2023 Program Report

Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) Program

May 2024

U.S. Department of Transportation

Federal Highway Administration

FOREWORD

The Fixing America's Surface Transportation Act, or "FAST Act," (Pub. L. No. 114-94) established the Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) Program to make competitive grants for the deployment of advanced transportation technologies. This report fulfills the requirement of Section 503 (c)(4)(G) of Title 23, United States Code, to make available to the public information that describes the effectiveness of grant recipients in meeting their ATCMTD projected deployment plans by posting an annual report on the DOT Website. The report describes the effectiveness of grantees in meeting their projected deployment plans, as well as findings on the safety, mobility, environmental, operational efficiency, and other effects of the technology deployments. It presents an overview of Fiscal Year (FY) 2016, FY 2017, FY 2018, FY 2019, FY 2020, and FY 2021 ATCMTD projects with information as of March 31, 2023, including key technologies grantees are planning to deploy. It also highlights performance measures grantees are using and initial grantee insights and lessons learned regarding their technology deployments.

Cover photo: Alyson West/*A view of Wacker Drive at dusk*, n.d. Available at PBIC Image Library (pedbikeimages.org), last accessed October 11, 2022.

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The FAST Act (Pub. L. No. 114-94) established the ATCMTD Program to make competitive grants for the deployment of advanced transportation technologies. The law directs that beginning 3 years after the first grant award and annually thereafter, the Secretary of Transportation shall post on the DOT Website a report about the ATCMTD Program (23 U.S.C. 503(c)(4)(G)). The report should provide credible, useful information on the effectiveness of grantees in meeting their projected deployment plans, as well as findings on the safety, mobility, environmental impacts, operational efficiency, and other impacts of the technology deployments. This report represents the fourth report. It provides an overview of Fiscal Year (FY) 2016– 2021 ATCMTD projects and describes the findings from one completed project. It also highlights performance measures grantees are using and grantee insights and lessons learned regarding their technology deployments.</td></tr>
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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		
in²	square inches	645.2	square millimeters	mm²
ft²	square feet	0.093	square meters	m²
yd²	square yard	0.836	square meters	m²
ac	acres	0.405	hectares	ha
mi²	square miles	2.59	square kilometers	km²
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft³	cubic feet	0.028	cubic meters	m³
yd³	cubic yards	0.765	cubic meters	m³
	NOTE: volumes greater than 1000 L shall be shown in m³			
		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")
oz	ounces	28.35	grams	g
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	candela/m²	cd/m²
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in²	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		
mm²	square millimeters	0.0016	square inches	in²
m²	square meters	10.764	square feet	ft²
m²	square meters	1.195	square yards	yd²
ha	hectares	2.47	acres	ac
km²	square kilometers	0.386	square miles	mi²
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m³	cubic meters	35.314	cubic feet	ft³
m³	cubic meters	1.307	cubic yards	yd³
mL	milliliters	0.034	fluid ounces	fl oz
		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
g	grams	0.035	ounces	oz
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m²	candela/m²	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/in²

*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

Abbreviation	Definition
AI	artificial intelligence
AI-ITMS	Artificial Intelligence Enhanced Integrated Transportation Management System
ATCMTD	Advanced Transportation and Congestion Management Technologies Deployment
ATMS	advanced traffic management system
AV	automated vehicle
AVL	automatic vehicle location
CAD	computer-aided dispatch
CAV	connected and automated vehicle
CCTV	closed-circuit television
CSW	Curve Speed Warning
CV	connected vehicle
C-V2X	cellular vehicle-to-everything
CVDF	Connected Vehicle Data Framework
CVPD	Connected Vehicle Pilot Demonstration
DMS	dynamic message sign
DOT	U.S. Department of Transportation
DSRC	dedicated short-range communication
DSS	decision support system
EV	electric vehicle
FAST Act	Fixing America's Surface Transportation Act
FCC	Federal Communications Commission
FHWA	Federal Highway Administration
FRATIS	Freight Advanced Traveler Information System
FY	fiscal year
HMI	human-machine interfaces
HOV	high-occupancy vehicle
ICM	integrated corridor management
ITS	intelligent transportation system
LED	light-emitting diode
LiDAR	light detection and ranging
MaaS	mobility-as-a-service
MICMA	Multimodal Integrated Corridor Mobility for All
ML	machine learning
MOD	mobility-on-demand
MWCOG	Metropolitan Washington Council of Governments
NFTA	Niagara Frontier Transportation Authority
NITTEC	Niagara International Transportation Technology Coalition
OBU	onboard unit
RFID	radio-frequency identification
RSU	roadside unit

RTA	Regional Transit Authority
SPaT	signal phase and timing
SWIW	Spot Weather Impact Warnings
TCFC	Texas Connected Freight Corridors
TDM	travel demand management
TMC	traffic management center
TPAS	Truck Parking Availability System
TSMO	Transportation Systems Management and Operations
TSP	Transit signal priority
UAS	unmanned aircraft systems
V2I	vehicle-to-infrastructure
V2V	vehicle-to-vehicle
V2X	vehicle-to-everything

EXECUTIVE SUMMARY

BACKGROUND

This report is the fourth program report on the ATCMTD Program. The multiyear, comprehensive surface transportation reauthorization FAST Act (Pub. L. No. 114-94) established, among other programs, the ATCMTD Program, which funds grantees to deploy advanced technologies to improve safety, efficiency, system performance, and infrastructure return on investment.[1] The law sets aside $60 million each fiscal year (FY), from FY 2016 through FY 2020, for grant awards[2] and requires the DOT to award grants each year to at least 5 and no more than 10 eligible entities.[3] This authority was extended through FY 2021 by the Continuing Appropriations Act, 2021 and Other Extensions Act.[4]

The FAST Act outlines key reporting requirements for the grantees, including annual reports to the Secretary of Transportation.[5] These reporting requirements allow DOT to understand grantees' progress and the outcomes of their project deployments, providing insight into which technologies and types of projects have the most potential to advance FAST Act goals of improving transportation safety, efficiency, and system performance. In addition, the FAST Act prescribes that DOT must make publicly available a program report beginning 3 years after the first grant award and annually thereafter.[6] The purpose of the program report is to provide information on the effectiveness of grantees in meeting their projected deployment plans. As specified in the FAST Act, the program report should include data on impacts related to:

- Traffic-related fatalities and injuries
- Traffic congestion and improved travel time reliability
- Transportation-related emissions
- Multimodal system performance
- Access to transportation alternatives
- Public access to real-time integrated traffic, transit, and multimodal transportation information to make informed travel decisions
- Cost savings to transportation agencies, businesses, and the traveling public
- Other benefits to transportation users and the public[7]

[1]FAST Act, § 6004 (codified at 23 U.S.C. 503(c)(4) (2018)).
[2]23 U.S.C. 503(c)(4)(I)(i) (2018).
[3]23 U.S.C. 503(c)(4)(D)(i) (2018).
[4]Pub. L. No. 116-159, div. B, title I, § 1101, 134 Stat. 709, 725 (2020).
[5]23 U.S.C. 503(c)(4)(F) (2018).
[6]23 U.S.C. 503(c)(4)(G) (2018).
[7]23 U.S.C. 503(c)(4)(G)(i)-(viii) (2018).

STATUS OF GRANT AWARDS

The ATCMTD Program has awarded 58 grants through FY 2021, including 8 in FY 2016, 10 in FY 2017, 10 in FY 2018, 10 in FY 2019, 10 in FY 2020, and 10 in FY 2021.[8] The grantees represent a diverse set of metropolitan and rural areas from across the United States. They are deploying a range of advanced technologies, including connected vehicle (CV) applications, automated vehicles (AV), adaptive signal systems, integrated corridor management (ICM), real-time traveler information systems, green technologies (e.g., light-emitting diode, electric vehicle (EV) shuttles), artificial intelligence/machine learning, and infrastructure maintenance and monitoring systems, among other technologies.

All grantees in FYs 2016–2019 have executed their agreements. In addition, all grantees in FYs 2016–2019 received funding obligations. As of March 31, 2023, 9 of the 10 FY 2020 grantees have executed their agreements, and 5 of the 10 grantees have received funding obligations. Of the 10 FY 2021 grantees, 5 have executed their agreements, and 1 has received funding obligations. Chapter 2 lists the grant awards in each fiscal year.

SUPPORT TO GRANTEES

The FHWA provides crosscutting project support to all grantees through a variety of mechanisms. The FHWA-organized Early Deployer Cohort Program is a voluntary roundtable of 7 grantees (with an additional 18 grantees who chose to be informal members) that meets monthly via a Webinar conference to provide status updates, share technical knowledge, and exchange information about grantees' challenges and lessons learned.[9] In addition, FHWA provides performance measurement support and has prepared a report, *Evaluation Methods and Techniques: Advanced Transportation and Congestion Management Technologies Deployment Program*, designed to assist grantees in evaluating their projects.[10] The FHWA also responds to any grantee requests for information and shares these responses with other grantees, if applicable.

STATUS OF PERFORMANCE MEASUREMENT

As of March 31, 2023, one grantee—Greater Cleveland Regional Transit Authority (RTA)—has completed its project and submitted a final report. The RTA, an FY 2017 grantee, implemented a new onboard and integrated communications system, replacing its outdated technology with new features, including state-of-the-art vehicle alarms, priority cellular service, new radio

[8]For two grantees, Ada County Highway District, ID (FY 2017) and Greenville, SC (FY 2017), FHWA and the grantees mutually agreed to terminate the grant. For both projects, the obligated funds were deobligated (no ATCMTD funds were expended for either of these projects).
[9]Informal members of the Early Deployer Cohort Program attend monthly meetings but do not present at the meetings or share status updates.
[10]*Evaluation Methods and Techniques: Advanced Transportation and Congestion Management Technologies Deployment Program*: https://ops.fhwa.dot.gov/publications/fhwahop19053/index.htm.

communications towers, and a turn-by-turn navigation system. As a result of the new system's deployment, RTA reported that it experienced improvements in systems operations and real-time traveler information. The RTA also noted that the provision of complimentary Wi-Fi service on all fixed-route and rail vehicles has enhanced the user experience, providing potential equity benefits.[11]

While many grantees are in the planning phase of their deployment process, working on activities such as stakeholder engagement, system documentation (e.g., the concept of operations), and technology procurement, a growing number of projects have begun testing and deploying technology applications. This report includes a more detailed status update (referred to as project highlights) for eight projects. These projects were selected as highlights to demonstrate the range of technologies being deployed, with an emphasis on projects that have reached the testing or piloting phase.

Grantees are using a range of performance measures (as described in their annual reports and evaluation plans) to assess the benefits of their deployments. The performance measures tend to focus most heavily on improved safety and mobility, as well as improving system performance and operational efficiencies. Grantees also provide performance measures for reducing emissions, integrating real-time information, reducing costs, improving institutional efficiency, enhancing access to transportation alternatives, and advancing equity.

INSIGHTS ON GRANTEES' CHALLENGES AND LESSONS LEARNED

This report also highlights the grantees' challenges and lessons learned that grantees described in their quarterly reports and annual reports. Grantees mentioned various challenges, with some of the top mentions including:

- Technology, equipment, or data issues
- Schedule delays
- Project costs
- Vendors/contracts
- Supply chain

For a number of grantees, these challenges have led to schedule delays. In addition, grantees provided lessons learned and recommendations primarily related to stakeholder engagement and project management, including lessons learned that had not been reported previously.

[11] *Advanced Transportation and Congestion Management Technologies Final Report*. Greater Cleveland RTA ATCMTD Final Report (July 2021).

About This Report

Section 6004 of the FAST Act, codified at 23 U.S.C. 503(c)(4), requires the development of this program report, which fulfills the requirement of Section 503 (c)(4)(G) of Title 23, United States Code, to make available to the public information that describes the effectiveness of grant recipients in meeting their ATCMTD projected deployment plans by posting an annual report on the DOT Website. Per 23 U.S.C. 503(c)(4)(G), the report shall include data on how the program has:

- Reduced traffic-related fatalities and injuries
- Reduced traffic congestion and improved travel time reliability
- Reduced transportation-related emissions
- Optimized multimodal system performance
- Improved access to transportation alternatives
- Provided the public with access to real-time integrated traffic, transit, and multimodal transportation information to make informed travel decisions
- Provided cost savings to transportation agencies, businesses, and the traveling public
- Provided other benefits to transportation users and the general public

CHAPTER 1. INTRODUCTION

This report is the fourth annual program-level report on the ATCMTD Program. The FAST Act, a Federal law providing long-term funding for surface transportation infrastructure planning and investment from FY 2016 through FY 2021, established the ATCMTD Program, stating:

… the Secretary [of Transportation] shall establish an advanced transportation and congestion management technologies deployment initiative to provide grants to eligible entities to develop model deployment sites for large-scale installation and operation of advanced transportation technologies to improve safety, efficiency, system performance, and infrastructure return on investment.[12] This authority was extended through FY 2021 by the Continuing Appropriations Act, 2021 and Other Extensions Act.[13]

BACKGROUND

The ATCMTD Program funds grants to deploy advanced technologies in support of FAST Act safety, mobility, environmental impact, and operational efficiency goals.[14] The law sets aside $60 million each fiscal year from FY 2016 through FY 2021 for the grant awards,[15] with the Federal share of funding not to exceed 50 percent of the total cost of the project.[16] The law

[12] 23 U.S.C. 503(c)(4) (2018).
[13] Pub. L. No. 116-159, div. B, title I, § 1101, 134 Stat. 709, 725 (2020).
[14] 23 U.S.C. 503(c)(4)(A) (2018).
[15] 23 U.S.C. 503(c)(4)(I)(i) (2018).
[16] 23 U.S.C. 503(c)(4)(J) (2018).

requires DOT to award grants each year to at least 5 and no more than 10 eligible entities, with not more than 20 percent of the funds each year to a single entity. The awards should be diverse with respect to the technologies being deployed and geographic location.[17] In addition, the law requires that candidates' applications include a technology deployment plan,[18] quantifiable system performance objectives,[19] quantifiable safety, mobility, and environmental benefit projections, a plan for partnering with other institutions, and an explanation of how applicants will leverage existing technology and infrastructure for the project.[20]

GRANTEE REPORTING REQUIREMENTS

The ATCMTD Program includes a number of key reporting requirements for grantees, including annual reports to the Secretary of Transportation.[21] The reporting requirements allow the FHWA to monitor grantees' deployment progress and to understand the impacts of grantees' projects, providing insight into which technologies and types of projects are most effective at advancing FAST Act goals of improving transportation safety, efficiency, and system performance. The grantees can also use the information to improve the operations of their deployments. The grantees' reporting feeds directly into this program report, allowing other State and local entities to learn from grantee successes and challenges when executing their advanced technology deployments.

The following sections summarize grantees' key reporting requirements.

