Cost Estimating, Transportation Engineering Project Management, Transportation Engineering P6 Scheduling, and Risk Management.

Texas Tech Whitacre College of Engineering—Served as an adjunct professor for a senior level undergraduate transportation engineering course. Developed curriculum and instructed a dedicated transportation engineering course that covered roadway, railroad, safety, and aviation engineering. I also served as a faculty advisor for the student chapter of the Institute of Transportation Engineers and advisor for transportation engineering graduate student research programs.

EDUCATION

Bachelors of Science, Civil Engineering University of Texas at San Antonio, May 2003

PROFESSIONAL LICENSURE

Licensed Professional Engineer, State of Texas, No. 102457

Licensed Professional Engineer, State of New Mexico, No. 20098

PAST WORK EXPERIENCE

Dates	Position(s)	Organization
Oct 2017—Present	Deputy Director Traffic Operations Division	Texas Department of Transportation
Jan 2016—Sep 2017	Project Manager	Kimley Horn & Assoc
Aug 2014—Dec 2015	Adjunct Professor	Texas Tech Whitacre College of Engineering
May 2003—Dec 2015	Lubbock District Traffic Engineer	Texas Department of Transportation

State Project Leads

Caroline A. Mays, AICP – Texas Lead Director
1300 Red River Dr., Aubrey, TX 76227
Cell: 770-519-0349 | Email: carolineaam@yahoo.com

YEARS OF EXPERIENCE: 19

- Director, Freight and International Trade Section
- Texas Department of Transportation

BIOGRAPHICAL SUMMARY

Caroline Mays is responsible for overseeing] TxDOT's comprehensive and multimodal Freight, International Trade and Border Planning Programs. Her specific responsibilities include: 1) implementation of FAST Act freight provisions; 2) developing and implementing a comprehensive Statewide Freight Mobility Plan and Texas-Mexico Border Transportation Master Plan; 3) convening and managing the statewide Freight Advisory Committee and the Border Trade Advisory Committee; 4) developing statewide freight policies and investment strategies; 5) developing and carrying out strategic plan for TxDOT's activities for addressing freight, international trade and border issues; and 6) communicating and coordinating with internal and external stakeholders. Her experience in transportation planning includes: Freight Transportation, International Trade and Border; Intelligent Transportation Systems (ITS); Systems Management and Operations and Incident Management; Transit Planning; and Long Range Transportation Planning. She has presented on freight, International trade, border, and ITS transportation issues at national, state, regional, local, and industry forums and provides on-going technical assistance on the subject.

HIGHLIGHTS OF TRANSPORTATION PLANNING EXPERIENCE

Texas Department of Transportation (TxDOT)—Director, responsible for spearheading the development of the Agency's Freight Planning Program and creating and overseeing the Texas Freight Advisory Committee and as well as spearheading the development of the Texas Freight Mobility Plan.

Texas Freight Mobility Plan—Program director responsible for overseeing the development and implementation of this statewide comprehensive and multimodal freight mobility plan.

Texas-Mexico Border Transportation Master Plan—Program director responsible for overseeing the development of the binational comprehensive and multimodal border transportation master plan and overseeing the Border Trade Advisory Committee.

Atlanta Regional Freight Planning Program—Program manager responsible for initiating and developing the Atlanta Regional Commission's freight planning program. Created an on-ongoing Freight Advisory Task Force comprised of freight stakeholders and other regional planning partners to discuss and address freight and goods transportation issues in the Atlanta region.

Atlanta Regional Freight Mobility Plan (Winner of 2008 AMPO Award)—Project manager responsible for overseeing the development of the Atlanta region's first comprehensive freight mobility plan that addresses freight and goods movement challenges and opportunities.

Atlanta Regional Intelligent Transportation Systems (ITS) Architecture and Strategic Plan—Project manager responsible for spearheading the development of the Atlanta Regional ITS Architecture and Strategic Plan. Managed the implementation and maintenance of Architecture and Strategic Plan. Also oversaw the Architecture compliance including utilization of Systems Engineering Approach in all ITS projects deployed in the region and ensured the architecture was used to support ITS project implementation.

EDUCATION

M.Sc. Pl., Urban and Regional Planning, University of Toronto, 1998

BES, Honors Urban and Regional Planning, University of Waterloo, 1996

AFFILIATIONS AND REGISTRATIONS

- A member of the American Planning Association (APA) and member of the American Institute of Certified Planners (AICP)
- Chair of the Transportation Research Board (TRB) Agricultural Transportation Committee and a member of the Intermodal Freight Transportation Committee and a friend of the Urban Freight Committee, and Freight and Logistics Planning Committee.

PAST WORK EXPERIENCE

Dates	Position(s)	Organization
Feb 2016—Present	Director, Freight and International Trade Section	Texas Department of Transportation
Jul 2013—Jan 2016	Freight Transportation Planning Branch Manager	Texas Department of Transportation
Nov 2012—Jun 2013	Statewide Freight Planning Coordinator	Texas Department of Transportation
Dec 2001—Jan 2009	Principal Transportation Planner	Atlanta Regional Commission (ARC) Transportation Planning Division
Feb 1999—Nov 2001	Transportation Planner-Transit	County of Rockland Department of Planning and Public Transportation
Jun—Aug 1997	Intern	United Nations

Reza Karimvand, PE

Arizona Department of Transportation – Arizona Lead

OVERVIEW

A transportation professional offering 30 years of experience in planning, design, and construction of the roadway; traffic engineering elements and intelligent transportation systems. Thorough understanding of federal, state, and local policies in administering transportation services and managing projects, with the proven ability to integrate technical, institutional, and financial elements for sustainable development. Demonstrated ability to proactively lead and motivate diverse team of professionals to new level of success (Transportation Technology Group at the TOC August 2010-December 2015, prior to formation of TSMO). Proven ability to successfully analyze and identify potential challenges and opportunities, and develop innovative solutions to promote efficiency and improve customer experience. Ability to apply

for and successfully receive funding for Federal Grants (TIGER Grant, Advanced Congestion Managements Grant, FASTLANE Grant, SHRP 2 L02/L07 Grant and Commercial Vehicle Information Systems and Networks (CVISN) Grant.

