

2020 Program Report

Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) Program



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of Transportation

**Federal Highway
Administration**

Foreword

The Fixing America's Surface Transportation Act or "FAST Act" established the Advanced Transportation Congestion Management Technologies Deployment (ATCMTD) Program to make competitive grants for the deployment of advanced transportation technologies. The law directs that, beginning three years after the first grant award, and annually thereafter, the Secretary of Transportation shall post on the U.S. Department of Transportation (USDOT) website a report about the ATCMTD Program. (Section 6004 of the FAST Act (Pub. L. 114-94), codified at 23 U.S.C. 503(c)(4)(G)). This report fulfills that reporting requirement. 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 impacts of the technology deployments. It presents an overview of Fiscal Year (FY) 2016, FY 2017, and FY 2018 ATCMTD projects, including key technologies grantees are planning to deploy. It also highlights performance measures grantees are using, and initial grantee insights and lessons learned with respect to their technology deployments.

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LIST OF ACRONYMS

Acronym	Definition
ACTION	Advanced Connected Transportation Infrastructure and Operations Network
AI	artificial intelligence
AIITMS	Artificial Intelligence Enhanced Integrated Transportation Management System
ATCMTD	Advanced Transportation and Congestion Management Technologies Deployment
AV	automated vehicle
AVL	automatic vehicle location
CAD	computer-aided dispatch
CCTV	closed-circuit television
CO	carbon monoxide
CO ₂	carbon dioxide
CV	connected vehicle
CVPD	Connected Vehicle Pilot Demonstration
DSRC	Dedicated Short Range Communication
DSS	decision support systems
EMS	emerging mobility services
FAST Act	Fixing America's Surface Transportation Act
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FMVSS	Federal Motor Vehicle Safety Standards
FRATIS	Freight Advanced Traveler Information System
FY	fiscal year
GHG	greenhouse gas
GPS	Global Positioning System
ICM	integrated corridor management
ITS	intelligent transportation system
IGA	intergovernmental agreement
LED	light-emitting diode
MAP	map data
MOD	Mobility on Demand
NHTSA	National Highway Traffic Safety Administration
NO ₂	nitrogen dioxide
NOFO	Notice of Funding Opportunity
OBU	on-board unit
O ₃	ozone
PM	particulate matter
PSI	provider service identifiers

LIST OF ACRONYMS (Continuation)

RFID	radio frequency identification
RSU	roadside unit
SCMS	Security Credential Management System
SAE	Society of Automobile Engineers
SPaT	signal phase and timing
SO ₂	sulfur dioxide
SOV	single occupancy vehicle
TMC	traffic management center
TSMO	Transportation Systems Management and Operations
USDOT	U.S. Department of Transportation
V2I	vehicle-to-infrastructure
V2V	vehicle-to-vehicle
VHT	vehicle hours traveled
VLAN	virtual local area networks

EXECUTIVE SUMMARY

BACKGROUND

This report is the program report on the Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) Program. The multi-year, comprehensive surface transportation reauthorization Fixing America's Surface Transportation (FAST) Act 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 dollars each fiscal year (FY), from FY 2016 through FY 2020 for the grant awards,² and requires the U.S. Department of Transportation (USDOT) to award grants each year to at least five and no more than ten eligible entities.³

The FAST Act outlines key reporting requirements for the grantees, including annual reports to the Secretary of Transportation.⁴ These reporting requirements allow USDOT to understand the outcomes of grantees' deployments, providing insight on which technologies and types of projects are most effective at advancing FAST Act goals of improving transportation safety, efficiency, and system performance. In addition, the FAST Act prescribes that the USDOT must make publicly available a program report beginning three years after the first grant award, and annually thereafter.⁵ 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 public⁶

¹ FAST Act § 6004; 23 U.S.C. 503(c)(4).

² FAST Act § 6004; 23 U.S.C. 503(c)(4)(I)(i).