Quarterly Reports

All grantees submit quarterly reports to FHWA, which include descriptions of current work completed and work planned for the upcoming quarter, status of procurements and key milestone dates, any significant problems encountered, tabulated costs, the work performed in support of DOT goals, and any budget revisions.

Annual Reports

One year after each grantee completes its executed grant agreement, and each year thereafter, the law requires that grantees submit a report to the Secretary of Transportation (referred to as the "annual report" in this document) that describes deployment impacts, including:[22]

- Project deployment and operational costs compared to the benefits and savings the project provides;

[17] 23 U.S.C. 503(c)(4)(D) (2018).
[18] 23 U.S.C. 503(c)(4)(C)(ii)(I) (2018).
[19] 23 U.S.C. 503(c)(4)(C)(ii)(II) (2018).
[20] 23 U.S.C. 503(c)(4)(C)(ii)(III) (2018).
[21] 23 U.S.C. 503(c)(4)(F) (2018).
[22] 23 U.S.C. 503(c)(4)(F) (2018).

- Data on whether the project has helped reduce traffic crashes, congestion, costs, and other benefits of the deployed systems;
- Data on the effectiveness of measuring and improving transportation system performance through the deployment of advanced technologies;
- The efficacy of providing real-time integrated traffic, transit, and multimodal transportation information to the public to make informed travel decisions; and
- Lessons learned and recommendations for future deployment strategies to optimize transportation efficiency and multimodal system performance.

Evaluation Plans

As part of their applications, many grantees proposed to develop evaluation plans, which were incorporated into their cooperative agreements after execution. Beginning in FY 2018, it became mandatory for grantees to create evaluation plans. Evaluation plans outline project goals, evaluation methods and design, performance measures, data collection procedures, and evaluation risks.[23]

SUPPORT TO GRANTEES

The FHWA provides performance measurement support to the grantees to assist them in meeting their reporting requirements. In addition, through the Early Deployer Cohort Program outlined later in this section, FHWA provides technical assistance to help grantees overcome any challenges or issues they may be facing in their deployments. The FHWA also responds to any grantee requests for direction. If FHWA learns information from one grantee that applies to other grantees, it shares the information.

Performance Measurement Support

The FHWA provided grantees with an annual report template that they are encouraged to use in fulfilling this evaluation plan reporting requirement (see appendix A). The annual report template contains four sections. The Introduction and Overview section asks grantees to provide a project description and indicate the technologies they are deploying and the project's goals. The Evaluation/Research Activities section asks grantees to list their performance measures and research activities by goal area. The Findings section requests information on grantees' findings (tied to performance measures). The Wrap-Up section presents grantees with the following series of questions:

- How is the project doing with respect to meeting original expectations (i.e., as stated in the project proposal)? Note here any *major* deviations or changes in scope from the original proposal due to either project-driven outcomes or other unforeseen challenges.

[23]Beginning with FY 2018 awards, all grantees are required to prepare evaluation plans. See section A.5 of the 2018 FHWA Notice of Funding Opportunity No. 693JJ318NF00010: https://www.grants.gov/web/grants/view-opportunity.html?oppId=303763.

- Are there any aspects of your project that you consider cutting-edge, noteworthy, or innovative?
- How do the project's deployment and operational costs compare to the benefits and savings the project provides (i.e., can you provide an objective benefit-cost analysis or alternate subjective comparison)?
- What lessons have been learned to date from your deployment, specifically regarding future deployment strategies to optimize transportation efficiency and multimodal system performance? Please note lessons learned regarding challenges in technology deployment (e.g., technical, institutional), research (e.g., performance measurement), or other lessons learned.
- What recommendations can you provide regarding future deployment strategies in this/these area(s)?

To assist grantees in preparing their evaluation plans and conducting their evaluations, FHWA provided grantees with an "Evaluation Checklist"—a high-level list of issues and topics that grantees should consider when preparing their evaluation plans. In addition, FHWA has produced the report, *Evaluation Methods and Techniques: Advanced Transportation and Congestion Management Technologies Deployment Program*, to assist grantees in developing credible evaluations that measure the impacts of their technology deployments.[24] The document provides an overview of evaluation design and performance measurement and includes chapters related to specific methods (benefit-cost analysis, survey design, and emissions analysis), as well as a limited set of technologies that are either being commonly deployed among grantees or where additional technical assistance would be particularly useful (CVs, AVs, and adaptive signal control).

Early Deployer Cohort Program

The FHWA has been providing support to grantees through the Early Deployer Cohort Program, a voluntary roundtable of 7 grantees (with 18 additional grantees who chose to be informal members) that meets monthly via Webinar conference to provide status updates and share information about their progress, challenges, and lessons learned. The Early Deployer Cohort Program has been a resource for connecting grantees facing similar technical and institutional challenges.

The FHWA modeled the ATCMTD Early Deployer Cohort Program on a similar program administered as part of the Connected Vehicle Pilot Demonstration (CVPD) Program, which began in 2015 and is still ongoing. Based on the success of the cohort CVPD Program, the ATCMTD Program adopted the same model. The FHWA tailors the topics addressed at the meetings to the needs and interests of the grantees and has developed a file-sharing site to exchange relevant resources.

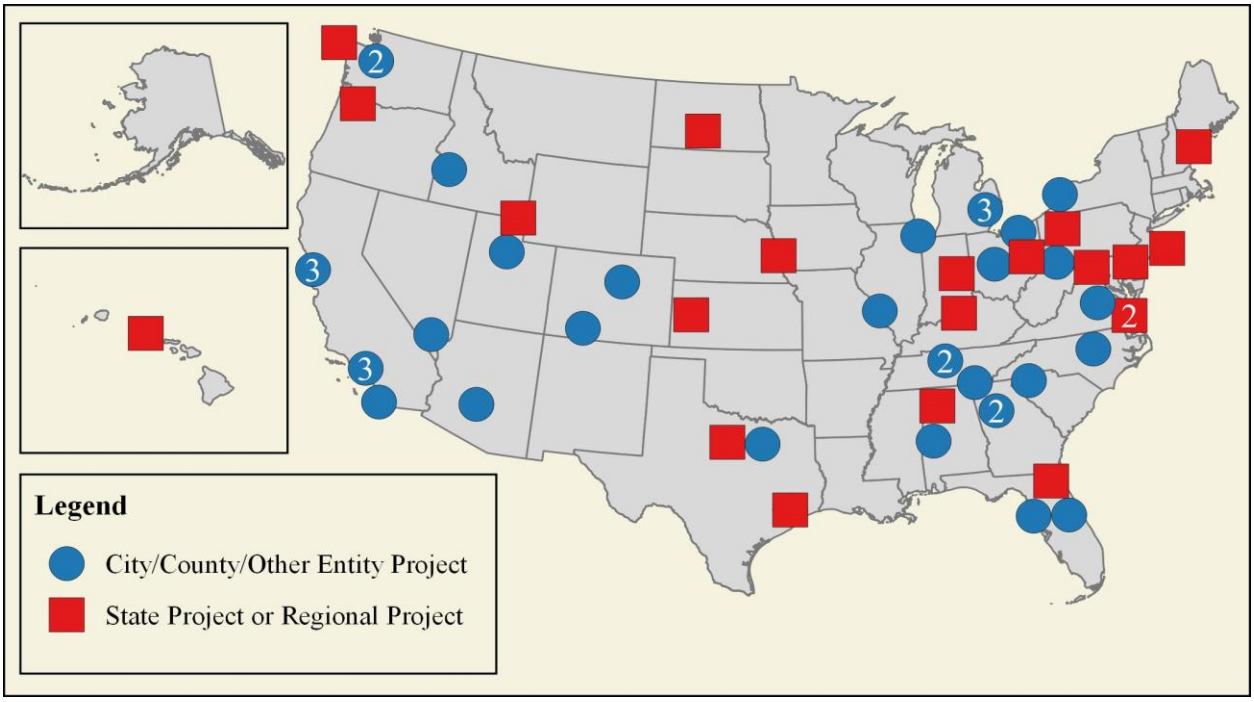
[24] *Evaluation Methods and Techniques: Advanced Transportation and Congestion Management Technologies Deployment Program*: https://ops.fhwa.dot.gov/publications/fhwahop19053/index.htm.

CHAPTER 2. OVERVIEW OF GRANTEE PROJECTS

This chapter provides a general overview of the grantee projects. Across the 6 fiscal years of this program, FHWA received 298 applications and awarded 58 grants, including 8 in FY 2016, 10 in FY 2017, 10 in FY 2018, 10 in FY 2019, 10 in FY 2020, and 10 in FY 2021.[25]

The grantees represent a diverse array of agencies, including city, county, and other local agencies and State DOTs, as shown in Figure 1. In addition, the ATCMTD Program has awarded grants equally to rural and nonrural projects.

All grantees in FYs 2016–2019 have executed their agreements. In addition, all grantees in FYs 2016–2019 received funding obligations. As of March 31, 2023, 9 of the 10 FY 2020 grantees have executed their agreements, and 5 of the 10 grantees have received funding obligations. Of the 10 FY 2021 grantees, 5 have executed their agreements, and 1 has received funding obligations.



Source: FHWA.

Figure 1. Map. Advanced Transportation and Congestion Management Technologies Deployment Program grantees.[26]

[25]For two grantees, Ada County Highway District, ID (FY 2017) and Greenville, SC (FY 2017), FHWA and the grantees mutually agreed to terminate the grant. For both projects, the obligated funds were deobligated (no ATCMTD funds were expended for either of these projects).
[26]See Projects by Fiscal Year section for a complete list of projects.

PROJECTS BY FISCAL YEAR

The lists that follow identify each of the project grantees by fiscal year. Each bullet point contains the project name at the time of award, followed by the lead entity grantee in italics. For brief descriptions of each project, please see appendix B.

Fiscal Year 2021 Awards

The ATCMTD Program awarded the following 10 grants in FY 2021:

- Proactive Route Operations to Avert Congestion in Traffic (PROACT) Alabama, *Alabama DOT*
- An End-to-End Decision Support System for Integrated Smart Electric Grid and Transportation System Management, *City of Chattanooga*
- Chicago Centralized Transit Signal Priority Project (CCTSP), *City of Chicago*
- Great Plains Rural Freight Technology Corridor Project, *Kansas DO*
- Kentucky's Wrong Way Driving and Integrated Safety Technology, *Kentucky Transportation Cabinet*
- Port of Los Angeles Gateway, *Port of Los Angeles*
- EZConnect: An Open and Cloud-Based Mobility Center Providing One-Stop Access for Travel Needs of Underserved Customers, *NEORide*
- Electric Vehicle User Range Anxiety Solution for Rural North Dakota, *North Dakota DOT*
- Smart and Connected Atlantic City Expressway, *South Jersey Transportation Authority*
- Washington State Ferries Terminal Wait Times Traveler Information System, *Washington State DOT*

Fiscal Year 2020 Awards

The ATCMTD Program awarded the following 10 grants in FY 2020:

- Advancing Connectivity and the Economy Through Technology in the San Diego Region, *San Diego Association of Governments*
- Pinellas Connected Community, *Pinellas County Public Works Department*
- Emergency Vehicle Preemption Using Connected Vehicle Technology, *Georgia DOT*
- Maine Advanced Signal Control and Connected Vehicle System for Safe, Efficient, and Equitable Rural Transportation (MAST) Project, *Maine DOT*
- Smart Intersections: Paving the Way for a National Connected and Automated Vehicles Deployment (CAV), *University of Michigan*
- Integrated Safety Technology Corridor, *Regional Transportation Commission of Southern Nevada*

- Charlotte Avenue/Dr. Martin L King, Jr Boulevard Transit Headways and Congestion Management, *Metro Government of Nashville and Davidson County (Public Works Department)*
- S.M. Wright Smart Corridor, *City of Dallas*
- Utah Broadly Connected, *Utah DOT*
- Autonomous Truck Ready, *Virginia Port Authority*

Fiscal Year 2019 Awards

The ATCMTD Program awarded the following 10 grants in FY 2019:

- MWCOG: Deployment of Personalized and Dynamic Travel Demand Management (TDM) Technology in the Washington, DC, Baltimore, MD, Richmond, VA Megaregion, *Metropolitan Washington Council of Governments (MWCOG)*
- I–4 Florida's Regional Advanced Mobility Elements (FRAME), *Florida DOT*
- Implementing Cellular V2X Technology to Improve Safety and Intelligent Transportation Systems (ITS) Management in Hawaii, *Hawaii DOT*
- Intelligent Woodward Corridor Project, *Michigan DOT*
- I–270 Predictive Layered Operation Initiative (PLOI), *Missouri DO*
- Multimodal Connected Vehicle Pilot, *North Carolina DOT*
- DriveOhio I–70 Truck Automation Corridor, *Ohio DOT*
- Artificial Intelligence-Powered Decision Support Tools for Integrated Corridor Management, *Tennessee DOT*
- Artificial Intelligence Meets Integrated Corridor Management: Realizing the Next Generation of Regional Mobility, *Virginia DOT*
- Deployment of the Washington State Virtual Coordination Center (VCC) for Multimodal Integrated Corridor Management, *Washington State DOT*

Fiscal Year 2018 Awards

The ATCMTD Program awarded the following 10 grants in FY 2018:

- Bay Area Mobility-On-Demand Project, *Contra Costa Transportation Authority*
- Advanced Connected Transportation Infrastructure and Operations Network (ACTION), *University of Alabam*
- Wolf Creek Pass Advanced Technology Deployment, *Colorado DOT*
- Artificial Intelligence Enhanced Integrated Transportation Management System (AI-ITMS) Deployment Program, *Delaware DOT*
- Georgia DOT Connected Vehicles, *Georgia DOT*
- Multi-State Rural Integrated Corridor Management, *Nebraska DOT*
- Oregon Smart Mobility Network, *Oregon DOT*
- Work Zone Reservation and Traveler Information System, *Pennsylvania DOT*

- I–10 Corridor Coalition Truck Parking Availability System (I–10 Corridor Coalition TPAS), *Texas DOT*
- Utah Connected, *Utah DOT*

Fiscal Year 2017 Awards

The ATCMTD Program awarded the following 10 grants in FY 2017:

- Loop 101 Mobility Project, *Arizona DOT*
- Global Opportunities at the Port of Oakland Freight Intelligent Transportation System, *Alameda County Transportation Commission*
- Connecting the East Orlando Communities, *Florida DOT*
- SMART Arterial Management, *Ada County Highway District*
- Improving Safety and Connectivity in Four Detroit Neighborhoods, *City of Detroit*
- Connecting Cleveland Project, *Greater Cleveland Regional Transit Authority (RTA)*
- Greenville Automated (A-Taxi) Shuttle, *County of Greenville*
- The Texas Connected Freight Corridors Project, *Texas DOT*
- Truck Reservation System and Automated Work Flow Data Model, *Virginia Port Authority*
- Multimodal Integrated Corridor Mobility for All, *Seattle DOT*

Fiscal Year 2016 Awards

The ATCMTD Program awarded the following eight grants in FY 2016:

- Freight Advanced Traveler Information System (FRATIS), *Los Angeles County Metropolitan Transportation Authority*
- City of San Francisco ATCMTD Initiative, *San Francisco Municipal Transportation Agency*
- Los Angeles DOT Implementation of Advanced Technologies to Improve Safety and Mobility within the Promise Zone, *Los Angeles DOT*
- Denver Smart City Program, *City and County of Denver*
- A Connected Region: Moving Technological Innovations Forward in the NITTEC27 Region, *Niagara Frontier Transportation Authority (NFTA)*
- NW 33 Smart Mobility Corridor, *Union County, City of Marysville, and City of Dublin*
- SmartPGH, *City of Pittsburgh*
- ConnectSmart: Connecting TSMO and Active Demand Management, *Texas DOT*

SUMMARY OF TECHNOLOGY DEPLOYMENTS

[27] Niagara International Transportation Technology Coalition.