EDUCATION

Bachelor of Science in Civil Engineering
Louisiana Tech University, Ruston, Louisiana, March 1982

PROFESSIONAL REGISTRATION

- Registered Professional Engineer (Civil), State of Arizona, Registration # 35893

PROFESSIONAL AFFILIATIONS

- Institute of Transportation Engineers (ITE)—Member Status
- American Society of Civil Engineers (ASCE)—Member Status
- Intelligent Transportation System (ITS) Arizona Chapter—Member Status
- National Academies Transportation Research Board, NCHRP Project Panel Member
- AASHTO Subcommittee on Vehicle to Infrastructure (V2I) Deployment Initiative Technical Group
- Member of National Committee on Multi-Modal Intelligent Traffic Safety System (MMITSS) Development Group (MDG)

EXPERIENCE

10/2015 (formation of TSMO Division) to Present—Arizona Department of Transportation, Phoenix, Arizona.

Systems Technology and Innovation Development Manager

- Overseeing the development of ITS Technology statewide including:
  - » Connected Vehicle (CV) program
  - » Integrated Corridor Management (ICM)
  - » Smart Truck Parking (STP)
  - » Performance Measure (PM)
  - » Smart Ramp Metering (SRM)
  - » Dust Warning System (DWS)
  - » Signal Centralization System (SCS)
- Led multiple successful Federal Grant applications to the funding stage: Loop 101 Mobility ($6 mil), Fast Lane ($50 mil), CVSIN (300k), and SHRP 2 L02/L07 Performance Measure ($100k).
- Leading the effort and instrumental in the success of the I-10 Corridor Coalition which will allow the efficient flow of Trucks from Texas to California through collective resource sharing and automation to provide seamless travel for the Trucking Community.
- Coordinated interactions with the American Indian Tribes and Communities in Arizona regarding I-10 Corridor Coalition. Specifically the Gila River Indian Community, Ak-Chin Indian Community, Tohono O'odham Nation and Salt River Pima-Maricopa Indian Community.
- Leading and overseeing the Design and Construction of highly sophisticated dust monitoring system on I-10 in Pinal County area, including Variable Speed Limit (VSL), Fiber Optics

Backbone, Dynamic Message Signs (DMS), X-Band radar system and integration of entire system into State Traffic Operation Center.

- Leading Workforce Development project for ITS and TSMO in regional level. After completion of this project, this report will be integrated to U.S. DOT's national effort for ITS workforce development in the nation.
- On a National Level:
  - » A member of Vehicle to Infrastructure (V2I) Deployment Initiative Technical Group, which offers review and input to the U.S. DOT connected vehicle guidance and related program and products.
  - » A member of Signal Phasing and Timing (SPaT) challenge and U.S. DOT Multi-Modal Intelligent Traffic Signal System (MMITS) Group which is responsible for formulation of guidance to public agencies throughout the nation.
  - » Champion for ITS workforce development and presenter in U.S. DOT National Webinar in ITS workforce development.
- Contributing member of several National Cooperative Highway Research Program (NCHRP), specifically NCHRP 03-124, "*Principle and guidance for presenting Drivers with Dynamic Information on Active Traffic Management*" and NCHRP 20-68A, "*US Domestic Scan Program, Integrated Corridor Management (ICM)"*.
- Successfully led the incident driven ICM program for Loop 101 in Scottsdale that has received National attention for being low-cost and a highly successful program for incident-driven congestion management among ADOT, MCDOT and City of Scottsdale.
- Leading the Systems Technology Development through multimillion dollar projects statewide.

09/2010 to 10/2015—Arizona Department of Transportation, Phoenix, Arizona

Assistant State Engineer

- Led all Intelligent Transportation Systems (ITS) for the ADOT. Duties included providing oversight and guidance to Planning, Development, Design, Construction support, System Integration as well as Operation and Maintenance of all ITS system and Active Traffic Management Systems statewide.
- Led the Project Management for:
  - » Active Traffic Management Systems (ATMS)
  - » Traveler Information Systems (TIS)
  - » Traffic Incident Management (TIM)
  - » Rural Transportation Systems (RTS)
  - » Traffic Signal Synchronization (TSS)
  - » Multi-Modal Intelligent Traffic Signal System (MMITSS)
- Led the redesign of state of the art Traffic Operations Center, a multi-million dollar project, to bring Active Traffic Management (ATM), Traffic Incident Management (TIM) and Travel Time Expansion (TTE) to the forefront, making Arizona a National Leader in ITS.
- Managed the Traffic Operation Center. A 24-hour operation that managed traffic-impacting incidents on the state highway system.
- Responsible for $2.5M annual budget for administration and maintenance.
- Led Active Traffic Management including Variable Speed Limit (VSL), Wrong Way Detection (WWD), Smart Ramp Metering (SRM) in the Maricopa Association of

Governments (MAG) region, as well as Integrated Corridor Management (ICM) for Loop 101 in the Phoenix area.
- Leading member of Arizona Connected Vehicle Program.
- Actively involved as a subject matter expert for incorporating ATM technology, on the 22 mile Loop 202, Multi Billion dollars expansion project.
- Instrumental in highly intense and time restricted review of Federal Grant reports (FAST LANE, ATCMTD for Loop 101 Mobility project).

10/2001 to 08/2010—Arizona Department of Transportation, Tucson, Arizona
Regional Traffic Engineer, Southern Region

09/1997 to 09/2001—Arizona Department of Transportation, Tucson, Arizona
Transportation Engineering Specialist, Southern Region

04/1995 to 09/1997—Arizona Department of Transportation, Phoenix, Arizona
Transportation Engineering Specialist, Traffic Engineering Design Group

1/1992 to 04/1995—Engineers International, Inc., Tucson, Arizona
Civil Engineer

1/1991 to 12/1992—MOD Construction Company, Rockville, Maryland
Construction Division Manager

Paul A. Sittig—New Mexico Department of Transportation

New Mexico Lead

EXPERIENCE SUMMARY

Over 10 years of planning, program and staff management experience, more than five of which are from my work at the New Mexico Department of Transportation, where I started as a Urban and Regional Planner-Advanced in November 2012, where I was NMDOT's state freight planner. I was promoted to Technical & Freight Planning Supervisor in July 2017. My project management responsibilities include technical review of the major statewide functional classification re-evaluation, and managing the Freight-Related Economic Development Opportunity Study. My staff managerial responsibilities have also included personnel oversight and development.