³ FAST Act § 6004; 23 U.S.C. 503(c)(4)(D)(i).

⁴ FAST Act § 6004; 23 U.S.C. 503(c)(4)(F).

⁵ FAST Act § 6004; 23 U.S.C. 503(c)(4)(G).

⁶ FAST Act § 6004; 23 U.S.C. 503(c)(4)(G)(i-viii).

STATUS OF GRANT AWARDS

The ATCMTD Program has awarded 28 grants through FY2018, including eight in Fiscal Year (FY) 2016, 10 in FY 2017, and 10 in FY 2018.⁷ Representing a diverse set of metropolitan and rural areas located across the U.S., the grantees are deploying a range of advanced technologies, including connected vehicle (CV) applications, automated vehicles, adaptive signal systems, integrated corridor management (ICM), real-time traveler information systems, green technologies (e.g., electric vehicles), and infrastructure maintenance and monitoring systems, among other technologies.

All grantees in FYs 2016 and 2017 have executed their agreements and received funding obligations. Among the FY 2018 grantees, the Federal Highway Administration (FHWA) has executed eight of the 10 agreements as of February 2020 and is working with the other grantees to execute their agreements. Table 1 below illustrates the awards made in each year. Each cell contains the project name, followed by the lead entity grantee in italics.

Table 1. Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) Projects awarded Fiscal Year 2016 through Fiscal Year 2018.

FY 2016 Awards	FY 2017 Awards	FY 2018 Awards
Freight Advanced Traveler Information System, <i>Los Angeles County Metropolitan Transportation Authority</i>	Loop 101 Mobility Project, <i>Arizona Department of Transportation (DOT)</i>	Bay Area Mobility-On-Demand Project, <i>Contra Costa Transportation Authority</i>
Los Angeles DOT Implementation of Advanced Technologies to Improve Safety & Mobility with the Promise Zone, <i>Los Angeles DOT</i>	Global Opportunities at the Port of Oakland Freight Intelligent Transportation System, <i>Alameda County Transportation Commission</i>	Advanced Connected Transportation Infrastructure and Operations Network (ACTION), <i>University of Alabama</i>

⁷ For two grantees, Ada County Highway District, Idaho (FY 2017) and Greenville, South Carolina (FY 2017), FHWA and the grantees mutually agreed to terminate the grant. For both projects, the obligated funds were de-obligated (no ATCMTD funds were incurred for either of these projects).

Table 1. Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) Projects awarded Fiscal Year 2016 through Fiscal Year 2018 (Continuation).

FY 2016 Awards	FY 2017 Awards	FY 2018 Awards
Denver Smart City Program, <i>City and County of Denver</i>	Ada County Highway District SMART Arterial Management, <i>Ada County Highway District</i>	Artificial Intelligence Enhanced Integrated Transportation Management System (AIITMS) Deployment Program, <i>Delaware DOT</i>
A Connected Region: Moving Technological Innovations Forward in the Niagara International Transportation Technology Coalition (NITTEC) Region, <i>Niagara Frontier Transportation Authority</i>	Improving Safety and Connectivity in Four Detroit Neighborhoods, <i>City of Detroit</i>	GDOT Connected Vehicles, <i>Georgia DOT</i>
Marysville, OH 33 Smart Mobility Corridor, <i>Union County Ohio, City of Marysville and City of Dublin</i>	Connecting Cleveland Project, <i>Greater Cleveland Regional Transit Authority</i>	Multi-State Rural Integrated Corridor Management (I-80), <i>Nebraska DOT</i>
SmartPGH, <i>City of Pittsburgh</i>	Greenville Automated (A-Taxi) Shuttles, <i>County of Greenville</i>	Oregon Smart Mobility Network, <i>Oregon DOT</i>
ConnectSmart: Connecting Transportation Systems Management and Operations (TSMO) and Active Demand Management, <i>Texas DOT</i>	The Texas Connected Freight Corridors Project, <i>Texas DOT</i>	Work Zone Reservation and Traveler Information System, <i>Pennsylvania DOT</i>
	Truck Reservation System and Automated Work Flow Data Model (Virginia), <i>Virginia Port Authority</i>	I-10 Corridor Coalition Truck Parking Availability System (I-10 Corridor Coalition TPAS), <i>Texas DOT</i>
	Multimodal Integrated Corridor Mobility for All, <i>City of Seattle DOT</i>	Utah Connected, <i>Utah DOT</i>