The ATCMTD grants awarded from FY 2016 through FY 2021 support the deployment of a range of advanced transportation technologies.[28] Some of the key technologies include CVs and connected infrastructure; real-time traveler information; ICM and decision support systems (DSS); infrastructure maintenance and monitoring technologies; adaptive traffic signal control; artificial intelligence (AI), machine learning (ML), and advanced analytics; AVs; and green technology (e.g., light-emitting diode (LED) lighting, EV shuttles). Table 1 highlights the number of deployment projects for each of these key technologies.[29] Many projects deploy more than one technology. For a more detailed list of the deployed technologies in the projects, please see appendix B.

Table 1. Advanced Transportation and Congestion Management Technologies Deployment grantee key technology deployments, as of March 31, 2023.

Technology	Number of Projects (56 Projects Total)
Real-time traveler information	48
Connected vehicles/connected infrastructure	47
Integrated corridor management/decision support systems	25
Infrastructure maintenance/monitoring	16
Adaptive signals	13
Artificial intelligence/machine earning/advanced analytics	13
Automated vehicles	8
Green technology (LED lighting, electric vehicle shuttles)	5

The grantee projects also span a range of modes and service models. In addition to passenger vehicles, many of the projects either focus on or have a component that includes freight, transit, pedestrian/bicyclist, or mobility-on-demand (MOD), as shown in table 2. Many projects address more than one mode or service model.

Table 2. Advanced Transportation and Congestion Management Technologies Deployment grantee project modes/services, as of March 31, 2023.

Mode/Service Model	Number of Projects (56 Projects Total)
Passenger vehicle	35
Transit	25
Pedestrian/bicyclist	23
Freight	14
Mobility-on-demand	7

[28]For two grantees, Ada County Highway District, ID (FY 2017) and Greenville, SC (FY 2017), FHWA and the grantees mutually agreed to terminate the grant. These two projects are not included in this section or any following sections of this report.
[29]Table 1 is not an exhaustive list; it represents the most prevalent technologies being deployed.

GRANTEE DEPLOYMENT STATUS

One FY 2017 grantee, the Greater Cleveland RTA, completed its project as of March 31, 2023. However, many grantees are still in the planning phase of their deployment process, working on activities including stakeholder engagement, system documentation (e.g., the concept of operations), and technology procurement. A growing number of projects have begun testing and deploying technology applications. Table 3 illustrates the overall deployment status of FY 2016–FY 2021 grantees by showing the number of projects at different stages of deployment.[30]

Table 3. Advanced Transportation and Congestion Management Technologies Deployment Fiscal Years 2016–2021 grantee project status as of March 31, 2023.

Deployment Status	Number of Projects (42 Projects Total)
Planning stages	17
Piloting/testing/partial deployment	13
Completed deployment	12

PROJECT HIGHLIGHTS

This section of the report highlights the activities of eight grantees, providing a more detailed description of their progress. The eight projects were selected to demonstrate the range of technologies being deployed, emphasizing projects that have reached the testing or piloting phase. These projects also demonstrate the diverse modes that are being addressed. The eight project highlights include:

- A Connected Region: Moving Technological Innovations Forward in the NITTEC Region
- City of San Francisco ATCMTD Initiative
- Multimodal Integrated Corridor Mobility for All (MICMA)
- The Texas Connected Freight Corridors Project
- Improving Safety and Connectivity in Four Detroit Neighborhoods
- Utah Connected
- MWCOG: Deployment of Personalized and Dynamic Travel Demand Management (TDM) Technology in the Washington, DC, Baltimore, MD, Richmond, VA Megaregion

[30]The table excludes two FY 2017 grantees who mutually agreed with FHWA to terminate their grants and the five FY 2020 grantees and nine FY 2021 grantees for whom funding has not yet been obligated by FHWA.

A Connected Region: Moving Technological Innovations Forward in the NITTEC Region (2016)

Source: Niagara Frontier Transportation Authority.

Figure 2. Logo. Niagara International Transportation Technology Coalition logo.

supports NFTA's ability to address the unique challenges that face binational regions.
This project is currently in the process of using existing and new data sources to develop a central transportation management software, subsystems, and field infrastructure for regional partners. This system extends ICM activities to the broader regional transportation network to support monitoring and operations through a performance measurement platform. By using a DSS application with an Expert Rule Engine and simulation model, the system assists stakeholders in cooperatively responding to incidents, congestion, and emergencies.

On the public-facing side, this project provides real-time traffic information for travelers and commercial vehicle operators. The information can also be used by external applications for connected commercial vehicles that communicate directly or through mobile applications. In addition, a pilot deployment will provide real-time parking space availability at a truck or park-and-ride facility.

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The NFTA is enhancing safety and mobility across the Buffalo-Niagara frontier in Western New York State and Southern Ontario, Canada. Through a multiagency, technology-enabled, integrated regional mobility management system, this project aims to advance border crossing performance, improve travel time reliability for residents, tourists, and commercial vehicle operations, detect and clear incidents faster, provide real-time traveler information, and support data sharing across agencies. This collaborative approach

Project partners:

- Niagara International Transportation Technology Coalition
- Buffalo and Fort Erie Public Bridge Authority
- City of Buffalo
- Greater Buffalo-Niagara Regional Transportation Council
- Ministry of Transportation, Ontario
- New York State Department of Transportation
- New York State Thruway Authority
- Niagara Falls Bridge Commission
- Niagara Frontier Transportation Authority
- Erie County

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City of San Francisco Advanced Transportation and Congestion Management Technologies Deployment Initiative (2016)

The City of San Francisco's **AdvanceSF** project seeks to advance transportation infrastructure for a smarter and more mobile city to benefit all users. Through its three project elements, AdvanceSF will improve system performance, enhance access to transportation alternatives, and expand real-time transportation information, resulting in safety, mobility, and environmental benefits.

For the **Connected Corridor Proof of Concept Pilot**, a multimodal intelligent traffic signal system was deployed at 10 intersections along the 3rd Street corridor in 2020, an area with frequent public transit service, significant pedestrian crossings, and occasional heavy traffic volume along with construction vehicles. The project used light detection and ranging (LiDAR), an innovative sensor technology, to improve traffic signal timing and determine near-miss incidents. The project returned promising results for transit—up to a 20-percent savings in travel time and a reduction of up to 75 percent in red light delay. The project team seeks to build on the work by operationalizing the proof of concept corridorwide in 2024.

The **Treasure Island Autonomous Shuttle Pilot** includes the procurement, testing, and deployment of electric AV shuttles to serve intraisland trips and increase access around the island. The shuttles, which will provide free rides during the pilot, will serve as connections between residential, recreational, and commercial areas on the island and will connect users to bus and ferry services. Deployed in a mixed-use environment, this pilot will help deployers understand the use of an AV shuttle for first- and last-mile connections, as well as lead to an understanding of how new residents' travel decisions are shaped by shuttle availability. The 3-month pilot funded by this grant has been extended to 9 months with additional funding from the Metropolitan Transportation Commission's Innovative Deployments to Enhance Arterials Shared Automated Vehicles program.

The **Treasure Island Connected Congestion Toll System** will be designed and constructed to serve as the foundation for a congestion pricing program for trips to and from Treasure Island. The toll system will collect tolls electronically from vehicles entering and exiting the island. Rates will be higher during peak periods in an effort to encourage transit use and thus ease severe congestion during peak periods. Toll revenues will pay for expanded transit (bus, ferry, shuttle) services and TDM programs for island residents and visitors. Public transit and vanpool vehicles will not be charged a toll to incentivize high-occupancy vehicle travel. Current island residents, who are primarily low-income, will also be exempt from paying tolls. Other affordability efforts include a multioperator Transit Pass with steep discounts for low-income residents and workers, and a subsidy program for current resident-serving businesses.

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Multimodal Integrated Corridor Mobility for All (MICMA) (2017)

Source: Seattle DOT.

Figure 3. Photograph. Seattle mobility corridor.

The City of Seattle DOT is creating a multimodal operations environment to improve travel for all users on and around the University of Washington campus through its **MICMA** project. MICMA will improve mobility for passenger vehicles, emergency vehicles, pedestrians, and bicyclists through various targeted technologies and an improved system for delivering transportation-related information to users.

Seven elements comprise MICMA. As part of **base ITS enhancements**, Seattle DOT installed adaptive signal control at 35 intersections on 4 arterial roads. Achieving this milestone allows Seattle DOT to implement other key innovations in the project area. **Pedestrian surge management** will leverage adaptive signals to change signal timing when high volumes of pedestrians are present. Nonintrusive **cyclist detection** technologies will ensure cyclists (shown in Figure 3) are detected at signals on par with cars, integrating them into the adaptive signal control system. The **Green Wave** project element will enable signal preemption for approaching Seattle Fire Department emergency vehicles and support clearance of downstream traffic. Washington DOT and Seattle DOT are coordinating **ICM** strategies as the two entities consider automated incident data sharing to improve joint response when incidents affect both agencies' facilities. In addition, Seattle DOT will integrate incident data with its current open data platform, adding valuable data (e.g., traffic counts and crashes) to a data portal for Seattle DOT use with the possibility of making it public. As part of the upgrade to its data portal, Seattle DOT will enhance its **mobility-as-a-service** (MaaS) open data stream by converting accessible walking path information (curb ramps and sidewalks) to a machine-readable format. Finally, Seattle DOT will implement **automated traffic signal performance measures** to provide operations statuses and other data to further improve multimodal mobility.

Innovative project elements:

- **Green Wave** fuses real-time traffic congestion data with automatic vehicle location (AVL)/computer-aided dispatch (CAD) emergency vehicle location data to trigger a traffic signal response while the fire department vehicles are approaching the intersection.
- Seattle DOT believes theirs is the first pilot in the United States to integrate **cyclist detection** with adaptive signal control.
- **Pedestrian surge management** will detect both approaching and waiting pedestrians to adjust signal times at high-volume locations.
- Improvements to Seattle DOT's **MaaS platform** will support the development of national standards to MaaS data by improving the private sector's ability to pull the data into their own traveler information systems.

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The Texas Connected Freight Corridors Project (2017)

Source: Texas DOT.

Figure 4. Illustration. Texas Connected Freight Corridors.

Public and private stakeholders are collaborating to deploy CV technologies on Texas DOT fleet vehicles and commercial vehicles through the **Texas Connected Freight Corridors (TCFC)** project. The TCFC aims to improve the safety of the traveling public, reduce truck-related crashes, and reduce the time trucks spend in congestion. The service area includes the 865-mile Texas Triangle (shown in Figure 4) of I–35 (including an extension to Laredo), I–45, I–10 (linking Austin, Dallas-Fort Worth, Houston, and San Antonio), and the I–30 technology corridor between Dallas and Fort Worth.

The TCFC's CV technologies will use radio and cellular signals to enable communication between infrastructure and stakeholder vehicles to broadcast key safety and mobility notifications. In the project's first phase, the TCFC team worked with stakeholders to identify potential CV applications, and in the project's second phase, five are in development: 1) work zone warning, 2) queue warning, 3) wrong-way driver alert, 4) freight signal priority, and 5)

advanced traveler information systems. Through the implementation of these applications in the near term, trucks operated by six freight partners, including automated truck partners, will receive real-time information about traffic and roadway conditions that affect safety and mobility. Freight signal priority will enable truck drivers to move more efficiently through signalized intersections near distribution centers, reducing stops and truck idling time. This **connected system** benefits the environment, reduces the need for vehicle and roadway maintenance, and reduces costs for freight operators.

The TCFC team is developing a Connected Vehicle Data Framework (CVDF) prototype to collect and aggregate statewide system data for internal and third-party use. The CVDF builds on a previous CV Pooled Fund Study project, which implemented a set of common interfaces to share CV and transportation data with third parties to deliver infrastructure to vehicle communications. The TCFC will deploy 82 roadside units and 61 onboard units for the project's deployment. To further maximize the benefits of this project long term, Texas DOT is also exploring ways to extend the CV applications and technologies to similar highway corridors with a significant amount of truck volume. Additional partnerships with third-party data providers are also under development to expand the reach of the CV technology being deployed through in-vehicle apps.

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Improving Safety and Connectivity in Four Detroit Neighborhoods (2017)

The **Improving the Safety, Mobility, and Connectivity of Four Detroit Neighborhoods** project is led by the City of Detroit. This project aims to improve safety, mobility, and connectivity, as well as reduce congestion, and cut emissions along two city corridors, East Jefferson Avenue between I–375 and Alter Road and Livernois Avenue between Puritan Avenue and M-102/8 Mile Road. Currently, the project team is reviewing contractor/vendor submittals of specific ITS technologies against project specifications before approval for installation procurement. Deployment and installation, system integration and testing are planned for later this year, with the post deployment evaluation expected in late 2023 and throughout 2024. While the project is in the construction phase, the city has made progress toward leveraging existing city infrastructure and technologies at various signalized intersections along both corridors to ensure compatibility with the proposed technologies, as well as to support the evaluation of baseline conditions prior to deployment.

The city plans to install various ITS technologies along the corridors. (1) Traffic signal preemption and priority system is being deployed to reduce congestion and improve emergency first responder response times. Without installing additional hardware on emergency response

vehicles or requiring additional maintenance, the preemption and priority system will use the existing CAD system and signal central software to detect approaching emergency response vehicles, make minor adjustments to traffic signals to give emergency vehicles priority, and provide preemption if necessary. (2) A traffic gap generation system is also being planned to be implemented at selected locations that can support the identification and mitigation of those periods of time where traffic gap availability in between signalized intersections may be reduced or limited. The intent of this system is to allow the city to have the capability to inject gaps into the traffic patterns, thereby allowing traffic seeking to exit side streets or driveway approaches to do so more effectively. The programming on signal controllers will utilize detection data, algorithms, or similar logic processes, to estimate traffic conditions at midblock locations, assess, and safely create gaps in traffic flow, when justified. Parameters of adjustments considered could include extending all red intervals and leading pedestrian intervals in the presence of pedestrians. (3) Also, to reduce congestion, the city plans to implement an adaptive and/or responsive dynamic traffic signal operation system that will utilize infrastructure detection assets to actively monitor traffic conditions, assess, and adapt signal timing as necessary to improve traffic flow, including unpredictable or unexpected traffic conditions. This system is anticipated to be compatible with and can be integrated with the city's central advanced traffic management system (ATMS).