EDUCATION

B.S., City and Regional Planning, Cal Poly San Luis Obispo, 2008

EMPLOYMENT HISTORY

Planner I with the County of San Luis Obispo, 2007—2012

New Mexico Department of Transportation, 2012—present

EXPERIENCE

New Mexico Department of Transportation, 2012—present
Technical & Freight Planning Supervisor

I currently manage statewide, multimodal freight planning for the NMDOT, coordinating with Rail and Aviation Bureaus who also include freight planning for their respective modes, as well the Metropolitan Planning Organizations (MPO) and NMDOT's US/Mexico border-focused International Programs in their regional freight planning efforts. Additionally, I coordinate with the I-10 Connected Freight Corridor Coalition and the Western States Freight Coalition, both regional planning efforts focused on freight, and represent New Mexico in national freight-related transportation issues and coordination. I also worked developed a freight project selection and prioritization matrix, and with consultant support, updated the New Mexico Freight Plan to be FAST Act compliant.

I manage the roadway classifications for NMDOT, including National Highway System and Functional System classifications, working with MPOs, Regional Transportation Planning Organizations (RTPO) and NMDOT Districts to ensure that local roadway use is reflected to support project development and prioritization, as well as funding eligibility and reporting requirements. I also manage staff who work on technical and freight planning efforts.

I oversee the management of the New Mexico Statewide Travel Demand Model (NMSTDM), including dedicated staff and contracts to support the maintenance and upgrade of the NMSTDM, to ensure this tool is kept current and useful for future forecasts and project evaluations.

I also manage the Local Technical Assistance Program (LTAP), both the heavy equipment trainer with NMDOT and the contract with the University of New Mexico (UNM) to serve as the New Mexico LTAP Center.

Urban and Regional Planner – Advanced

While working as an Urban and Regional Planner, I started serving as the freight planner for NMDOT, coordinating with partners in the state and beyond, and oversaw the development of the MAP-21 compliant State Freight Plan.

I served as the technical manager of the statewide Functional System re-evaluation, working with consultants to capture and accurately reflect roadway use conditions throughout the state in coordination with local entities.

I also managed the Northeast RTPO, overseeing the work of two individuals who worked to develop and implement the regional transportation plan.

County of San Luis Obispo

Planner I, 2007 – 2012

While working at the County of San Luis Obispo, I processed land use, grading, cellular facility and subdivision permits, ensuring compliance with local and state regulations, presenting projects to local community groups for public input, and to hearing boards for final decisions.

Joseph Rouse—CALTRANS—California Lead
5716 Nonnie Avenue Sacramento, CA, 95841 | (916) 969-9824 | josefmrouse@gmail.com

SUMMARY

Joe Rouse serves as the chief of the Office of System Operations for the Division of Traffic Operations at the California Department of Transportation (Caltrans). The Office of System Operations provides leadership in mobility management on the California State Highway System through operational strategies, incident management and traveler information. The office oversees managed lanes operations, traveler information programs, and the state's 12 Transportation Management Centers, which track and manage road conditions on the State Highway System. Joe is also the department's technical and policy expert on tolling and congestion pricing.

PROFESSIONAL EXPERIENCE

Caltrans Division of Traffic Operations—Sacramento, CA

Supervising Transportation Engineer October 2017—Present

Serving as chief of the Office of System Operations in the Division of Traffic Operations, directing and supervising staff in the statewide program oversight of managed lanes operations, park & ride facilities, traveler information programs, incident management, and lane closure management.

Supervising Transportation Engineer October 2015—October 2017

Served as the Program and District Liaison for the Division of Traffic Operations at Caltrans HQ. Acted as a coordinator between Traffic Operations and other Divisions in Caltrans and the Federal Highway Administration to help address engineering and business issues. Provided technical support and assistance to Caltrans District staff, regional transportation agencies, and consultants on managed lanes projects.

Supervising Transportation Engineer August 2013—August 2015

Responsible for strategic planning and policy development for managed lanes on the California state highway system (either HOV lane improvements or new HOV/HOT/express toll lane projects). Provided technical support to Caltrans and regional transportation agency partners on the development and operation of managed lanes. Worked on the feasibility of Caltrans developing priced managed lanes systems and expanding the department's tolling authority.

Senior Transportation Engineer November 2007—August 2013

Functional manager for the managed lanes and park & ride programs. Developed statewide policies and procedures for programs and helped develop program budgets and workload standards. Worked with local agencies and Caltrans Districts on managed lane planning efforts and provided technical support on the development and operation of managed lanes.

Caltrans District 3 Division of Traffic Operations—Sacramento, CA

Senior Transportation Engineer August 2015—October 2015

Served as Acting Chief of the Office of Freeway Operations. Directed and supervised engineers and administrative personnel in activities such as safety and operation reviews, freeway operations, ramp metering operations and studies, environmental document reviews, managed lane operations and studies, and production and review of traffic reports.

Transportation Engineer April 2005—April 2007

Project engineer for minor safety and operational improvement projects. Developed signing and striping plans for various jobs in District.

Transportation Engineer November 2001—August 2004

Collected and reviewed traffic count data to analyze and develop work windows for planned traffic restrictions. Advised field staff on appropriate work windows. Assisted in the development of traffic management plans for small and large scale closures. Evaluated closures to determine real-time traffic conditions.

Caltrans North Region Construction—Marysville, CA

Transportation Engineer May 2007—November 2007

Served as resident engineer on "Safe Routes to School" project, which included installation of first traffic signal in the community. Developed numerous design changes to address errors and differing site conditions. Delivered project on time and within budget.