Source: FHWA

SUPPORT TO GRANTEES

FHWA provides cross-cutting project support to all grantees through a variety of mechanisms. The FHWA-organized Early Deployer Cohort Program is a voluntary roundtable of seven grantees (with an additional six 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. 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.⁸ FHWA also responds to any grantee requests for information and shares these responses with other grantees, if applicable.

STATUS OF PERFORMANCE MEASUREMENT

Grantees are at different levels of progress in their deployments; however, it is still too early to report on safety, mobility, environmental, system performance, and other impacts. As a result, this program report summarizes the 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 mobility and safety, as well as reduced emissions. Grantees also provide performance measures for enhancing access to transportation alternatives, integrating real-time information, improving equity, and improving system performance and operational efficiencies.

INITIAL INSIGHTS ON GRANTEES' CHALLENGES AND LESSONS LEARNED

This report also highlights the grantees' challenges, lessons learned, and recommendations that grantees described in their quarterly reports, annual reports, and evaluation plans.

Recommendations are for multiple audiences, including FHWA, grantees, other deployers, and potential ATCMTD applicants. At this early stage, key grantees' challenges revolve around:

- Institutional issues (stakeholder/agency coordination; institutional processes, and procurement)
- Cost/scope issues
- Technical issues (technical/application maturity and availability; interoperability)

In their lessons learned and recommendations, grantees' suggestions include:

- Conduct stakeholder coordination early in the process.
- Engage with vendors and manufacturers in advance of the design phase to discuss desired functionality, application use cases, etc.
- Test all equipment (e.g., using an on-site pilot or laboratory-setting tests) prior to deployment.
- Be flexible and adjust existing practices or standards, as needed, to accommodate the deployment of these new technologies.

Future USDOT program reports may provide findings on the mobility, safety, environmental, and system performance impacts of the grantees' technology deployments and continue to report on grantees' insights on the challenges and lessons learned of their deployments.

⁸ *Evaluation Methods and Techniques: Advanced Transportation and Congestion Management Technologies Deployment Program*: <https://ops.fhwa.dot.gov/publications/fhwahop19053/index.htm>

About this Report

FAST Act Section 6004, codified at 23 U.S.C. 503(c)(4), requires the development of this program report. The law directs that beginning three years after the first grant award, and annually thereafter, the Secretary of the U.S. Department of Transportation (USDOT) shall post on the USDOT website an ATCMTD program report that describes the effectiveness of grant recipients in meeting their projected deployment plans. Per the FAST Act, 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; or
- Provided other benefits to transportation users and the general public.

This report summarizes program findings for grants awarded in Fiscal Years 2016 and 2017, the first two cohorts of the program.

CHAPTER 1. INTRODUCTION

This report is the program-level report on the ATCMTD Program.¹ The FAST Act, a Federal law providing long-term funding for surface transportation infrastructure planning and investment from Fiscal Year (FY) 2016 through FY 2020, established the ATCMTD Program, stating:

“...the Secretary [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.”²

BACKGROUND

The ATCMTD Program funds grantees to deploy advanced technologies in support of FAST Act safety, mobility, environmental, and operational efficiency goals.³ The law sets aside \$60 million each fiscal year for the grant awards,⁴ with the Federal share of funding not to exceed 50 percent of the total cost of the project.⁵ The law requires USDOT to award grants each year to at least five and no more than 10 eligible entities, with not more than 20 percent of the funds each year to a single entity. The

¹ Findings for FY 2018 grantees were not available at the time of writing this report, so only the summaries of FY 2018 grantee deployments are provided.