Two additional deployments focus on monitoring traveler behavior and environmental conditions to inform city strategies on future traffic management, mode planning, and safety improvements planning and enforcement. (4) An environmental quality monitoring system measuring environmental quality conditions such as air pollution will be implemented at select locations along the project corridors. (5) Intersection compliance detection systems detecting traveler compliance issues and near-miss events at signalized intersections, such as running red lights or pedestrians entering crosswalks on "Don't Walk" indications, are also planned. A pilot video analytics-based solution has already been deployed that is similar to the planned intersection compliance system that will be deployed at more locations for this project. The pilot system being evaluated uses computer vision, AI, and ML to detect and quantify near-misses and traffic violation events at an intersection along Jefferson Avenue. (6) Within this project, the city is also seeking to create a CV testbed that allows the city to remain active, informed, and prepared for the potential expansion of complimentary technology solutions in this space, building capacity for CV technology to directly communicate safety and mobility messages to travelers in the future.

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Utah Connected (2018)

Through its **Utah Connected** project, the Utah DOT improves real-time situational awareness, safety, and mobility while developing lessons learned and recommendations for future deployments of advanced technologies. The Utah Connected project has three focus areas: Connected Systems, Connected Vehicles, and Connected People. The service area includes corridors in and around Salt Lake City, UT, as well as extensions of technologies across the State.

The focus on **Connected Systems** creates a data ecosystem that integrates data from each of the project focus areas and promotes real-time situational awareness by developing a cloud-based data analytics platform. As part of Connected Systems, the platform collects weather-related data to inform Spot Weather Impact Warnings (SWIW) and integrates a security credential management system into Utah DOT's vehicle-to-infrastructure (V2I) applications. Utah DOT also uses existing fiber optic cable located along two critical canyon roads near Salt Lake City, a total of 25 miles in length, to monitor highway traffic through an innovative distributed acoustic system, which detects acoustic events, such as crashes, avalanches, and rockfalls.

Source: Utah DOT.

Figure 5. Photograph. Snowplows.

Connected Vehicles are a major focus of the Utah Connected project with multiple deployments. Snowplow preemption coverage has been extended to an additional 5 corridors in Utah County by equipping 17 additional snowplows (shown in Figure 5) and 82 signalized intersections, and transit signal priority (TSP) coverage has expanded along a major State route by equipping 34 additional buses. Data collected from both applications have been integrated into the data ecosystem.

Snowplow preemption findings:

- Plows can only request preemption when the salt spreader is activated, usually meaning the vehicle is plowing. Plows passing through intersections requested preemption 42.3 percent of the time, and over 83 percent of requests were granted.
- Where vehicles received snowplow preemption, general traffic speeds were 0.23 percent higher when it snowed, indicating a positive effect on corridor traffic. Overall, average plow speed was lower on equipped routes compared to nonequipped, though plow speeds at the corridor level showed mixed results. This variation may be due to differing storm characteristics, driver behavior, and other traffic conditions.
- The maintenance shed foreman reported positive feedback from plow operators, who indicated that plows stopped less, and fewer passenger vehicles attempted to pass the plows on equipped routes.
- Plow drivers on one challenging route noted that the preemption capability reduced their plowing time from 90 minutes to 45 minutes.

Utah DOT has also deployed a V2I application—Curve Speed Warnings (CSW)—at 14 high-risk curves in the Salt Lake Metro area, as well as SWIW, a vehicle-to-everything (V2X) application. As part of the CVs deployment, Utah DOT has also installed human-machine interfaces (HMI) into three vehicles; an HMI allows these vehicles to receive V2X messages from the SWIW and CSW applications to warn the drivers of hazards. Findings from these CV projects will inform future Utah deployments and have been shared with other agencies around the United States, helping to advance standards and deployment guidance.

Connected People efforts involved collecting lessons learned from an Automated Shuttle Pilot Deployment. Utah DOT performed a viability assessment for using AVs as a first-mile and last-mile solution, collecting data on public attitudes and trust toward AVs at eight separate shuttle sites. Of AV shuttle riders, 98 percent of respondents to a survey reported feeling safe and 95 percent felt that the Shuttle could complement public transit.

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MWCOG: Deployment of Personalized and Dynamic Travel Demand Management Technology in the Washington, DC, Baltimore, MD, Richmond, VA Megaregion (2019)

Source: MWCOG.

Figure 6. Logo. incenTrip logo.

The MWCOG is addressing congestion, energy use, and emissions and promoting multimodal travel choices through the deployment of **Personalized and Dynamic TDM Technology in the National Capital Megaregion**. This project integrates and expands existing TDM programs through a shared technology platform; provides personalized travel information to users; and enhances multimodal transportation access. The service area includes Washington, DC, Baltimore, Richmond, and surrounding rural counties across five States.

This project deploys seven TDM technologies. Five deployments were completed in late 2022, including:

- *Personalized and Dynamic TDM in Existing Service Areas* provides personalized and dynamic traveler information and offers customized incentives through the incenTrip mobile application. The goal of the application is to reduce congestion, energy use, and emissions by nudging travelers to utilize non-single-occupancy-vehicle modes, off-peak departure times, and less congested routes.
- *Technology Deployment in the Entire District of Columbia, Maryland, and Virginia Megaregion and Adjacent Rural Counties* expands the TDM service area to cover a larger commute shed.
- *Multimodal Reward and Payment Integration* expands the incentive options available through the incenTrip mobile application by partnering with third-party organizations to offer monetary credits, gift cards, transit credits, and tolling credits.
- *TDM Deployment for Nonrecurrent Congestion Mitigation* extends the personalized and dynamic incentives to mitigate nonrecurrent congestion, such as congestion caused by crashes, weather, work zones, or special events.
- *Corridor-Level TDM Deployment for Multimodal ICM and Transportation Systems Management and Operations (TSMO)* integrates personalized and dynamic TDM strategies for major corridors that experience high levels of congestion. Commuters along the corridors are rewarded with incentives based on the type of travel mode they choose to use.

The final two deployments are in the design and development stages:

- *Integration of Employer-Funded TDM for Shared-Platform Deployment* will integrate employer TDM programs with the incenTrip application, so users can earn incentives provided by both employers and agencies. The platform is anticipated to act as a gamification tool for encouraging sustainable commuting to workplaces throughout the region.

- *Customized Multimodal Trip Planner for Older Adults and Persons with Disabilities* is expected to provide customized traveler information and referrals to specialized mobility services for these population groups.

Initial findings:
The MWCOG Project team has analyzed the initial data and found that the project has reduced vehicle miles traveled and single-occupancy-vehicle travel. Interest and activity in the application have grown substantially since the project began in November 2020; monthly trip logging has grown by 200 percent, monthly incentive redemptions have doubled, and nearly 500 active participants have joined the program. The value of the benefits, including reduced congestion, emissions, and fuel, has exceeded the value of the incentives paid. The estimated return on investment was also greater following the expansion of the program geographically and the addition of new incentives.

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CHAPTER 3. GRANTEE PERFORMANCE MEASUREMENT

This chapter presents the overall status of performance measurement among the FY 2016–FY 2020 grantees[31] and describes key findings from the Greater Cleveland RTA Project. In addition, the chapter highlights common performance measures grantees are using to measure deployment effectiveness.

OVERALL STATUS OF PERFORMANCE MEASUREMENT

As part of the ATCMTD Program application process, applicants are required to include:

> Quantifiable safety, mobility, and environmental benefit projections, such as data-driven estimates of how the project will improve the region's transportation system efficiency and reduce traffic congestion.[32]

As a result, all grantees from FY 2016 through FY 2021 included proposed performance measures or targets in their applications. In addition, as noted in chapter 1, executed agreements require many grantees to develop evaluation plans that outline project goals, evaluation methods and design, performance measures, and data collection procedures. As of March 2023, 35 grantees had submitted evaluation plans: 5 FY 2016 grantees, 5 FY 2017 grantees, 9 FY 2018 grantees, 9 FY 2019 grantees, and 7 FY 2020 grantees.

As of March 31, 2023, one grantee—Greater Cleveland RTA—has received approval for their final report. The Oregon DOT has completed one component of its project, the unmanned aircraft systems (UAS) reconstruction. All other grantees are in the piloting/testing or planning phase, so it is too early for them to have findings related to performance measurement.

Performance Measurement Findings: Greater Cleveland Regional Transit Authority

The RTA, an FY 2017 grantee, became the first ATCMTD grantee to complete its deployment project in August 2020, and its final report has been accepted by FHWA. The RTA replaced and upgraded its transit communication, CAD, and AVL systems, implementing a number of new features, including state-of-the-art vehicle alarms, priority cellular service, new radio communications towers, and turn-by-turn navigations. After installing these technology components, RTA observed numerous benefits, including improved system and operational efficiency, a more robust traveler information system, and an improved and more equitable user experience for RTA's riders. The 2021 American Public Transportation Association Think

[31]Since 2021 projects have yet to be obligated, these grantees are not yet required to submit any evaluation plans or reports. Performance measurement data has not been collected from these grantees.
[32]23 U.S.C. 503(c)(4)(C)(ii)(III) (2018).

Transit Conference honored RTA with an award for "Most Innovative."[33] The 2021 program report described the key findings of RTA's completed project.

Performance Measurement Findings: Oregon Department of Transportation

The Oregon DOT has completed its UAS Crash Reconstruction project (one of its nine projects). The Oregon DOT assisted the Oregon State Police with procuring equipment, training troopers, and deploying five small UAS aircraft to expedite site investigations following serious injury or fatality crashes. Findings from the field indicate that UAS reconstruction significantly reduced reconstruction times, but there was a negligible difference in lane clearance times between UAS and non-UAS reconstructions due to various factors. In addition, the quality of the data captured during a UAS reconstruction was improved and more valuable to end users. The UAS collected more than 20 million data points in a test, whereas the other technologies collected fewer than 200 points. The drones could provide a more comprehensive context for an event, including factors that otherwise may not be considered at the time of the investigation (e.g., vehicle orientation, the debris field, surrounding obstructions, or the impact of weather). The Oregon DOT concluded that UAS provides the most cost effective and efficient method of crash scene data capture, particularly when evidence spans a significant linear distance of roadway.

SUMMARY OF GRANTEE PERFORMANCE MEASURES

Grantees tailor performance measures to their specific projects; however, for many projects, the core metric is similar. For example, a grantee with a transit project may use "improved transit vehicle travel time," whereas a grantee with a freight project may use "reduction in travel times along key port access corridors." While these performance measures vary by mode and geographic location depending on the scope of their respective projects, the core of both metrics is travel time. Table 4 lists the most common core performance measures grantees use across reported goal areas. If multiple grantees use a performance measure, the number of grantees is noted in parentheses, e.g., (n=3). The goals shown in Table 4 align with requirements in the FAST Act and impacts identified by the Secretary in the notices of funding opportunity (e.g., improved safety, reduced traffic congestion, equity).

Grantees are not reporting on all of the goal areas that align with the requirements in the FAST Act. Grantees provide performance measures and report on key areas relevant to their deployments.

[33] "RTA Named 'Most Innovative' at the 2021 Trapeze-Vontas Conference," Greater Cleveland Regional Transit Authority, April 27, 2021, http://www.riderta.com/news/rta-named-most-innovative-2021-trapeze-vontas-conference.

Table 4. Common advanced transportation and congestion management technologies deployment grantee performance measures by goal area, 2023.[34]

Goal Area	Common Performance Measures
Improved safety	• Number/rate of crashes (vehicle, bike, pedestrian) (n=23) • Incident response time (n=9) • Number of incidents (n=9) • Crash type/trend/severity (n=7) • Perceived safety (driver/transit user/nonuser impressions) (n=6)
Reduced congestion/improved mobility	• Travel time (n=16) • Travel time reliability (n=14) • Delay (n=14) • Speed (n=8) • Throughput (n=5)
Reduced environmental impacts	• Emissions (n=10) • Fuel consumption (n=6) • Idle time (n=5) • Vehicle occupancy (n=3) • Travel time (n=3)
Improved system performance (including optimized multimodal system performance)	• Delay (n=8) • Mobility measures (travel time, bottleneck mitigation) (n=6) • On-time performance (n=5) • Perceived system effectiveness (n=5)
Enhanced access to transportation alternatives	• User satisfaction (n=4) • Vehicle occupancy (n=4) • Number of passengers/ridership (n=3) • Number of trips/rides (n=2)
Effectiveness of providing integrated real-time transportation information to the public to make informed decisions	• Number aware of/using information (n=6) • User feedback/perception (n=6) • Information accuracy (n=2) • Data type/availability/open data (n=2) • Delay/on-time performance (transit) (n=2)

[34]If multiple grantees use a performance measure, the number of grantees is noted in parentheses, e.g., (n=3).

Table 4. Common advanced transportation and congestion management technologies deployment grantee performance measures by goal area, 2023.(continuation).[34]

Goal Area	Common Performance Measures
Equity[35]	• Demographic information • Number of rural-specific applications • Percentage of people reporting improved travel experience (survey) • Number of trips (from Communities of Concern/provided to people with disabilities) • Response times of accessible vehicle trips (for shared rides pilot) • Response time for trips from Communities of Concern (for shared rides pilot) • Traffic-related injuries in Communities of Concern
Reduced costs	• Benefit-cost analysis/benefit-cost ratio (n=5) • Congestion costs (n=5) • Mobility costs (miles traveled, etc.) (n=5) • Technology costs (n=2)
Institutional and/or administrative benefits	• Information sharing between agencies/stakeholders (n=7) • Improved understanding/awareness of technologies (n=4) • Lessons learned (n=3) • Improved efficiency/access to data (n=2) • Perceived benefit/stakeholder feedback (n=1)

[35]N=1 for all of the measures in this category.

CHAPTER 4. GRANTEE REPORTED CHALLENGES AND LESSONS LEARNED

This chapter presents grantees' reported challenges and lessons learned as of March 31, 2023, based on their experiences deploying advanced technologies. Through the required annual and quarterly reports, as well as the Early Deployer Cohort Program, grantees have identified challenges and lessons learned of interest to FHWA, other grantees, and deployers more generally.