Caltrans North Region Division of Design & Engineering Services—Sacramento, CA

Transportation Engineer March 1999—October 2001

Developed project studies and supporting documents and performed design work on various roadway projects, including freeway reconstruction, highway widening, roadway rehabilitation, and traffic signals. Participated in rotational assignment in North Region Division of Construction. Served as construction inspector on roadway rehabilitation projects and a freeway widening and interchange reconstruction project. Participated in rotational assignment in District 3 Division of Traffic Operations. Studied the impacts of various traffic operational improvements, participated in congestion monitoring, and conducted traffic counts.

EDUCATION

California State University, Sacramento—Sacramento, CA

BS, Civil Engineering, Dec 1998

San Jose State University—San Jose, CA

MS, Transportation Management, Jun 2008

Capstone paper was "Improving the Implementation of Tolled Road Facilities in California". Paper was nominated by the University as a candidate for an award from the Council of University Transportation Centers.

RESUME APPENDIX – PART 2: BIOGRAPHIES FOR SELECTED TECHNICAL TEAM STAFF

State Technical Staff

Texas ITS/Operations Staff: **George J. Villarreal** of TxDOT is also the Texas IT technical lead person.

Arizona ITS/Operations Staff: **Charla A. Glendening**, AICP, ADOT. Ms. Glendening is the Statewide Planning Manager for the Arizona Department of Transportation (ADOT) in Phoenix. She supervises statewide plans including the Long Range Transportation Plan, Freight Plan, Bike/Ped Plan and the Tribal Program. She has worked in the field of Planning for 19 years, and her experience includes both public and private sector work. Charla received her Bachelor's degree in Urban Planning from the University of Colorado, Boulder and is a certified professional planner through the American Planning Association.

New Mexico ITS/Operations Staff: **Charles Remkes**, NMDOT. Mr. Remkes, NMDOT's Chief of Intelligent Transportation Systems (ITS) manages the NMDOT's Intelligent Transportation Systems. This entails all of the NMDOT's activities associated with ITS planning, design, construction, deployment, operations and maintenance as well as administering all ITS-related budgets and financial tracking. He gives strategic direction for the planning and implementation of advanced technology applications at both the Transportation Management Center in Albuquerque and for ITS services throughout the state. It includes applications related to traffic operations, traveler information dissemination, incident detection/management, road weather management, and construction activities. He oversees the development of the technical specifications, standard serial drawings and classifications used for ITS equipment on NMDOT projects and have the continued responsibility for their maintenance including any associated revisions. He ensures the NMDOT's operations continue to be in full compliance with all federal and state regulations including ITS Architecture maintenance and ITS Systems Engineering requirements for project development.

California ITS/Operations Staff: **Joe Rouse**, Chief of the Office of System Operations for the Division of Traffic Operations at the California Department of Transportation (Caltrans) will also be acting as the California technical contact, until staff is assigned to the role.

SYSTEMS ENGINEERING TEAM

Cambridge Systematics is already under contract on a TxDOT task that is working with the I-10 Corridor Coalition to define the I-10 Corridor Coalition TPAS. Upon ATCMTD grant award, this contract will be leveraged by TxDOT to have Cambridge Systematics perform systems engineering, preliminary design activities, and deployment coordination of the I-10 Corridor Coalition TPAS. The Cambridge Systematics team will consist of Mark Jensen, Krista Jeannotte, Daniel Stock and Brian Stewart. Their bios are below.

Mark Jensen is a Principal and Senior Systems Engineer with Cambridge Systematics, has 30 years of experience, and is a specialist in the development of freight technology applications. He recently completed supporting Caltrans and FHWA on a groundbreaking V2V prototype test program which successfully demonstrated truck platooning using Volvo trucks on California Freeways. Between 2011 and 2015, in support of LA METRO and FHWA, and involving the Gateway Cities COG, the two ports, and trucking/terminal industry stakeholders, he led the development of the Freight Advanced Traveler Information System (FRATIS) ConOps, System

Requirements, architecture, development and testing in Los Angeles. Additionally, he is currently working with Caltrans, Arizona DOT, NMDOT and TxDOT to develop a ConOps for the I-10 Connected Corridor between California and Texas.

Krista L. Jeannotte is a Principal of Cambridge Systematics, has more than 25 years of experience, and is a specialist in ITS and freight technology applications, systems engineering, and the evaluation of technology deployments. Some example projects include: Alameda County Transportation Commission (ACTC) 7th Street Grade Separation and Port Arterial Improvements Project – Port of Oakland Freight ITS; Gateway Cities ITS Implementation Plan for Goods Movement; FHWA Developing and Testing FRATIS with Public and Private Partners in the Los Angeles-Gateway Region; and Tranzit Xpress Hazmat Fleet Management and Monitoring System Evaluation. Ms. Jeannotte received a Master's degree in Civil Engineering, Transportation from the University of California at Berkeley; and a Bachelor's degree in Civil Engineering from the California State Polytechnic University at Pomona.

Daniel Stock, who recently joined Cambridge Systematics (CS), has 37 years of experience including economic assessment, benefit/cost analysis, operations analysis, policy analysis, business case development, and research design and management. His focus for the past 24 years has been on determining impacts of programmatic, technological and infrastructure improvements on the profitability, safety and security of transportation investments. Mr. Stock has also led a number of technology pilot tests and deployments including Commercial Vehicle safety and security technology systems and governmental ITS systems, many of which were turnkey systems still in operation by private and local and state agency stakeholders.

Brian Stewart. Mr. Stewart is an Associate with Cambridge Systematics with a deep background in planning for commercial vehicles operation, safety, and parking and FMCSA-related technology deployments. Relevant experience includes: Serving as DPM on the Nevada Truck Parking Implementation Plan; Serving as technical lead or DPM on a number of weigh station (for Washington State JTC, Idaho Transportation Department, Tennessee Highway Patrol, and Arizona DOT) and truck routing (Chicago Metropolitan Agency for Planning and Harris County, TX) projects; and Involvement with FMCSA projects examining the efficiency of electronic screening technology and potential programs for FMCSA's "Beyond Compliance" efforts in addition to supporting the ITD program both directly to FMCSA and as part of a Program Management team for the State of Tennessee.