² FAST Act § 6004; 23 U.S.C. 503(c)(4).

³ FAST Act § 6004; 23 U.S.C. 503(c)(4)(A).

⁴ FAST Act § 6004; 23 U.S.C. 503(c)(4)(I)(i).

⁵ FAST Act § 6004; 23 U.S.C. 503(c)(4)(J).

awards must be diverse with respect to the technologies being deployed and geographic location.⁶ In addition, the law requires that applicants complete an application with a technology deployment plan, quantifiable system performance objectives, anticipated results and benefit projections, a plan for partnering with other institutions, and an explanation of how existing technology and infrastructure will be leveraged for the project.⁷

GRANTEE REPORTING REQUIREMENTS

The FAST Act outlines a number of key reporting requirements for grantees, including annual reports to the Secretary of Transportation.⁸ The reporting requirements allow FHWA to understand the impact of grantees' deployments, providing insight on 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 operations of their deployments. Finally, 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 own advanced technology deployments.

Grantees' key reporting requirements are summarized below.

Quarterly Reports

All grantees must 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, work performed in support of USDOT 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 (referred to as "annual report" in this document) that describes deployment impacts, including:⁹

- Project deployment and operational costs compared to the benefits and savings the project provides.
- Data on whether the project has helped reduce traffic crashes, congestion, costs, and other benefits of the deployed systems.

⁶ FAST Act § 6004; 23 U.S.C. 503(c)(4)(D).

⁷ FAST Act § 6004; 23 U.S.C. 503(c)(4)(C).

⁸ FAST Act § 6004; 23 U.S.C. 503(c)(4)(F).

⁹ FAST Act § 6004; 23 U.S.C. 503(c)(4)(F).

- 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.
- 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 then incorporated into their executed cooperative agreements. Evaluation plans outline project goals, evaluation methods and design, performance measures, data collection procedures, and evaluation risks.¹⁰

SUPPORT TO GRANTEES

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 below, FHWA provides technical assistance to help grantees overcome any challenges or issues they may be facing in their deployments. FHWA also responds to any grantee requests for direction, sharing information with other grantees, if applicable.

Performance Measurement Support

FHWA provided grantees with an annual report template that they are encouraged to use in fulfilling this reporting requirement (see [Appendix A](#)). The annual report template comprises four sections: The **Introduction and Overview** section asks grantees to provide a project description and to indicate the technologies they are deploying and the project's goals. In the **Evaluation/Research Activities** section, grantees are asked to list their performance measures and research activities (by goal area). The **Findings** section requests information on their 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.

¹⁰ Beginning with FY 2018 awards, all grantees are required to prepare evaluation plans. 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 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?)
- 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, etc.), 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,” that is, a high-level list of issues and topics that they should consider when preparing their evaluation plans. In addition, the FHWA has developed the following report, *Evaluation Methods and Techniques: Advanced Transportation and Congestion Management Technologies Deployment Program*, to assist grantees in writing credible evaluations that measure the impacts of their technology deployments.¹¹ 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 (connected vehicles, automated vehicles, and adaptive signal control).

Early Deployer Cohort Program

FHWA has been providing support to grantees through the Early Deployer Cohort Program, a voluntary roundtable of seven grantees (with an additional six 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.