GRANTEE REPORTED CHALLENGES

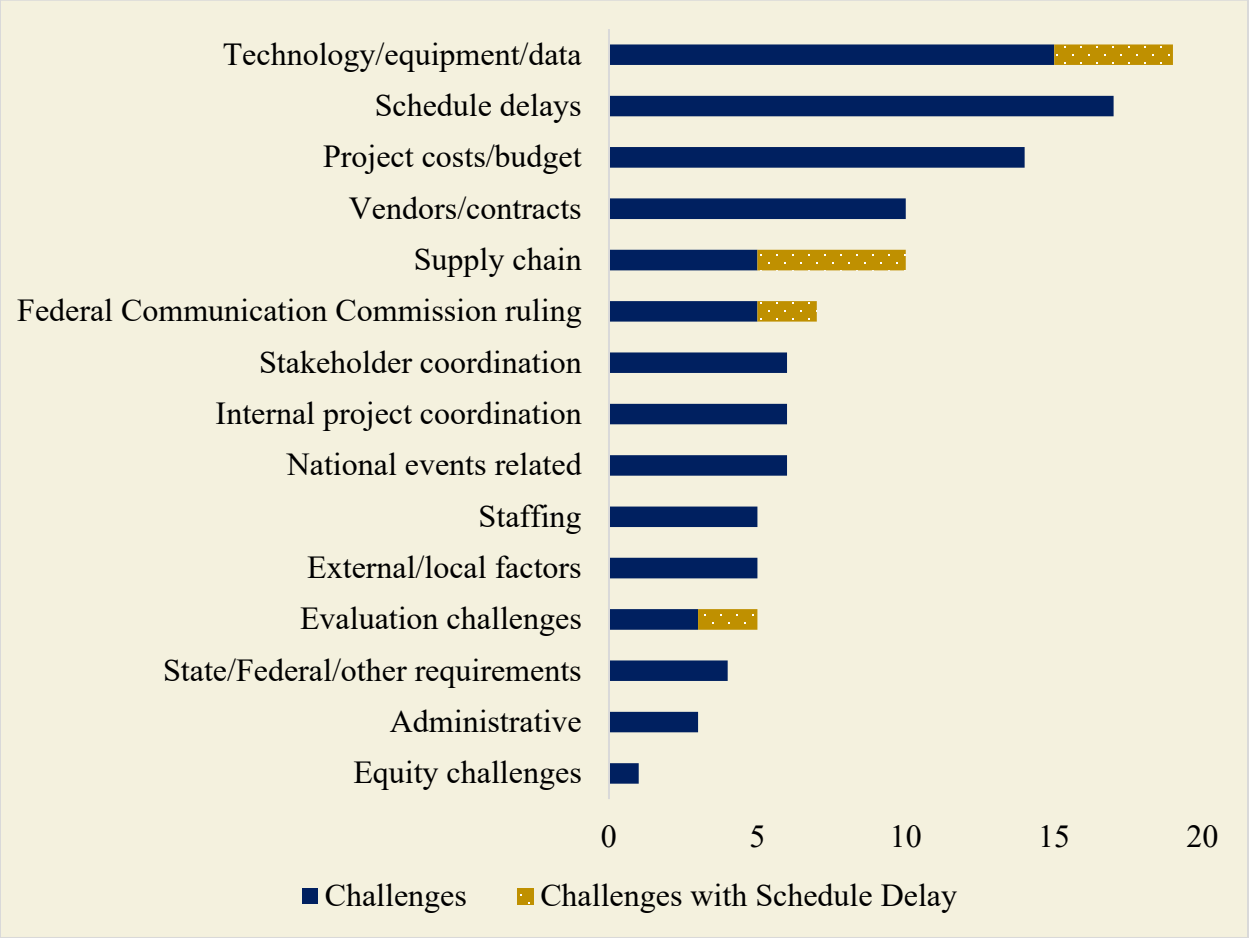
Various challenges cited by the grantees in their quarterly and annual reports include technology, equipment, or data problems, schedule delays, project costs or budget, vendor or contract issues, supply chain, the Federal Communications Commission (FCC) ruling regarding the Safety Band,[36] stakeholder coordination, internal project coordination, national events, staffing, external or local factors, and evaluation challenges, among others.

While the number of references to national events declined (relative to the last year's program report), national events continued to affect projects in multiple ways. For example, grantees cited challenges related to their inability to meet in person or to conduct onsite work, difficulty with technology installation and stakeholder coordination, supply chain delays, and staffing changes. Travel demand changes caused by national events continue to affect data baselines for certain projects. These issues also are reflected in impacts on some projects' costs and schedules.

Figure 7 shows the relative frequency of the different challenge categories reported by grantees. The crosscutting nature of schedule delays is reflected in the chart, based on the context in which the grantee mentioned the challenge. For example, if the grantee mentioned that staffing changes were contributing to schedule delay, this response is highlighted under staffing with the schedule delay color coding. There is also a separate schedule delay category because, in some cases, a grantee mentioned this challenge without providing additional information (e.g., the cause of the schedule delay).

Overall, technology, equipment, or data issues were mentioned most often. Challenges mentioned by somewhat fewer grantees include schedule delays, project costs or budget, supply chain, vendor or contract issues, the FCC ruling, stakeholder coordination, and internal project coordination. A number of the challenges were crosscutting; for example, one of the items coded as a cost issue referenced high procurement costs, which could also be viewed as a vendor and contract issue or a technology issue. For the list of specific challenges categorized under each topic, please see appendix C.

[36]The FCC's November 10, 2020, First Report and Order (86 FR 23281), approved on November 18, 2020, and published in the Federal Register on May 3, 2021, describes changes to the allocated 75 MHz of radio spectrum in the 5.9 GHz band used for vehicle and infrastructure communications, also known as the Safety Band.



Source: FHWA.

Figure 7. Chart. Relative frequency of key challenges across grantees' reports from April 2022 through March 2023.

GRANTEE LESSONS LEARNED

In their annual reports, grantees also described project lessons learned. Grantees mentioned topics related to stakeholder and agency coordination, vendor collaborations, project management, project costs, technology/equipment/data problems, and evaluation issues. Several of the lessons learned were repeated from previous reports, so table 5 highlights the lessons that grantees had not previously reported.[37] The lessons learned that were reported both this past year (April 2022–March 2023) and in previous years are listed in table 7 in appendix C.

[37]The lessons learned provided in table 5 are generally presented as written by the grantee. However, several revisions were made to remove the names of specific entities and maintain consistent syntax.

Table 5. Grantees' new lessons learned, April 2022–March 2023.

Category	Grantees' New Lessons Learned[38]
Stakeholder/agency coordination	• It is necessary to emphasize and understand agency-specific communication and decisionmaking processes for all of the agency stakeholders. Disconnects can arise between technical stakeholders directly involved in the project and the management and decisionmaking staff at that same agency. It is essential that there are clear processes in place to make sure both technical and management staff are aware of project activities, project decisions, implementation timeframes, and individual agency roles. Part of the coordination with individual agencies implementing specific projects will be to review internal processes, support internal communications and meetings, and ensure key staff at local agencies are receiving pertinent information.
Procurement/ vendors/industry collaborators	• When innovative technologies are not fully mature, procurement processes can be challenging. Describing the technical and operational characteristics of a new technology completely and clearly enough to allow for competition among vendors is difficult and can yield results that are different than anticipated.
Project management	• Allow more time for the unseen and make more time for up-front discussions that eliminate assumptions. • More in-depth up-front planning may be required than initially expected, including considerations for ongoing maintenance costs. • Flexibility is critical with issues related to technology changes and evaluations, impacts on teamwork, and wide variability in pricing due to national and international supply chains. • Improve internal and external staff knowledge and set realistic expectations of the AI/ML and each technology for the project. What can each technology do and what can it not do? Different people can have very different expectations of the capabilities of AI/ML, so it is important to be clear on the goals and expectations. Stress that with any new technology or process, there will be a learning period and continual improvement. The results on day 1 are not indicative of the full potential of the project.
Project costs	• Technology maturity may result in reduced costs for some elements of the innovations. However, there are increases in staffing costs.

[38]If multiple grantees mentioned a lesson learned, the number of grantees is noted in parentheses, e.g., (n=3).

Table 5. Grantees' new lessons learned, April 2022–March 2023 (continuation).

Category	Grantees' New Lessons Learned[38]
Technology, equipment, or data	• An early lack of consistency in the results may affect the level of trust that staff have in the platform. This can be mitigated by having a smaller group of users test and fine-tune the platform until it is ready for wider adoption. • Eliminating the need for several versions of software alpha builds will reduce cost and accelerate the schedule toward deployment and testing. • A well-defined migration plan, including a well-thought-through software version compatibility, is needed to sequence from the legacy front end to new software and new field devices. • Data needs to be understood in an operational context, and the successful integration of data from multiple agencies requires an understanding of how the operational community uses that data to serve its diverse jurisdictions and missions. For example, the Virtual Coordination Center operated for months with dispatch data from the local fire department, police department, and transit department. This data integrated well because it focused on the local area, and major blocking incidents (which resulted in system-generated alerts) were relatively rare. The inclusion of statewide data with numerous blocking incidents required geographic filtering of dispatch events and led to questions concerning the increased volume of system-generated alerts. The desirability and usefulness of these alerts could be determined by the evolving, diverse community of operational users, and the system needs to be responsive to what that community determines it needs to accomplish its various missions. • For AI DSS, wait until field devices and data are complete before initiating machine-learning model development or use data from other systems or already deployed devices that can provide the input data to teach the AI DSS with baseline information. • Develop data privacy and security plans. Be ready to adjust to new security standards or requirements from your agencies, State/national laws, technology companies, or third-party providers.

Table 5. Grantees' new lessons learned, April 2022–March 2023 (continuation).

Category	Grantees' New Lessons Learned[38]
Evaluation	• Efforts to measure the effectiveness of V2X-enabled systems have been impacted by the "noise" in various datasets. This isn't inherent in V2X systems or new to performance measurement but presented challenges in evaluations and will impact future assessment designs. • Snow season makes it difficult to predict changes to traffic data such as crashes, volumes, speed, and incidents. Accuracy of the trends identified would improve if multiple winter seasons could be averaged out with the rest of the year data.

CHAPTER 5. GRANTEES' CONCLUSIONS

The FAST Act established the ATCMTD Program to develop model deployments to improve safety, efficiency, system performance, and infrastructure return on investment. The DOT has awarded 58 projects from FY 2016 through FY 2021, including city and county projects, as well as statewide or regional projects. The projects represent a diverse set of advanced technology deployments across the United States. Some of the key technology deployments include CVs, advanced traveler information systems, ICM, maintenance and monitoring technologies, adaptive traffic signal control, AVs, and green technology (e.g., LED lighting and electric vehicle shuttles). The projects span a range of modes/service models: vehicle, freight, transit, pedestrian/bicyclist, and MOD. The law requires each grantee to submit annual reports that describe the impacts of their deployments.[39] The FHWA has provided the grantees with support to facilitate their deployments and assist them in meeting their reporting requirements.

This 2023 ATCMTD program report summarizes key findings from the Greater Cleveland RTA, the first project completed under the ATCMTD Program. As a result of its deployment, RTA has experienced improvements in systems operations and real-time traveler information. The provision of complimentary Wi-Fi service on all fixed-route and rail vehicles has also enhanced the user experience, providing potential equity benefits.[40] The Oregon DOT has also completed one component of its overall project—the deployment of UAS for crash reconstruction. The Oregon DOT achieved significant time savings in crash reconstruction using UAS and documented numerous lessons learned. However, due to several factors, there were no significant differences in lane clearance time between UAS and non-UAS reconstructions.

To date, other grantees are too early in their deployments to report on impacts. Among the projects with obligated funding, 12 grantees have completed deployment and are collecting evaluation data; an additional 13 grantees are piloting, testing, or beginning to deploy technologies, and 17 grantees are still in the planning phases. As a result, this program report provides project highlights for seven grantees who are either currently testing or soon to be testing technologies. It also summarizes core performance measures that grantees are using, as described in their annual reports and evaluation plans. The performance measures tend to focus most heavily on improved safety and mobility. Grantees also provide performance measures for reducing emissions, integrating real-time information, improving system performance and operational efficiencies, reducing costs, improving institutional efficiency, enhancing access to transportation alternatives, and advancing equity.

This report also highlights the grantees' challenges and lessons learned, as described in their quarterly and annual reports. Key challenges revolve around the following issues:

- Technology, equipment, or data

[39] 23 U.S.C. 503(c)(4)(F) (2018).
[40] *Advanced Transportation and Congestion Management Technologies Final Report*. Greater Cleveland RTA ATCMTD Final Report (July 2021).

- Schedule delays
- Project costs or budget
- Vendors or contracts
- Supply chain

Numerous grantees mentioned experiencing schedule delays in the context of other challenges (e.g., schedule delays resulting from technology or vendor issues).

In their lessons learned, grantees largely focused on the technical aspects of projects, such as using technology, equipment, or data, and also provided a number of suggestions related to project management and evaluation. The following paragraphs summarize several grantee lessons learned in these three areas:

- *Technology, equipment, or data*: Multiple grantees recommended several lessons learned related to transitions in technology. One grantee noted that having a smaller group of test users can mitigate concerns over inconsistent results in the early stages. Another grantee emphasized that a well-defined mitigation plan is needed to sequence from a legacy front end to new software and field devices. Multiple grantees also suggested lessons learned related to the operational context. One grantee highlighted the importance of understanding how data are used in order to successfully integrate multiple sources. Another grantee recommended developing data and security plans that can be adjusted for new standards or agency requirements.
- *Project management*: Two grantees emphasized the importance of up-front planning. One of the grantees suggested dedicating more time to eliminate assumptions in the early stages. Another two grantees addressed the variability in innovative technologies. One grantee recommended improving staff knowledge and setting realistic expectations of the technology, while the other focused on allowing for flexibility to manage the impacts and changes in pricing.
- *Evaluation*: One grantee indicated that "noise" in data could impact measurements of effectiveness and present challenges in evaluations. Another grantee noted that snow introduces challenges in predicting traffic patterns, so more data are needed to improve the reliability of evaluations.

As more grantees complete their projects in the next few years, subsequent program reports will highlight the impacts of the ATCMTD technology deployments, challenges, and lessons learned.

APPENDIX A. ANNUAL REPORT TEMPLATE

The purpose of this template is to assist grantees in preparing uniform annual reports. This template, while not required, is highly recommended, as FHWA intends to use the information from the grantees' annual reports to prepare the required Program Level Reports on the effectiveness of the ATCMTD grantees in meeting their projected deployment plans. The FHWA first issued this template to the grantees on February 11, 2019.