APPENDIX B: LETTERS OF SUPPORT

June 8, 2018

Ms. Brandye L. Hendrickson
Acting Administrator
Federal Highway Administration
U.S. Department of Transportation
1200 New Jersey Avenue, SE
Washington, DC 20590

RE: TxDOT Grant Application for ATCMTD program
I-10 Western Connected Freight Corridor Truck Parking Availability System (TPAS)

Dear Administrator Hendrickson:

Please accept this letter of support for the Texas Department of Transportation's (TxDOT) application to the Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) program to fund the I-10 Western Connected Freight Corridor Truck Parking Availability System (TPAS). Applying technology to improve the safety and mobility of freight along I-10 is an important foundation for economic development and efficiency in Texas and the southwestern United States.

This proposed project will cover four states along the I-10 corridor (Texas, New Mexico, Arizona, and California) and be led by Texas, the state with the most mileage along I-10. The TPAS project will help mitigate safety issues related to locating truck parking by providing drivers and their dispatcher's real-time information on where empty parking spots are in public rest areas along I-10 from Texas to California. This advanced technology project will thus contribute to the adopted state and federal goals of improved safety, efficiency, system performance, and infrastructure return on investment.

Thank you for your consideration of TxDOT's application and for your continued service to our nation. Should you have any questions, please do not hesitate to contact me.

Sincerely,

Isidro (Sid) Martinez
Director

825 South Saint Mary's Street • San Antonio, Texas 78205
☎ (210) 227-8651 🖷 (210) 227-9321 TTD 1 (800) 735-2989
www.alamoareampo.org

El Paso Metropolitan Planning Organization

June 18, 2018

Ms. Brandye L. Hendrickson
Acting Administrator
Federal Highway Administration
U.S. Department of Transportation
1200 New Jersey Avenue, SE
Washington, DC 20590

RE: TxDOT Grant Application for Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) program
I-10 Western Connected Freight Corridor Truck Parking Availability System (TPAS)

Dear Administrator Hendrickson:

The El Paso Metropolitan Planning Organization supports the Texas Department of Transportation's (TxDOT) application to the Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) program to fund the I-10 Western Connected Freight Corridor Truck Parking Availability System (TPAS). Applying technology to improve the safety and mobility of freight along I- 10 is an important foundation for economic development and efficiency in Texas and the southwestern United States.

This proposed project will cover four states along the I-10 corridor (Texas, New Mexico, Arizona, and California) and be led by Texas, the state with the most mileage along I-10. The TPAS project will help mitigate safety issues related to locating truck parking by providing drivers and their dispatcher's real-time information on where empty parking spots are in public rest areas along I-10 from Texas to California. This advanced technology project will thus contribute to improved safety, efficiency, system performance, and infrastructure return on investment.

Thank you for your consideration of TxDOT's application. Should you have any questions, please feel free to contact me at (915) 212-0258.

Sincerely,

Michael Medina, CNU-A
Executive Director

211 N. Florence Street, Suite 202 El Paso, Texas 79901 Phone: (915) 212-0258 Fax (915) 212-0257
www.elpasompo.org

NEW MEXICO TRUCKING ASSOCIATION, INC.
4700 LINCOLN NE • ALBUQUERQUE, NEW MEXICO 87109
(505) 884-5575 • FAX (505) 342-6308 www.nmtrucking.org

Secretary Elaine L. Chao
US Department of Transportation
1200 New Jersey Ave, SE
Washington, DC 20590

Dear Secretary Chao:

We are aware that the states of Texas, New Mexico, Arizona and California (the ***I-10 Corridor Coalition***) are responding, with the Texas Department of Transportation as the lead agency, to a Notice of Funding Opportunity from the U.S. Department of Transportation (USDOT) under the ATCMTD program for the final design and full implementation of the **I-10 Truck Parking Availability System (TPAS)**.

The New Mexico Trucking Association Inc and its 250+ members and our concern for Highway safety believe this project is essential to that goal.

We understand that this project would help improve highway safety, both for commercial drivers and the public. It would provide commercial drivers with reliable information about where they can safely park to rest, reduce hazardous ramp and shoulder parking, and help insure drivers on the road are well rested. This project will benefit private sector freight and shipping services by making commercial drivers and freight trucks more productive during their hours of service, thereby increasing economic competiveness along the I-10 corridor.

New Mexico Trucking Association supports the I-10 Corridor Coalition's bid to deploy the TPAS system for this project. Also, if the I-10 Corridor Coalition is successful in obtaining USDOT funding for this project, New Mexico Trucking Association would like to volunteer to assist the I-10 Corridor Coalition and USDOT by being an active stakeholder on the project, and in providing access to member motor carriers and trucking fleets for planning and fielding these technologies. We believe that our involvement is this project will be crucial in supporting the design and deployment of a system that meets the needs of our member drivers.

Sincerely,

Johnny R. Johnson
New Mexico Trucking Association Managing Director

ARIZONA TRUCKING
association

June 5, 2018

Secretary Elaine L. Chao
US Department of Transportation
1200 New Jersey Ave, SE
Washington, DC 20590

Dear Secretary Chao:

We are aware that the states of Texas, New Mexico, Arizona and California (the ***I-10 Corridor Coalition***) are responding, with the Texas Department of Transportation as the lead agency, to a Notice of Funding Opportunity from the U.S. Department of Transportation (USDOT) under the ATCMTD program for the final design and full implementation of the **I-10 Truck Parking Availability System (TPAS)**.

The Arizona Trucking Association (ATA) is a non-profit trade association that promotes safety and represents the trucking interests in Arizona. We represent fleets of virtually every size and sector that operate in Arizona. ATA serves as the trucking industry's primary voice on transportation and other public policy issues. Additionally, we work hand and hand with our the public sector partners to promote safety on our nation's roads and highways.