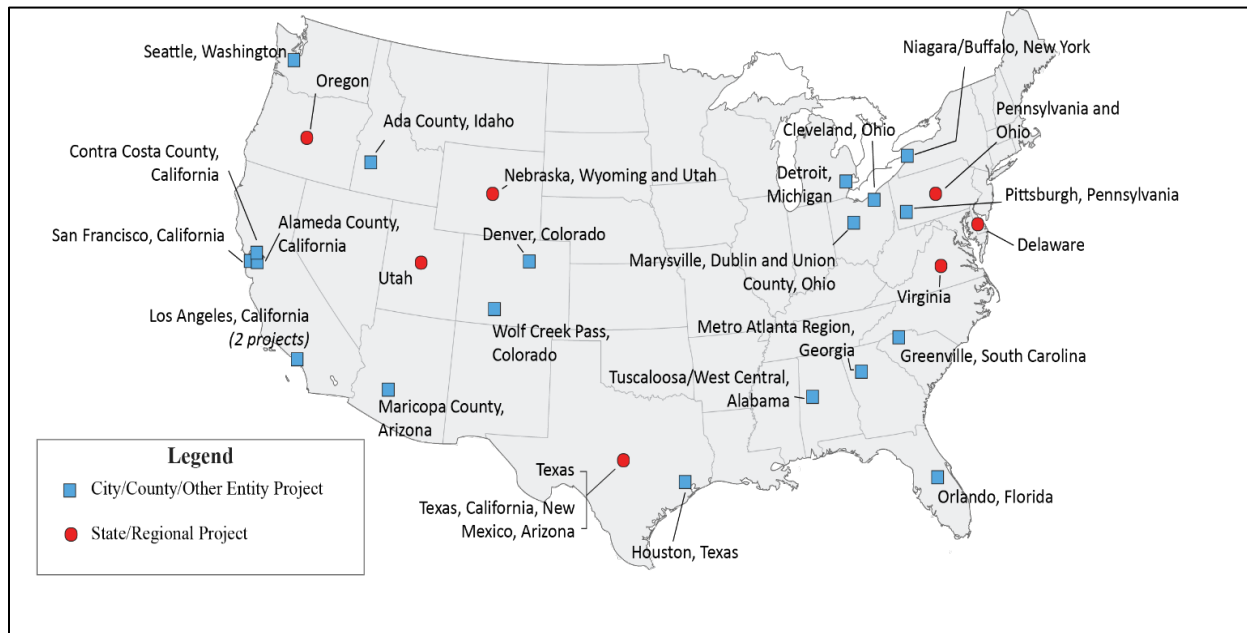
FHWA modeled the ATCMTD Early Deployer Cohort Program on a similar program administered as part of the Connected Vehicle Pilot Demonstration (CVPD) Program. Based on the success of the CVPD Cohort Program, the ATCMTD Program adopted the same model. At the start of the Early Deployer Cohort Program, FHWA polled attendees on the topics of greatest

¹¹ *Evaluation Methods and Techniques: Advanced Transportation and Congestion Management Technologies Deployment Program*: <https://ops.fhwa.dot.gov/publications/fhwahop19053/index.htm>

interest to them and designed meetings to address these topics. FHWA has also developed a file-sharing site for the exchange of relevant resources.

CHAPTER 2. OVERVIEW OF GRANTEE PROJECTS

This chapter provides a general overview of the grantee projects awarded through Fiscal Year (FY) 2018. The Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) Program has awarded 28 grants to date, including eight in FY 2016, 10 in FY 2017, and 10 in FY 2018.¹ The grantees represent a diverse array of U.S. metropolitan and rural areas. (See Figure 1). All FY 2016 and FY 2017 grantees have executed their agreements and received funding obligations. Among the FY 2018 grantees, the Federal Highway Administration (FHWA) has executed eight agreements as of February 2020, and is working with the other grantees to execute agreements.



Source: FHWA

Figure 1. Map. Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) Program Grantees.

¹ For two grantees, Ada County Highway District, Idaho (FY 2017) and Greenville, South Carolina (FY 2017), FHWA and the grantees mutually agreed to terminate the grant. For both projects, the obligated funds were de-obligated (no ATCMTD funds were incurred for either of these projects).

PROJECTS BY FISCAL YEAR

Tables 2, 3, and 4 identify each of the project grants by fiscal year, location, and amount. For brief descriptions about each project, please see [Appendix B](#).