Reporting Requirement

Federal statute 23 U.S.C. 503(c)(4)(F) provides: *"For each eligible entity that receives a grant under this paragraph, not later than 1 year after the entity receives the grant, and each year thereafter, the entity shall submit a report to the Secretary that describes—*

(i) deployment and operational costs of the project compared to the benefits and savings the project provides; and

(ii) how the project has met the original expectations projected in the deployment plan submitted with the application, such as—

- *I. data on how the project has helped reduce traffic crashes, congestion, costs, and other benefits of the deployed systems;*
- *II. data on the effect of measuring and improving transportation system performance through the deployment of advanced technologies;*
- *III. the effectiveness of providing real-time integrated traffic, transit, and multimodal transportation information to the public to make informed travel decisions; and*
- IV. *lessons learned and recommendations for future deployment strategies to optimize transportation efficiency and multimodal system performance."*

This template has four parts:

- Part 1 of 4: Introduction and Overview
- Part 2 of 4: Evaluation/Research Activities
- Part 3 of 4: Findings
- Part 4 of 4: Wrap-Up

SAMPLE

PART 1 OF 4: INTRODUCTION AND OVERVIEW

Project Title:
Grant Award Recipient:
Annual Report Period: *[insert date range]*
Prepared By: *[name, agency, and title]*
*NOTE: Responses to questions 1–3 should reflect the **current** project scope and goals. If there have been no changes in project scope or goals (since the last annual report), responses to questions 1–3 should be the same as the previous annual report.* **1. Please provide a *high-level* description of your project, including the intended beneficiaries. (Please limit to approximately 350 words or less.) *Note: in Part 4 of 4, question 1, you will be asked to note any major deviations or changes in scope due to either project-driven outcomes or other unforeseen challenges.***
2. Please indicate which ATCMTD-targeted technologies your project covers *(check all that apply).* ☐ Advanced traveler information systems ☐ Advanced transportation management technologies ☐ Infrastructure maintenance, monitoring, and condition assessment ☐ Advanced public transportation systems ☐ Transportation system performance (monitoring) data collection, analysis, and dissemination ☐ Advanced safety systems, including vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication, autonomous vehicle development or deployment, and associated technologies that would enable V2V or V2I, including cellular or other technology ☐ Integration of ITS using a smart grid or similar energy distribution and charging systems ☐ Electronic pricing and payment systems ☐ Advanced mobility and access technologies, such as dynamic ridesharing and information systems to support human services for elderly, disabled, or disenfranchised individuals ☐ Other (Describe) _____

SAMPLE

3. What are your project's goals? *(Check all that apply.)* Note: For each goal identified, you will be asked in Part 2 and Part 3 to map your project's performance measures and findings to date, respectively.

☐ Improved safety

☐ Reduced congestion and/or improved mobility (e.g., travel time reliability)

☐ Reduced environmental impacts (e.g., emissions and/or energy)

☐ Improved system performance/optimized multimodal system performance

☐ Enhanced access to transportation alternatives

☐ Effectiveness of providing integrated real-time transportation information to the public to make informed travel decisions

☐ Reduced costs

☐ Institutional or administrative benefits (e.g., increased interagency coordination)

☐ Other benefits (please specify):

_____

☐ Other goals (please specify):

_____

SAMPLE

PART 2 OF 4: EVALUATION/RESEARCH ACTIVITIES

Please complete the following table regarding your evaluation activities. For each goal area that is applicable to your project, provide the performance measures and a status update on your research activities. The update should include the status of baseline data collection (if applicable) and any challenges or data limitations. If research is completed, please indicate that here in Part 2, but please reserve findings for Part 3.

Goal Area	Performance Measures: Quantitative and Qualitative (if multiple technologies apply, please note the different technologies)	Research Update (e.g., baseline data collection, challenges, milestones achieved)
Improved safety (e.g., reduced crashes)	1. 2. Etc.	
Reduced congestion/improved mobility (e.g., travel time reliability)	1. 2. Etc.	
Reduced environmental impacts	1. 2. Etc.	
Improved system performance (including optimized multimodal system performance)	1. 2. Etc.	
Enhanced access to transportation alternatives	1. 2. Etc.	
Effectiveness of providing integrated real-time transportation information to the public to make informed travel decisions	1. 2. Etc.	
Reduced costs	1. 2. Etc.	
Institutional or administrative benefits	1. 2. Etc.	

SAMPLE

PART 3 OF 4: FINDINGS

For each applicable goal area, please describe the impacts of your project based on findings from the performance measures. If data collection is still underway (i.e., findings are not yet available), indicate "In Progress" in the Findings column. Please use the Notes/Considerations column to include any other relevant information regarding the evaluation. Note: the numbering for the findings should correspond to the numbering used for performance measures in Part 2.

Goal Area	Findings (tied to performance measures; also include any anecdotal evidence)	Notes/ Considerations
Improved safety (e.g., reduced crashes)	1. 2. 3. Etc.	
Reduced congestion/improved mobility (e.g., travel time reliability)	1. 2. 3. Etc.	
Reduced environmental impacts	1. 2. 3. Etc.	
Improved system performance (including optimized multimodal system performance)	1. 2. 3. Etc.	
Enhanced access to transportation alternatives	1. 2. 3. Etc.	
Effectiveness of providing integrated real-time transportation information to the public to make informed decisions	1. 2. 3. Etc.	
Reduced costs	1. 2. 3. Etc.	

SAMPLE

Goal Area	Findings (tied to performance measures; also include any anecdotal evidence)	Notes/ Considerations
Institutional and/or administrative benefits	1. 2. 3. Etc.	
Other benefits: **Please specify:**	1. 2. 3. Etc.	
Other benefits: **Please specify:**	1. 2. 3. Etc.	
Other goals [add if needed]: **Please specify:**	1. 2. 3. Etc.	

SAMPLE

PART 4 OF 4: WRAP-UP

1.	In your view, how is the project doing with respect to meeting original expectations (i.e., as stated in the project proposal)? Note here any *major* deviations or changes in scope from the original proposal due to either project-driven outcomes or other unforeseen challenges (e.g., unavailability of presumed data, unforeseen legal or administrative constraints, unexpected stumbling blocks, obvious delays, time-consuming tasks, or executive decisions to alter course).
2.	Are there any aspects of your project that you consider cutting-edge, noteworthy, or innovative? If yes, please describe.
3.	How do deployment and operational costs of the project compare to the benefits and savings the project provides (i.e., can you provide an objective benefit-cost analysis or alternate subjective comparison)?
4.	What are lessons learned to date from your deployment, specifically regarding future deployment strategies to optimize transportation efficiency and multimodal system performance? Please note lessons learned with respect to challenges in technology deployment (e.g., technical, institutional), research (e.g., performance measurement), or other lessons learned.
5.	What recommendations can you provide regarding future deployment strategies in this/these area(s)?
6.	Do you have any final comments or feedback?

APPENDIX B. ADVANCED TRANSPORTATION AND CONGESTION MANAGEMENT TECHNOLOGIES DEPLOYMENT PROJECT DESCRIPTIONS

This section provides a summary of each ATCMTD project selected for an award, including grant amount, project goals, and technologies being deployed.

FISCAL YEAR 2021 PROJECTS

Proactive Route Operations to Avert Congestion in Traffic (PROACT) Alabama *(Alabama DOT)*

- Grant Amount: $5,000,000
- Project Goals: This project improves highway management and operations to connect residents to jobs, healthcare, education, and service through reduced congestion, improved measurement of operational performance, a reduced number of and severity of crashes, and improved real-time information to improve mobility.
- Technologies Being Deployed: Advanced traffic technologies and decision support tools, including dedicated short-range communication (DSRC), cellular vehicle-to-everything (C-V2X), cellular, 900-MHz radios, an advanced road weather monitoring and forecasting tool and technologies, CV probe data, a central traffic management system and machine vision for signalized intersection operations and safety, CV hardware for a freight priority application, and traveler information system applications.

An End-to-End Decision Support System for Integrated Smart Electric Grid and Transportation System Management *(City of Chattanooga)*

- Grant Amount: $4,577,721
- Project Goals: This project improves access to EV charging stations, accelerates deployment of clean transportation, reduces transportation-related emissions, reduces traffic incidents, improves travel time reliability, optimizes multimodal system performance and access, and provides cost savings to transportation agencies, businesses, and users.
- Technologies Being Deployed: A centralized citywide traffic management system, smart electric grid monitoring and management system, EV charging infrastructure online monitoring system, system-of-systems analytics and E2E, a DSS for EV charging, personalized EV charging information system, Cellular/DSRC, roadside cameras, intersection LiDARs, and wireless communication technologies.

Chicago Centralized Transit Signal Priority Project *(City of Chicago DOT and Chicago Transit Authority)*

- Grant Amount: $3,990,000
- Project Goals: This project enhances the use of existing transportation capacity to reduce costs and improve return on investment, advance public transportation systems, implement advanced safety systems, reduce environmental impacts, and address racial equity barriers to opportunity.

- Technologies Being Deployed: Centralized TSP system utilizing existing infrastructure, high-frequency bus AVL location reporting, an interface between central bus system and ATMS, video analytics and AI technology at intersections with DSRC or C-V2X communication, and remote TSP requests placed on the signal controller by ATMS.

Great Plains Rural Freight Technology Corridor Project *(Kansas DOT)*

- Grant Amount: $6,679,072
- Project Goals: This project uses advanced technologies to deliver traffic, weather, and other operational information to commercial truckers to optimize freight routing, improve safety, reduce congestion, and improve economic opportunities for low-income communities of color.
- Technologies Being Deployed: Fiber optic communication cables to enable V2I, road weather information systems (RWIS), microwave vehicle detection systems, signal phase and timing (SPaT), CV integrations for freight vehicles, dynamic message sign (DMS), and an expansion of online real-time traveler information.

Kentucky's Wrong-Way Driving and Integrated Safety Technology *(Kentucky Transportation Cabinet)*

- Grant Amount: $5,147,300
- Project Goals: This project detects and deters wrong-way incidents by alerting other drivers and emergency responders and improves existing ITS to monitor and detect other safety concerns related to pedestrians, debris, and halted vehicles on the roadway.
- Technologies Being Deployed: Computing and video processing with thermal cameras, automatically activated flashing LEDs on wrong-way signs, DMS, machine readable QR codes on wrong-way signage, and DSRC/5.9 GHz spectrum.

Port of Los Angeles Gateway *(Port of Los Angeles)*

- Grant Amount: $3,000,000
- Project Goals: This project improves trucking, drayage, and terminal operator activities by streamlining cargo staging and empty returns, which will decrease congestion at the port.
- Technologies Being Deployed: Web-based user portal, digital twin, ML, AI, microservice architecture, internet of things, radio-frequency identification (RFID), Wi-Fi, Bluetooth®, and an application program interface.

EZConnect: An Open and Cloud-Based Mobility Center Providing One-Stop Access for Travel Needs of Underserved Customers *(NEORide)*

- Grant Amount: $1,493,313
- Project Goals: This project improves the availability of real-time information to connect underserved riders to multiple transit agencies providing service through a central system, which reduces congestion and increases customer access and satisfaction.
- Technologies Being Deployed: A cloud-based real-time mobility coordination center with an open data exchange, vehicle-to-everything (V2X) technologies, a trip planner

with integration with the EZfare payment system, and a centralized reservation and coordination system.

Electric Vehicle User Range Anxiety Solution for Rural North Dakota *(North Dakota DOT)*

- Grant Amount: $1,449,000
- Project Goals: This project accelerates the deployment of electric vehicle charging stations, creates jobs, and advances access to clean transportation in rural areas.
- Technologies Being Deployed: Wi-Fi, electronic pricing and payment systems at charging stations, and smart grid technologies.

Smart and Connected Atlantic City Expressway *(South Jersey Transportation Authority)*

- Grant Amount: $8,748,763
- Project Goals: The project transforms the Atlantic City Expressway into a smart and connected corridor to serve transportation users safely and efficiently while supporting the deployment of CAVs in the future.
- Technologies Being Deployed: DSRC/C-V2X for cashless tolling, roadside units (RSU), onboard units (OBU), and congestion pricing algorithms.

Washington State Ferries Terminal Wait Times Traveler Information System *(Washington State DOT)*

- Grant Amount: $5,122,345
- Project Goals: This project improves service reliability and efficiency, increases ridership, improves customer experience, and supplements existing city and highway congestion information to provide more comprehensive travel information.
- Technologies Being Deployed: Cellular/4G/5G communications, Bluetooth® and Wi-Fi readers, microwave detection sensors, license plate recognition systems, lidar, location-based services data, RFID, and a systemwide terminal wait time traveler information system.

FISCAL YEAR 2020 PROJECTS

Advancing Connectivity and the Economy Through Technology in the San Diego Region *(San Diego Association of Governments)*

- Grant Amount: $9,298,300
- Project Goals: This project improves safety, expands transportation services and choices, provides the tools for actively managing all transportation systems, enhances access and services to transportation information, and adapts to transportation trends and services for all modes.
- Technologies Being Deployed: Mobility hub technologies, smart intersection system, CV roadside and onboard equipment, border wait time monitoring system, next-generation traveler information, CV border tolling, and commercial vehicle inspection technology.

Pinellas Connected Community *(Pinellas County Public Works Department)*

- Grant Amount: $9,298,300
- Project Goals: This project improves the safety of pedestrians and intersections within the region, improves mobility within the region, accelerates deployment of V2X technologies, reduces the number and severity of traffic crashes, and increases driver, passenger, and pedestrian safety.
- Technologies Being Deployed: CV technologies, including emergency vehicle preemption, TSP, speed warning, intersection warning, vehicle hazard warning, and emergency vehicle warning; demand management; decision support; work zone monitoring; mobile phone-based OBU application; and video analytics technologies.

Emergency Vehicle Preemption Using Connected Vehicle Technology (*Georgia DOT)*

- Grant Amount: $3,206,809
- Project Goals: This project reduces incident response time, reduces ambulance transport time, decreases pedestrian crashes, facilitates arterial traffic flow, and reduces delay, measures and reports quantifiable system performance measures, and enables system reproducibility and transferability to other Metro Atlanta regions and national locations.
- Technologies Being Deployed: Includes 15 dual-mode (DSRC and C-V2X) RSUs, 170 dual-mode OBUs installed in incident management vehicles and ambulances, a real-time information smartphone application, and a security credential management system.

Maine Advanced Signal Control and Connected Vehicle System for Safe, Efficient, and Equitable Rural Transportation (MAST) Project *(Maine DOT)*

- Grant Amount: $3,471,615
- Project Goals: This project maximizes investments, lessens environmental impacts by monitoring and rapidly correcting operating deficiencies, measures operational performance, reduces crash severity, increases traveling public awareness, responds rapidly to changing operational status, improves economic benefits, increases operational CV footprint and integration of advanced technologies, and enhances understanding of traffic flow.
- Technologies Being Deployed: Advanced traffic controllers, traffic detection system, DSRC and cellular V2I infrastructure and units, cellular modem and hardwire communication infrastructure, automated traffic signal performance measures, and traffic signal control data analytics based on AI.