We understand that this project would help improve highway safety, both for commercial drivers and the public. It would provide commercial drivers with reliable information about where they can safely park to rest, reduce hazardous ramp and shoulder parking, and help insure drivers on the road are well rested. And by making the commercial driver and the truck more productive during their hours of service, this project will result in improved benefits to private sector freight and shipping services, this enhancing economic competiveness along the I-10 corridor.

The Arizona Trucking Association supports the I-10 Corridor Coalition's bid to deploy the TPAS system for this project. Also, if the I-10 Corridor Coalition is successful in obtaining USDOT funding for this project, the Arizona Trucking Association would like to volunteer to assist the I-10 Corridor Coalition and USDOT in being an active stakeholder on the project, and in providing access to member motor carriers and trucking fleets to assist the I-10 Corridor Coalition in planning and fielding these technologies. We believe that our involvement is this project will be crucial in supporting the design and deployment of a system that meets the needs of our member drivers.

Sincerely,

Tony Bradley
President and CEO

June 5, 2018

Secretary Elaine L. Chao
US Department of Transportation
1200 New Jersey Ave, SE
Washington, DC 20590

Dear Secretary Chao:

We are aware that the states of Texas, New Mexico, Arizona and California (the ***I-10 Corridor Coalition***) are responding, with the Texas Department of Transportation as the lead agency, to a Notice of Funding Opportunity from the U.S. Department of Transportation (USDOT) under the ATCMTD program for the final design and full implementation of the **I-10 Truck Parking Availability System (TPAS)**.

The CTA is the nation's largest statewide trade association representing the trucking industry. Established in 1934, our 1,400+ members represent all segments of the industry, including both small and mid-sized family owned companies headquartered in California as well as large logistics providers in the Fortune 1000.

We understand that this project would help improve highway safety, both for commercial drivers and the public. It would provide commercial drivers with reliable information about where they can safely park to rest, reduce hazardous ramp and shoulder parking, and help insure drivers on the road are well rested. And by making the commercial driver and the truck more productive during their hours of service, this project will result in improved benefits to private sector freight and shipping services, this enhancing economic competiveness along the I-10 corridor.

The California Trucking Association supports the I-10 Corridor Coalition's bid to deploy the TPAS system for this project. Also, if the I-10 Corridor Coalition is successful in obtaining USDOT funding for this project, CTA would like to volunteer to assist the I-10 Corridor Coalition and USDOT in being an active stakeholder on the project, and in providing access to member motor carriers and trucking fleets to assist the I-10 Corridor Coalition in planning and fielding these technologies. We believe that our involvement is this project will be crucial in supporting the design and deployment of a system that meets the needs of our member drivers.

Sincerely,

Eric Sauer
CTA Senior Vice President of Government Affairs

APPENDIX C: BENEFIT/COST ANALYSIS

BENEFIT ANALYSIS

The envisioned I-10 Corridor Coalition TPAS project is anticipated to provide benefits in the areas of safety (crash reduction from searching for parking while fatigued and/or beyond their HOS and parking in unsafe conditions), mobility (reduced travel-time savings due to reduced crashes and truck driver time searching for parking), environmental (reduced truck emissions and fuel use), other cost savings (nonfuel vehicle operating costs from reduced miles searching for parking), and state of good repair (reduced wear and tear on roadway ramps and shoulders from illegal truck parking). The benefit/cost analysis was performed utilizing the FHWA Tool for Operations Benefit/Cost Analysis (TOPS-BC) and other spreadsheet methods. The benefits analysis was informed by additional inputs from:

- Emissions, vehicle delay, and fuel use associated with truck crashes and fatigue-related crashes from U.S. DOT Federal Motor Carrier Safety Administration (FMCSA).
- Accident data from Texas Peace Officer's Crash Reports processed by the TxDOT, University of New Mexico, Geospatial and Population Studies, Traffic Research Unit (TRU) on behalf of NMDOT, ADOT Statewide Safety Data Mart Crash Data, California Highway Patrol's Statewide Integrated Traffic Records System (SWITRS) database processed by the University of California, Berkeley SafeTREC's Transportation Injury Mapping System (TIMS).
- Evaluations of existing and proposed truck Property damage only (PDO) crashes from statewide average accident rates from Caltrans' Life-Cycle Benefit/Cost Model (Cal-B/C).
- Estimates of fuel use and CO_2 from the U.S. Energy Information Administration (EIA).
- Truck emission rates from the U.S. Environmental Protection Agency (EPA).
- Recommended monetized values and BCA methods from the U.S. DOT's Benefit/Cost Analysis Guidance.

Safety Benefits

Data on fatalities, injuries, and property damage only incidents were obtained from each of the 4 States. For States where fatigue-related crash data were not available, fatigue-related crashes were estimated using a factor of 13 percent.[21] The average annual fatigue-related crashes are summarized in Table C.1.

Table C.1 Average Annual Fatigue-Related Crashes on I-10 by State

Summary Crashes	California[a,b]	Arizona[c]	New Mexico[d]	Texas[a]	Average Annual
Fatalities	1.8	0.6	0.7	0.7	3.8
Injuries	40	8	7	14	70
No Injuries	78	15	10	30	133
Total	**120**	**24**	**18**	**44**	**206**

[a] Average based on three years of crash data 2015-2017.
[b] Property crash only (PDO) crashes estimated using statewide highway accident rates from Cal-B/C, accessed 5/24/18.
[c] Average based on five years of crash data 2011-2016.
[d] Average based on three years of crash data 2014-2016.

Mobility Benefits

The mobility benefits from the I-10 Corridor Coalition TPAS project include delay savings to the public using this facility from the reduced crashes, as well as reduced travel times to truck drivers from increased productivity from the available truck parking information.

[21] FMCSA: https://www.fmcsa.dot.gov/safety/driver-safety/cmv-driving-tips-driver-fatigue, accessed 5/23/18.