Table 2. Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) Fiscal Year 2016 projects.

Project Name	Location	Grant Amount
Freight Advanced Traveler Information System (FRATIS)	Los Angeles, California	\$3,000,000
Los Angeles DOT Implementation of Advanced Technologies to Improve Safety and Mobility with the Promise Zone	Los Angeles, California	\$3,000,000
City of San Francisco ATCMTD Initiative	San Francisco, California	\$10,990,760
Denver Smart City Program	Denver, Colorado	\$6,000,007
A Connected Region: Moving Technological Innovations Forward in the Niagara International Transportation Technology Coalition (NITTEC) Region	Niagara / Buffalo, New York	\$7,813,256
Marysville, OH 33 Smart Mobility Corridor	Cities of Marysville, Dublin, and Union County, Ohio	\$5,997,500
SmartPGH	Pittsburgh, Pennsylvania	\$10,899,318
ConnectSmart: Connecting Transportation Systems Management and Operations (TSMO) and Active Demand Management	Houston, Texas	\$8,939,062

Source: FHWA

Table 3. Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) Fiscal Year 2017 projects.

Project Name	Location	Grant Amount
Loop 101 Mobility Project	Maricopa County, Arizona	\$6,000,000
Global Opportunities at the Port of Oakland Freight Intelligent Transportation System	Alameda County, California	\$9,720,000
Connecting the East Orlando Communities	Orlando, Florida	\$11,946,279
Ada County Highway District SMART Arterial Management	Ada County, Idaho	\$2,250,000
Improving Safety and Connectivity in Four Detroit Neighborhoods	Detroit, Michigan	\$2,182,000
Connecting Cleveland Project	Cleveland, Ohio	\$5,850,000
Greenville Automated (A-Taxi) Shuttles	Greenville County, South Carolina	\$4,000,000
The Texas Connected Freight Corridors Project	Texas	\$6,090,221
Truck Reservation System and Automated Work Flow Data Model	Virginia	\$1,550,000
Multimodal Integrated Corridor Mobility for All	Seattle, Washington	\$4,091,000

Source: FHWA

Table 4. Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) Fiscal Year 2018 projects.

Project Name	Location	Grant Amount
Bay Area Mobility-On-Demand Project	Contra Costa County, California	\$8,000,000
Advanced Connected Transportation Infrastructure and Operations Network (ACTION)	Tuscaloosa and West Central Alabama	\$8,034,003
Wolf Creek Pass Advanced Technology Deployment	Wolf Creek Pass, Colorado	\$2,366,298
Artificial Intelligence Enhanced Integrated Transportation Management System (AIITMS) Deployment Program	Delaware	\$4,996,949
GDOT Connected Vehicles	Metro Atlanta Region, Georgia	\$2,500,000
Multi-State Rural Integrated Corridor Management (I-80)	Nebraska, Wyoming and Utah	\$2,755,000
Oregon Smart Mobility Network	Oregon	\$12,000,000
Work Zone Reservation and Traveler Information System	Ohio and Pennsylvania	\$2,697,750
I-10 Corridor Coalition Truck Parking Availability System (TPAS)	California, New Mexico, Arizona, Texas	\$6,850,000
Utah Connected	Utah	\$3,000,000

Source: FHWA

SUMMARY OF TECHNOLOGY DEPLOYMENTS

The ATCMTD grants awarded (from FY 2016 through FY 2018) support the deployment of a range of advanced transportation technologies. Some of the key technologies include connected vehicles (CVs), automated vehicles, adaptive traffic signal control, advanced traveler information systems, integrated corridor management (ICM)/decision support systems (DSS), green technology (e.g., electric vehicles), and infrastructure maintenance and monitoring technologies.² Table 5 highlights the number of deployment projects for each of these key technologies. For a more detailed list of the deployed technologies in the projects, please see [Appendix B](#).

² Table 5 is not an exhaustive list; it represents the most prevalent technologies being deployed.