Smart Intersections: Paving the Way for a National Connected and Automated Vehicles (CAV) Deployment *(University of Michigan)*

- Grant Amount: $9,950,098
- Project Goals: This project reduces crashes and fatalities; improves safety for drivers, passengers, vulnerable road users, and first responders; reduces carbon emissions;

improves operational performance; reduces infrastructure costs; improves return on investment; and paves the way for a national CAV deployment.
- Technologies Being Deployed: C-V2X and DSRC dual-mode RSUs; DSRC and V2V fleets; smart sensors with edge computing, authentication, authorization, and accounting server; data analytics; and an advanced V2X technology living lab.

Integrated Safety Technology Corridor *(Regional Transportation Commission of Southern Nevada)*
- Grant Amount: $6,000,000
- Project Goals: This project streamlines traffic flow, enhances the use of real-time data and analytics, reduces the number and severity of crashes, and enhances the monitoring of infrastructure to identify and prioritize repairs.
- Technologies Being Deployed: Active traffic management, wrong-way driver notifications, strategic traffic management sites, high-occupancy vehicle (HOV) detection, and an integrated data platform and interface.

Charlotte Avenue/Dr. Martin L King, Jr Boulevard Transit Headways and Congestion Management *(Metro Government of Nashville and Davidson County, Public Works Department)*
- Grant Amount: $1,500,000
- Project Goals: This project uses technology to enhance connectivity to employment, institutional, and cultural destinations, transforming the operation of a key transit corridor and setting the stage for future technology investments throughout the region. It also improves safety, mobility, equity, choice, and the overall quality of life for city residents.
- Technologies Being Deployed: Connected transit vehicle technology, connected V2I intersection upgrades, TSP, congestion management technology, fleet headway management software, and real-time bus occupancy data.

S.M. Wright Smart Corridor *(City of Dallas)*
- Grant Amount: $4,000,000
- Project Goals: This project improves the system performance of the S.M. Wright corridor, provides advanced performance measures for evaluating operations, reconnects and revitalizes economically disadvantaged areas, connects high-density residential areas with small-scale neighborhood commercial uses, and provides information to other entities for deploying the project's technologies.
- Technologies Being Deployed: Smart traffic signal packages, smart bus shelters, autonomous vehicles, advanced emissions monitoring, RSUs, OBUs, roadside control units, connected mobility control center, connected mobility platform, deep learning versatile platform, data analytics platform, integrated mobility interface, CV transit pedestrian alert system, and traffic management system improvements.

Utah Broadly Connected *(Utah DOT)*

- Grant Amount: $5,450,000
- Project Goals: This project leverages real-time information to improve safety, mobility, and system efficiency, enhance the quality of life, and prepare Utah's transportation network for future deployments.
- Technologies Being Deployed: CV applications using V2X technology, including DSRC and C-V2X for CSW, spot weather impact warning, intersection safety, roadway departure warning, variable speed limit, infrastructure monitoring, and TSP applications; data analytics, including ML, deep reinforcement learning, AI, and vehicle image reidentification: and cellular telematics technology; automated traffic signal performance metrics; third-party probe data (e.g., Bluetooth®); and data sharing tools.

Autonomous Truck Ready *(Port of Virginia)*

- Grant Amount: $2,102,500
- Project Goals: This project improves safety, reduces freight turnaround times, prepares Virginia's ports for increased shipping activity in the future, and develops and shares findings with other ports.
- Technologies Being Deployed: Autonomous truck movement, DSRC and C-V2X communications infrastructure, mobile communications infrastructure, and traffic map integration.

FISCAL YEAR 2019 PROJECTS

MWCOG: Deployment of Personalized and Dynamic Travel Demand Management (TDM) Technology in the Washington, DC, Baltimore, MD, Richmond, VA Megaregion
(Metropolitan Washington Council of Governments)

- Grant Amount: $2,970,000
- Project Goals: This project leverages the best available technology to maximize the cost effectiveness of a megaregion TDM program, integrates and expands existing TDM programs with a shared technology platform among all public- and private-sector partners, provides personalized, timely, and accurate travel information to all residents and visitors, and enhances multimodal transportation access and system performance for all user groups with rewards and gamification.
- Technologies Being Deployed: Advanced traveler information systems; TDM; advanced transportation management technologies; advanced public and shared transportation systems; advanced mobility and access technologies; multimodal trip planner/TDM programs for rural, low-income, and elderly/disabled persons; personalized and dynamic traveler incentives; and multimodal payment and reward integration.

I–4 Florida's Regional Advanced Mobility Elements (FRAME) *(Florida DOT)*

- Grant Amount: $10,071,600

- Project Goals: This project will work toward Florida DOT's strategic plan vision of increasing the delivery rate of fatality-free and congestion-free transportation systems by implementing CV and other emerging technology solutions, bringing safety and mobility benefits to the I–4 corridor.
- Technologies Being Deployed: Includes 689 CV RSUs and 670 OBUs with roadside-to-vehicle messages for lane closures, work zones, delays, congestion, end of the queue, incidents SPaT, speeds, and pedestrian-bicyclist safety; advanced traffic signal controllers with automated traffic signal performance measures, blank-out signs for route diversion, transit and freight signal priority, advance railroad crossing warnings, and wrong-way driving alerts.

Implementing Cellular V2X Technology to Improve Safety and Intelligent Transportation Systems (ITS) Management in Hawaii *(Hawaii DOT)*

- Grant Amount: $6,855,000
- Project Goals: This project reduces costs and improves return on investment through the enhanced use of existing transportation capacity; delivers environmental benefits that alleviate congestion and streamline traffic flow; reduces the number and severity of traffic crashes and increases safety; collects, disseminates, and uses real-time transportation-related information; monitors transportation assets to improve infrastructure management; delivers economic benefits by reducing delays; and accelerates deployment of V2V, V2I, and AV applications.
- Technologies Being Deployed: A cellular-based V2X system for all traffic devices and in-field devices in the State of Hawaii, C-V2X and DSRC equipment for motor vehicles, a remote browser-based platform for traffic operations personnel, a smartphone application for travelers, and preemption for emergency vehicles.

Intelligent Woodward Corridor Project *(Michigan DOT)*

- Grant Amount: $5,500,000
- Project Goals: This project provides increased safety for pedestrians, cyclists, and vehicle traffic; reduced congestion; more efficient public transportation; integrated multimodal transportation; transportation resiliency; operational effectiveness; and reduced maintenance and operating costs.
- Technologies Being Deployed: Pedestrian detection, prioritization, and alerts; traffic intersection preemption and signal priority for authorized vehicles, V2V and V2I communications; transportation system optimization through data analytics and edge computing; wrong-way driver detection; and alerts.

I–270 Predictive Layered Operation Initiative (PLOI) *(Missouri DOT: St. Louis Metropolitan Area, MO)*

- Grant Amount: $1,000,000

- Project Goals: This project predicts crashes and properly equips patrol officers to forestall crashes, lowering the number of incidents along I–270 North, improving incident detection time, and reducing arrival time for emergency response vehicles.
- Technologies Being Deployed: Predictive analytics and AI for incident management, advanced video analytics for improving pedestrian safety and wrong-way driving, and integrated modeling for road condition prediction.

Multimodal Connected Vehicle Pilot *(North Carolina DOT)*

- Grant Amount: $2,117,750
- Project Goals: This project improves mobility, reduces safety incidents, reduces environmental impacts, improves agency efficiency, and allows North Carolina DOT to deploy CV technology and applications more effectively within the State of North Carolina for further safety, mobility, and environmental benefits.
- Technologies Being Deployed: V2V and V2I CV applications, including TSP, multimodal applications (e.g., pedestrian, driver, bicyclist); intelligent traffic signal timing; red light violation warning; speed warning; as well as traveler information, high-resolution data, automated traffic signal performance measures, and pedestrian presence detection accessible pedestrian signal system.

DriveOhio I–70 Truck Automation Corridor *(Ohio DOT: I–70 Corridor)*

- Grant Amount: $4,400,000
- Project Goals: This project facilitates and provides host fleets and truck automation vendors an opportunity to deploy technology in revenue service, accelerates truck automation technology adoption, prepares standards and regulations for use by other deploying entities, and shares data and field experiences with the logistics industry.
- Technologies Being Deployed: Truck automation, including truck platooning, partial automation (Level 2), and high automation (Level 4) in revenue service by host fleets, as well as roadway automation readiness audit and related roadway repairs.

Artificial Intelligence-Powered Decision Support Tools for Integrated Corridor Management *(Tennessee DOT)*

- Grant Amount: $2,617,653
- Project Goals: This project develops DSS and subsequent strategies through the use of AI; reduces the cost to deploy, operate, and maintain ICM systems; builds a more scalable system to support traffic operations on corridors statewide; and improves the efficiency of ICM. This system creates a balanced, responsive, and equitable arrangement that monitors and controls traffic; shares traveler information with the public; improves system and travel time reliability; encourages mode shift; and improves the safety, efficiency, maintenance, operations, and mobility of all users (motorists, transit riders, transit operators, and freight haulers) along the corridor.
- Technologies Being Deployed: AI-based ICM DSS, Web interface for ICM partners, and traffic management center (TMC) ICM software integration.

AI Meets ICM: Realizing the Next Generation of Regional Mobility *(Virginia DOT*)

- Grant Amount: $4,355,000
- Project Goals: This project will use advanced data management and communications technologies to provide transportation system operators, service providers, commuters, and travelers with multimodal information and tools that enhance safety, optimize system performance, mitigate congestion, improve travel time reliability, and support on-demand, multimodal trip options.
- Technologies Being Deployed: DSS, AI, a cloud-based data store, and a portal regional commuter parking management system.

Deployment of the Washington State VCC) for Multimodal Integrated Corridor Management *(Washington State DOT)*

- Grant Amount: $3,424,361
- Project Goals: This project enhances both individual and interconnected agency operations in the day-to-day management of regional mobility to ensure the region's transportation system is safe, reliable, and sustainable, and it promotes economic vitality for the entire region. It also enables real-time information flow to allow shared map-based situational awareness; facilitates joint action in a virtual workspace to speed incident response, mitigate traffic impacts, and manage congestion on a daily basis; provides actionable information and alerts to agencies, mobility providers, and the traveling public; and enhances coordinated regional planning and operations through data analytics and predictive modeling.
- Technologies Being Deployed: A robust cloud-based system that enables multiagency, multimodal ICM through real-time information data collection, analysis, modeling, and dissemination.

FISCAL YEAR 2018 PROJECTS

Bay Area Mobility-On-Demand Project *(Contra Costa Transportation Authority)*

- Grant Amount: $8,000,000
- Project Goals: This project provides MOD to create a "one-stop shop" for viable mobility options by providing real-time, data-driven traffic updates and trip planning so travelers can make informed decisions about cost, travel time, mode, and route choices for their daily travel needs. The project will improve mobility trip reliability and congestion in the county.
- Technologies Being Deployed: MOD applications and services, mobility assets, and systems integration.

Advanced Connected Transportation Infrastructure and Operations Network (ACTION) *(University of Alabama)*

- Grant Amount: $8,034,003
- Project Goals: This project deploys CV and ITS technologies to allow the regional TMC to implement adjustments to traffic control strategies across the system. Data will enhance long-term planning in the region, and information will be shared with drivers.
- Technologies Being Deployed: Communications; DSRC radios; advanced data-logging traffic controllers; active signal control; wireless vehicle detection; traveler information systems; cable median crash sensors; and an end-user mobile application that provides benefits including pedestrian detection, work zone warnings, curve warning, emergency vehicle preemption detection, and more.

Wolf Creek Pass Advanced Technology Deployment *(Colorado DOT)*

- Grant Amount: $2,366,298
- Project Goals: This project transmits real-time information to travelers and dispatches emergency responders and incident management teams faster to improve safety on Wolf Creek Pass.
- Technologies Being Deployed: DSRC RSUs, weigh-in-motion technology and dynamic warning signs, road sensor systems, variable speed limits, cameras, variable message signs, and a fiber-optic and electric power network.

Artificial Intelligence Enhanced Integrated Transportation Management System AI-ITMS Deployment Program *(Delaware DOT)*

- Grant Amount: $4,996,949
- Project Goals: This project enables the deployment of an AI-ITMS and an AI-enhanced next-generation TMC to improve transportation systems performance for enhanced traffic safety, mobility, and air quality. In addition, the project will support people in making better transportation decisions by providing real-time information about incidents, travel times, anticipated delays, and routes.
- Technologies Being Deployed: Multimodal AI-enhanced transportation management and control system that collects and analyzes data to automatically detect anomalies and inefficiencies, disseminate real-time travel information, and generate congestion-mitigation solutions.

Georgia DOT Connected Vehicles *(Georgia DOT)*

- Grant Amount: $2,500,000
- Project Goals: This project creates and operates a regionwide CV network, providing SPaT messages at all key intersections and freeway ramps, which will enable CV applications to use this network to improve road safety and operations.
- Technologies Being Deployed: DSRC RSUs at signalized intersections, metered ramps, supporting infrastructure, and an open data portal.

Multi-State Rural Integrated Corridor Management *(Nebraska DOT)*

- Grant Amount: $2,755,000
- Project Goals: This project provides information to travelers by expanding Wyoming's CV pilot, deploying a variable speed limit in Nebraska, providing critical messages directly to freight vehicles, and disseminating truck parking information.
- Technologies Being Deployed: Information and communication management, regional data sharing, variable speed limits, DSRC, V2I applications, and a mobile road weather information system.

Oregon Smart Mobility Network *(Oregon DOT)*

- Grant Amount: $12,000,000
- Project Goals: This project creates an integrated multimodal network and helps the Oregon DOT with performance measurement, decision support, and active traffic, incident, and weather management.
- Technologies Being Deployed: Automatic traffic recorders, bicyclist and pedestrian counters, Bluetooth® travel-time systems, road weather decision support and information dissemination, closed-circuit television (CCTV) monitoring cameras, adaptive ramp metering, dynamic speed limits, freight signal priority, queue warning systems, SPaT, dynamic routing, next-generation TSP, V2X pedestrian/bicyclist, automated speed enforcement, red-light-running crash mitigation systems, UAS crash reconstruction, and battery backup systems.

Work Zone Reservation and Traveler Information System *(Pennsylvania DOT)*

- Grant Amount: $2,697,750
- Project Goals: This project enhances work zone operations and safety by providing accurate, standardized, and real-time work zone information across 40,551 miles of roadway traversing through Ohio and Pennsylvania. The system will also streamline work zone coordination between maintenance crews, construction crews, and traffic operation centers by removing the redundant and manual data inputs used today to schedule work zones.
- Technologies Being Deployed: Advanced traveler information systems, advanced transportation management technologies, and a digital road work reservation system.

I–10 Corridor Coalition Truck Parking Availability System (I–10 Corridor Coalition TPAS) *(Texas DOT)*

- Grant Amount: $6,850,000
- Project Goals: This project provides real-time parking information to truck drivers and dispatchers to make informed parking decisions. This project will increase public safety by reducing fatigue-related crashes with associated reductions in congestion and delay.
- Technologies Being Deployed: Advanced traveler information systems; advanced transportation management technologies; infrastructure assessment technologies; and transportation system performance data collection, analysis, and dissemination systems.