Crash-Related Travel-Time Benefits

The travel-time benefits to the general public from reduced crashes were estimated using the rates from Table C.2. The I-10 corridor through California, Arizona, New Mexico, and Texas is approximately 25 percent urban and 75 percent rural. Vehicle hours were converted to person hours using an average vehicle occupancy of 1.39 (U.S. DOT Benefit/Cost Analysis Guidance for Discretionary Grant Programs, 2017). Table C.3 presents the estimated annual travel-time savings from reduced crashes.

Table C.2 Estimated Delay Vehicle Hours per Crash

Roadway Type	Fatal	Injury	PDO
Urban Interstate	6,729	2,522	2,144
Rural Interstate	464	159	134

Source: U.S. DOT FMCSA Delay and Environmental Costs of Truck Crashes, 2013.

Table C.3 Estimated Annual Person Hours Delay Saved Due to Reduced Crashes

Roadway Type	Fatal	Injury	PDO	Total Hours
Urban Interstate	877	6,090	9,877	16,844
Rural Interstate	181	1,152	1,852	3,185
Total	**1,059**	**7,242**	**11,729**	**20,030**

Travel-Time Benefits from Truck Driver Productivity Improvements

The travel-time benefits associated with improved truck driver productivity was estimated using TOPS-BC and methods consistent with prior benefit/cost analysis for truck parking information projects. It assumes the available truck parking spaces will be used on average 5 days per week, once per day, with 80 percent utilization. The travel-time benefit was estimated by multiplying the number of available truck parking spaces in the corridor by the estimated utilization (80 percent) and the average time savings (15 minutes). The travel-time benefit to truckers was estimated to be 27,650 hours annually.

Environmental Benefits

The I-10 Corridor Coalition TPAS project will reduce emissions and fuel use from the reduced crashes and improved truck productivity from reduced vehicle miles traveled (VMT). Environmental benefits estimated for this benefit/cost analysis included:

- Crash-related emissions savings.
- Emissions saved from reduced VMT from parking availability information.
- Crash-related fuel savings.
- Fuel savings from reduced VMT from parking availability information.

Crash-Related Emissions Savings

The emissions benefits to the general public from reduced crashes were estimated using the estimated emissions per crash rates in Table C.4. Table C.5 presents the estimated annual emissions savings from reduced crashes.

Table C.4 Estimated Emissions per Crash (short tons)

Roadway Type	CO_2	CO	NOx	PM_{10}	$PM_{2.5}$	SO_2	VOC
Urban Interstate	10.77391	0.07593	0.01957	0.00166	0.0016	0.00019	0.00815
Rural Interstate	1.63494	0.01074	0.00625	0.00034	0.00033	0.00002	0.00073

Source: U.S. DOT FMCSA Delay and Environmental Costs of Truck Crashes, 2013

Table C.5 Estimated Annual Emissions Saved Due to Reduced Crashes (short tons)

Roadway Type	CO_2	CO	NOx	PM_{10}	$PM_{2.5}$	SO_2	VOC
Urban Interstate	55	0.391	0.101	0.009	0.008	0.001	0.043
Rural Interstate	25	0.166	0.096	0.005	0.005	0.000	0.011
Total	**81**	**0.556**	**0.197**	**0.014**	**0.013**	**0.001**	**0.054**

Emissions Benefits from Truck Driver Productivity Improvements

The emissions benefits associated with improved truck driver productivity was estimated using methods consistent with prior benefit/cost analysis for truck parking information projects. The emissions benefits were estimated by multiplying the number of available truck parking spaces in the corridor by the estimated utilization (80 percent), and the average reduced miles traveled (12 miles). The resulting reduction in miles traveled were then multiplied by truck emission rates from the U.S. Environmental Protection Agency.[22] CO_2 reductions were estimated based on fuel use a fuel use rate from the U.S. Energy Information Administration.[23] Instead of using average reduced miles traveled, total fuel savings was estimated (2 gallons saved) instead of miles traveled. The truck emissions rates and the resulting reduction in emissions from improved truck driver productivity are shown in Table C.6.

Table C.6 Annual Emissions Saved from Parking Information (short tons)

Emissions Type	CO_2	VOC	CO	NOx	$PM_{2.5}$	PM_{10}
Emissions Reduction Rate[a]	0.0112	0.447	2.311	8.613	0.202	0.219
Annual Tons Saved	2,477	0.654	3.380	12.6	0.295	0.320

[a] CO_2 emissions rate is in tons per gallon, other emissions are in grams per mile.

Crash-Related Fuel Savings

The fuel benefits to the general public from reduced crashes were calculated using the estimated excess fuel burned per crash rates shown in Table C.7. Table C.8 presents the estimated annual fuel savings from reduced crashes.

Table C.7 Estimated Excess Fuel Burned per Crash (gallons)

Roadway Type	Fatal	Injury	PDO
Urban Interstate	2,655.95	995.54	846.03
Rural Interstate	483.72	165.18	139.43

Source: U.S. DOT FMCSA Delay and Environmental Costs of Truck Crashes, 2013.

Table C.8 Estimated Annual Fuel Saved Due to Reduced Crashes (gallons)

Roadway Type	Fatal	Injury	PDO	Total Gallons
Urban Interstate	249	1,729	2,804	4,783
Rural Interstate	136	861	1,386	2,383
Total	**385**	**2,590**	**4,190**	**7,166**

Fuel Savings from Reduced VMT from Parking Availability Information

The fuel savings benefits associated with improved truck driver productivity was estimated using methods consistent with prior benefit/cost analysis for truck parking information projects. The fuel benefit was estimated by multiplying the number of available truck parking spaces in the corridor by the estimated utilization (80 percent), and the average fuel savings (2 gallons). The estimated fuel savings benefit to truckers was estimated to be 221,200 gallons annually.

[22] https://nepis.epa.gov/Exe/ZyPDF.cgi/P100EVY6.PDF?Dockey=P100EVY6.PDF, accessed 5/23/18.
[23] https://www.eia.gov/tools/faqs/faq.php?id=307&t=11, accessed 5/23/18.

Vehicle Operating Costs Benefits

The I-10 Corridor Coalition TPAS project is anticipated to reduce vehicle miles traveled which reduces vehicle operating costs. The vehicle operating costs benefit was estimated by multiplying the number of available truck parking spaces in the corridor by the estimated utilization (80 percent), and the estimated miles saved (15 miles). The estimated reduction in vehicle miles was estimated to be 1,327,200 miles annually.

Monetized Benefits Summary

The estimated benefits above were monetized using the rates shown below. Rates shown are in 2018 dollars. Rates were adjusted to 2018 dollars using an inflation rate of 3 percent consistent with TOPS-BC.

- Travel Time (per hour), from U.S. DOT Benefit/Cost Analysis Guidance for Discretionary Grant Programs, 2017:
  - Truck—$28.86
  - All purposes—$14.96
- Crashes (per occurrence), from U.S. DOT Benefit/Cost Analysis Guidance for Discretionary Grant Programs, 2017:
  - Fatality—$10,184,640
  - Injury—$184,597
  - Property Damage Only (PDO)—$4,511
  - KABCO—Incapacitating—$487,059
  - KABCO—Nonincapacitating—$132,613
  - KABCO—Possible Injury—$67,792
  - KABCO—No Injury—$3,395
- Fuel Use (per gallon excluding taxes), from EIA, 5-21-18—$3.28.
- Nonfuel Operating Costs for Truck (per VMT), from U.S. DOT Benefit/Cost Analysis Guidance for Discretionary Grant Programs, 2017—$1.02.
- Emission Cost (per short ton), CO and CO2 from TOPS-BC and others from U.S. DOT Benefit/Cost Analysis Guidance for Discretionary Grant Programs, 2017:
  - CO—$74
  - CO_2—$39
  - NOx—$7,826
  - PM—$358,010
  - VOC—$1,986
  - SO_2—$46,255

Table C.9 presents the expected annual monetary benefits for safety, mobility (travel time), environment (emissions and fuel use), and operating costs (vehicle operating costs) from the benefits analysis results.

Table C.9 Summary of I-10 Corridor Coalition TPAS Project Annual Benefits

$ Millions

	Safety	Travel Time	Environmental	Operating	Total
Annual Monetary Benefit	$5.1	$1.0	$1.2	$1.4	$8.7

Costs Analysis

The costs analysis was informed by inputs from:

- Vendor cost estimates for equipment, installation, warranty, and operations and maintenance costs.
- Cost estimates and operations and maintenance costs and useful life information from the FHWA ITS Cost Database and FHWA TOPS-BC.

The full programmatic costs associated with the I-10 Corridor Coalition TPAS project is estimated to be $13,700,000. This estimate includes PS&E, procurement, construction, and integration, construction management, and agency costs. A summary of the costs for the TPAS project elements is included in Table C.10.

Table C.10 Cost Estimates for I-10 Corridor Coalition TPAS Project Elements

Plan Elements	Full Programmatic Costs	Annual O&M Costs
Truck Parking Occupancy	$4,390,000	$329,000
Dynamic Parking Capacity Signs	$8,030,000	$243,000
I-10 Corridor Coalition TPAS Web/ Smartphone App and Integration	$1,280,000	$100,000
I-10 Corridor Coalition TPAS Totals	**$13,700,000**	**$672,000**

Benefit/Cost Analysis

The benefit/cost analysis for the I-10 Corridor Coalition TPAS project was conducted based on the U.S. DOT Benefit/Cost Analysis Guidance for Discretionary Grant Programs (2017) using a 20-year analysis period. Both the recommended 7 percent discount rate, and 3 percent sensitivity analysis, were calculated, as well as the undiscounted values. A summary of the benefit/cost analysis is shown in Table C.11. As shown, the project is estimated to have a benefit/cost ratio ranging between 4.7 and 6.3.

Table C.11 Benefit/Cost Summary for I-10 Corridor Coalition TPAS Project
Average Annual Values (2018)

Performance Measure	Undiscounted	3% Discount Rate	7% Discount Rate
Safety	$4,692,000	$3,408,000	$2,339,000
Mobility	$1,016,000	$738,000	$506,000
Environmental	$1,094,000	$794,000	$545,000
Vehicle Operating Costs	$1,251,000	$908,000	$623,000
Total Annual Benefit	$8,053,000	$5,848,000	$4,013,000
Total Annual Costs	$1,273,000	$1,052,000	$860,000
Benefit/Cost Ratio	6.3	5.6	4.7

APPENDIX D: LIST OF ACRONYMS

Term	Definition
API	Application program interface
ATCMTD	Advanced Transportation and Congestion Management Technologies Deployment
ATMS	Advanced transportation management system
AZDOT	Arizona Department of Transportation
BCA	Benefit/Cost Analysis
BCR	Benefit/Cost Ratio
Caltrans	California Department of Transportation
CCTV	Closed-circuit television
CMRS	Commercial Mobile Radio Service
ConOps	Concept of operations
DPCS	Dynamic parking capacity signs
DSRC	Dedicated short-range communications
EIA	U.S. Energy Information Administration
ELD	Electronic logging device
EPA	U.S. Environmental Protection Agency
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRATIS	Freight Advanced Traveler Information System
HOS	Hours of service
I-	Interstate
IT	Information technology
ITD	Innovative Technology Deployment
ITS	Intelligent transportation systems
JPO	Joint Program Office
MPO	Metropolitan Planning Organization
NMDOT	New Mexico Department of Transportation
NOFO	Notice of Funding Opportunity
O&M	Operations and maintenance
PDO	Property damage only
PP/TLD	Program Plan and Top-Level Design
RFID	Radio-frequency identification
ROW	Right-of-way
SWITRS	Statewide Integrated Traffic Records System (California)
TIMS	Transportation Injury Mapping System (California)
TMC	Transportation management center
TPAS	Truck parking availability system
TOPS-BC	Tool for Operations Benefit/Cost Analysis
TxDOT	Texas Department of Transportation
U.S. DOT	United States Department of Transportation
V2I	Vehicle to infrastructure
V2V	Vehicle to vehicle
WiFi	Wireless fidelity