Utah Connected *(Utah DOT)*

- Grant Amount: $3,000,000
- Project Goals: This project measures and improves the operational performance of the system to gain additional capacity, improves safety and preserves infrastructure, implements CV technology to improve safety and mobility, and uses AV technology to help solve the first-mile/last-mile problem.
- Technologies Being Deployed: Autonomous shuttle(s), fiber sensing, CV applications (plows, signals, transit, CSW, weather impact warning), and a data-sharing portal.

FISCAL YEAR 2017 PROJECTS

Loop 101 Mobility Project *(Arizona DOT)*

- Grant Amount: $6,000,000
- Project Goals: This project improves safety and existing arterial capacity in the Loop 101 corridor by deploying technology and systems to support ICM, public transportation, the Maricopa County DOT's SMARTDrive Program℠, and other connected traffic management and real-time information technologies.
- Technologies Being Deployed: A DSS; adaptive signal control technology; CV applications, including transit and emergency vehicle signal priority; ramp metering technology; and an ICM mobile applications suite.

GoPort Freight Intelligent Transportation Systems *(Alameda County Transportation Commission)*

- Grant Amount: $9,720,000
- Project Goals: This project improves traffic flow and goods movement to and within the Port of Oakland, reduces congestion, improves safety, provides improved traveler information, and reduces emissions. Collectively, these benefits will significantly improve port operational efficiencies, increasing the competitiveness of the port in the global market.
- Technologies Being Deployed: A new port-specific TMC, traffic sensors, advanced traveler information, traffic messaging, trucking information for mobile applications, rail grade warning, and terminal queue information.

Connecting the East Orlando Communities *(Florida DOT)*

- Grant Amount: $11,946,279
- Project Goals: This project improves pedestrian and bicyclist safety, enhances multimodal transportation, provides integrated real-time information for travelers, and connects/integrates data sources created and utilized by Florida DOT.
- Technologies Being Deployed: An innovative pedestrian and bicyclist collision avoidance system, RSUs, parking sensors, active detection technology, digital kiosks,

advanced traffic signal controls, dynamic ridesharing, and information systems for elderly and disabled individuals.

SMART Arterial Management *(Ada County Highway District)*
Note: This project was canceled, and obligated funds were returned.

- Grant Amount: $2,250,000
- Project Goals: This project was designed to optimize signal timing on five corridors to reduce congestion, increase safety, and enhance traffic flow.
- Technologies Being Deployed: DSRC radios, OBUs, radar technology for bicycle and vehicle detection, traffic software, and accessible pedestrian signals.

Improving Safety and Connectivity in Four Detroit Neighborhoods *(City of Detroit)*

- Grant Amount: $2,182,000
- Project Goals: This project improves safety at intersections, improves connectivity for residents, and increases the capacity for data communications.
- Technologies Being Deployed: Video detection and analytics, sensors, V2I communications, vehicle preemption, digital kiosks, DSRC, and Internet of Things gateway.

Connecting Cleveland Project *(Greater Cleveland Regional Transit Authority (RTA))*

- Grant Amount: $5,850,000
- Project Goals: This project improves communications infrastructure, enhances rider and passenger safety, and reduces rider travel time. The project also enhances the overall efficiency of the transportation system while contributing to community revitalization.
- Technologies Being Deployed: Advanced onboard equipment, real-time information and maintenance software, and an upgraded radio system.

Greenville Automated (A-Taxi) Shuttle *(County of Greenville)*
Note: This project was canceled, and obligated funds were returned.

- Grant Amount: $4,000,000
- Project Goals: This project improves access to transportation for disadvantaged and mobility-impaired residents.
- Technologies Being Deployed: Automated taxi shuttles using V2V and V2I technology, AV data collection and analysis, and real-time traveler information.

The Texas Connected Freight Corridors Project *(Texas DOT)*

- Grant Amount: $6,090,221
- Project Goals: This project integrates high-quality data from the I–35 Advanced Traveler Information systems into an existing route optimization software platform to enhance/optimize pretrip and enroute planning for regional carriers, leading to safety and congestion improvements.

- Technologies Being Deployed: Advanced traveler information systems and transportation management technologies, infrastructure condition-monitoring technologies, connected V2I and V2V technologies, freight parking system technologies, truck platooning technology, and border crossing technologies.

Truck Reservation System and Automated Work Flow Data Model *(Virginia Port Authority)*

- Grant Amount: $1,550,000
- Project Goals: This project creates a two-way data flow with the port and truckers, railroads, etc. The data model will model the size of scheduling windows and estimate the effects of congestion on mobility. RFID tag readers will automate the workflow of arriving trucks, reducing turnaround time.
- Technologies Being Deployed: RFID tag readers, software integration with container inventory management system, and a data model for standardizing status updates to truck dispatchers.

Multimodal Integrated Corridor Mobility for All *(Seattle DOT)*

- Grant Amount: $4,091,000
- Project Goals: This project improves traveler safety and mobility and creates real-time traveler plans.
- Technologies Being Deployed: Traffic signal system upgrades, communications network, CCTV, dynamic message signs, passive pedestrian detection and pedestrian demand-based signal timing, bicycle detection and mobile application, ICM solutions, mobility-as-a-service software, and kiosks.

FISCAL YEAR 2016 PROJECTS

Freight Advanced Traveler Information System (FRATIS) *(Los Angeles County Metropolitan Transportation Authority)*

- Grant Amount: $3,000,000
- Project Goals: FRATIS will reduce truck congestion and fuel usage by optimizing freight routes.
- Technologies Being Deployed: Truck trip dispatching optimization software, real-time information exchange system, and ecodrive applications.

City of San Francisco Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) Initiative *(San Francisco Municipal Transportation Agency)*

- Grant Amount: $10,990,760
- Project Goals: This project uses a series of advanced technologies to lower congestion in heavily trafficked areas, increase public transit speeds, reduce pedestrian collisions, decrease emergency vehicle response times, reduce truck signal delay, and lower truck speeds through sensitive neighborhoods.

- Technologies Being Deployed: New highway HOV lanes for transit/carpools; TSP and emergency vehicle preemption; electronic, autonomous shuttles; curb space for pickup/dropoff by carpools and ride-sourcing services; multimodal intelligent traffic signal systems located roadside and in-vehicle; and a connected, electronic toll system for the congestion pricing program.

Los Angeles DOT Implementation of Advanced Technologies to Improve Safety and Mobility within the Promise Zone *(Los Angeles DOT)*

- Grant Amount: $3,000,000
- Project Goals: This project uses advanced technology on Los Angeles' transit vehicles to improve safety and traffic flow and provides real-time information to transit riders in low-income neighborhoods.
- Technologies Being Deployed: Upgrades to the automatic traffic control and surveillance connected signal system, Bluetooth® Low Energy beacons, real-time bus arrival signs, and interactive digital kiosks with real-time information about transportation services.

Denver Smart City Program *(City and County of Denver)*

- Grant Amount: $6,000,007
- Project Goals: This project uses connected fleets and DSRC technology to improve travel time reliability, freight efficiency, and traffic management and make safer pedestrian crossings.
- Technologies Being Deployed: DSRC in 1,500 city fleet vehicles, automated pedestrian detection devices, a CV operational environment at the Denver TMC, and flashing beacons for slower pedestrians.

A Connected Region: Moving Technological Innovations Forward in the NITTEC Region *(Niagara Frontier Transportation Authority (NFTA))*

- Grant Amount: $7,813,256
- Project Goals: This project deploys technologies and strategies to improve border crossing performance, travel time, commercial vehicle operations, and safety. Additionally, the project will improve incident management and promote operational integration within NFTA.
- Technologies Being Deployed: CV applications supporting in-vehicle dissemination of alerts, advisories, parking, traffic, and weather information, improved traffic signal system, parking management analytics engine, and DSS.

NW 33 Smart Mobility Corridor *(Union County, City of Marysville, and City of Dublin)*

- Grant Amount: $5,997,500
- Project Goals: This project creates a smart mobility corridor with CV applications across multiple communities to improve safety and congestion while enhancing access to large employment sites and economic development.

- Technologies Being Deployed: CV technology for queue warning and speed harmonization, dynamic SPaT, pedestrian warning systems on the local street network, and real-time road weather performance data.

SmartPGH *(City of Pittsburgh)*

- Grant Amount: $10,899,318
- Project Goals: SmartPGH deploys "Smart Spine" corridors in Pittsburgh that layer environmental, communications, energy, and transportation infrastructure technologies to improve connections between isolated neighborhoods and major centers of employment. This project may improve real-time information access and optimize transit operations.
- Technologies Being Deployed: Conversion of nearly 40,000 City of Pittsburgh streetlights to LED technology with integrated control systems and installation of supplemental sensor technology, including pedestrian detection and air quality monitoring along Smart Spine corridors. In addition, Pittsburgh will deploy real-time adaptive traffic signals and DSRC units on buses for TSP, advanced traveler information systems, and optimized mobility.

ConnectSmart: Connecting Transportation Systems Management and Operations and Active Demand Management *(Texas DOT)*

- Grant Amount: $8,939,062
- Project Goals: ConnectSmart integrates various mobility technologies for carpooling, ridesharing, and shared electric bicycles to provide reliable multimodal travel time information.
- Technologies Being Deployed: Various regional advanced traveler information systems and data sources for predictive multi-/intermodal travel time, cost, and reliability information in an application.

APPENDIX C. SUMMARY OF GRANTEE REPORTED CHALLENGES AND LESSONS LEARNED

CHALLENGES

Table 6 provides additional details on the specific reported challenges referenced in chapter 4.

Table 6. Grantee reported challenges (April 2022–March 2023).

Challenge	Topics[41]
Technology, equipment, or data	• Procurement process delays (n=3) • Technical difficulties/unexpected bugs (n=2) • Construction changes • Identification of the best equipment • Technology readiness monitoring • Limited equipment capability • Maintenance labor issues • Security challenges • External/environmental factors on equipment • Network switch requirement • Technology system refinement
Schedule delays	• General reference to schedule revision and/or grant extension (n=5) • Technology lead time (n=4) • Procurement/technology readiness (n=4) • National events (n=3) • Workers' strike • Contract protests • Contractor unresponsiveness (i.e., to schedule requests)
Project costs or budget	• Construction/engineering costs changes (n=3) • Contractor budget changes (n=3) • Satisfaction of in-kind contributions (n=2) • Staffing budgets • Use of non-Federal and non-State funds to cover overruns • Revised budget due to grant extension • Reduced scope due to funding limitations • National events (i.e., caused schedule changes leading to budget revisions) • Multiple projects lead to allocation difficulties

[41] If multiple grantees mentioned a challenge, the number of grantees is noted in parentheses, e.g., (n=3).

Table 6. Grantee reported challenges (April 2022–March 2023) (continuation).

Challenge	Topics
Vendors or contracts	• Change orders and costs related to equipment (n=2) • Contracts in negotiation • Vendor staff turnover • Vendors working on product functionality • Surveying multiple vendors • New contract may not be executed in time • Meeting coordination between contractors • Issues with inflexible vendor schedules and equipment choices
Supply chain	• Delays due to supply chain (n=8) • Contractor extension • Equipment shortages
FCC ruling	• Project risk uncertainty (n=3) • Schedule delay or potential schedule delay (n=2) • Awaiting FCC licenses (n=2) • FCC decisions made deployment obsolete
Stakeholder coordination	• Infeasibility of in-person meetings (n=2) • Frequent engagement with many stakeholders to line up alternates • Coordination of project timelines among partner States • Non responsiveness of third parties • Challenges in executing project partner agreement
Internal project coordination	• Delay due to coordination with other projects • Pausing of in-person tasks • Amendment requirements (i.e., for agreements with project partners) • Implementation of processes to coordinate with procurement groups • Additional efforts to coordinate agencies and contractors in meetings • Giving operational community ownership of the design process
National event related	• Travel restriction effects on deployments • Transit ridership impacts • Ability to meet and conduct project tasks in person impacted (n=2) • Uncertainty from shelter-in-place orders affected the schedule • Impact of global shutdowns on the supply chain
Staffing	• Staff turnover (n=2) • Labor shortage • Labor market (i.e., hiring some skillsets became difficult) • Hiring of extra labor only for a short timeframe

Table 6. Grantee reported challenges (April 2022–March 2023) (continuation).

Challenge	Topics
External/local factors	• Construction projects impact data quality • Public perception of cameras • Workers' strike • Utility companies delayed in getting power to the project area • Difficulties with excavation work on a hillside
Evaluation challenges	• Additional testing and validation efforts necessary • Performance evaluation period reduced • Splitting test conditions between real-world and lab environments • Extending the project end date to allow for more data collection • Evaluation delayed by onboarding schedule changes
State and Federal requirements	• Firewall regulations and communications limitations • More ER vehicles are required to respond to each incident, and tablet/cellphone use is prohibited on the road impacting ER operations • Differences in data security requirements are a challenge for data sharing
Administrative	• Responding to FHWA comments • Balancing cooperative agreement requirements with the need to transition project to local funding • Revising documents to incorporate scope changes
Equity	• Seattle DOT has submitted a request to FHWA to modify the approach to passive cyclist detection due to equity concerns (i.e., the requirement to own a cellphone and maintain a data plan)

LESSONS LEARNED

Several of the lessons learned included in this report were repeated from previous reports that covered the period (April 2019–March 2022). Those lessons are listed in Table 7.

Table 7. Grantees' lessons learned (April 2022–March 2023) previously reported.

Category	Grantees' Previously Reported Lessons Learned

Stakeholder/ agency coordination	• Meet with project stakeholders early in the deployment process and maintain consistent coordination to help drive project success:
	  ○ An integral part of concept development with many project stakeholders is understanding each collaborator's concerns, challenges, operating environment, and system capabilities.
	  ○ Discussions with collaborators about translating user needs into system requirements should be held before the design phase.
	  ○ Early and consistent engagement is important, especially if there are many collaborators or if the project spans a large geographic area.
	  ○ Grantees recommended early coordination with technical personnel.
	  ○ Workshops and educational material help address the challenges in adaptation posed by working with a disparate suite of end users, such as the trucking community.
	• Form an advisory committee composed of regional agencies that can provide leadership and support in a collaborative environment to help the long-term success of the grantee's project.

Staffing	• Agility related to team resources and skills allows for diversification and quick response when situations, such as changes in travel patterns, arise.
Project management	• Identify tasks early in the deployment process that can start quickly or need additional dedicated resources. This step will help the deployment progress and ensure support exists for project tasks. • Recognize needs early on and as a situation develops to allow for proper contributions, participation, data collection, or design of systems based on learnings and developments. • Overlapping construction schedules should be identified early to coordinate disposition. • Deployers should account for testing, validation, and correction time in delivery schedules to allow for repeated testing phases for complex applications.

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