Table 5. Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) grantee technology deployments, Fiscal Year 2016 – Fiscal Year 2018.³

Technology	Number of Projects
CVs/Infrastructure	22
Real-Time Traveler Information	21
Adaptive Signals	13
Integrated Corridor Management (ICM) /Decision Support Systems (DSS)	10
Infrastructure Maintenance/Monitoring	7
Green Technology (light-emitting diode (LED)), electric vehicles)	4
Automated Vehicles	3

Source: FHWA

The grantee projects also span a range of modes/service models. In addition to vehicles, many of the projects either focus on or have a component that includes freight, transit, pedestrian/bicycle, or mobility-on-demand. Many projects address more than one mode or service model; Table 6 reflects the primary mode/service model of each project.

Table 6. Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) grantee project modes/services, Fiscal Year 2016 – Fiscal Year 2018.

Mode/Service Model	Number of Projects
Freight	9
Highway/Vehicle	7
Mobility-on-Demand	6
Pedestrian/Bicycle	4
Transit	2

Source: FHWA

³ One automated vehicle project and one CV project returned their grant awards.

CHAPTER 3. PERFORMANCE MEASUREMENT AND REPORTING

This chapter presents the status of performance measurement among the Fiscal Year (FY) 2016 and FY 2017 grantees and provides qualitative data on issues and challenges, as well as lessons learned during the deployments' planning phase.

STATUS OF PERFORMANCE MEASUREMENT

As part of the ATCMTD Program application process, the FAST Act requires grantees 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.”¹

As a result, all grantees from FY 2016 through FY 2018 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 October 2019, eight grantees had submitted evaluation plans: four FY 2016 grantees, three FY 2017 grantees and one FY 2018 grantee.

FHWA has prepared a publication, *Evaluation Methods and Techniques: Advanced Transportation and Congestion Management Technologies Deployment Program* to assist grantees in their evaluations.² For grantees who have yet to develop evaluation plans, the resource offers information on performance measures, specific methods (benefit cost analysis, survey design, emissions analysis), and specific technologies (connected vehicles (CVs), automated vehicles, and adaptive signal control).

Currently, all grantees are still in the planning phase or in the very early stages of deployment, so it is too early for them to have findings related to performance measurement. Only a few grantees have discussed baseline data collection in their annual reports:

- Denver Smart City Program (FY 2016)
- Los Angeles Promise Zone (FY 2016)
- A Connected Region: Moving Technological Innovations Forward in the Niagara International Transportation Technology Coalition (NITTEC) Region (FY 2016)
- Connecting East Orlando Communities (FY 2017)

¹ FAST Act § 6004; 23 U.S.C. 503(c)(4)(C)(ii)(III).

² *Evaluation Methods and Techniques: Advanced Transportation and Congestion Management Technologies Deployment Program*: <https://ops.fhwa.dot.gov/publications/fhwahop19053/index.htm>

Many grantees have provided performance measures in either an evaluation plan or annual report. Table 8 in [Appendix C](#) presents a summary of current grantee project performance measures for three key areas that align with requirements in the FAST Act and impacts identified by the Secretary in the Notices of Funding Opportunity (NOFOs):

- Reduced traffic related fatalities and injuries;
- Reduced traffic congestion/improved travel time reliability;
- Reduced transportation-related emissions.³

Table 9 in [Appendix C](#) presents a summary of current grantee project performance measures for other key areas that align with requirements in the FAST Act. These other key areas are listed below:

- 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.⁴

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

Common Performance Measures

Grantees are using different performance measures to quantify the impacts of their technology deployments. For the reduced traffic congestion/improved travel time reliability goal area, common performance measures include travel time reliability, travel time, and delay reduction, although grantees do tailor measures to their specific projects. For example, a grantee with a transit project used “improved transit vehicle travel time,” and a grantee with a freight project used “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 travel time core of the performance measure is the same. Similarly, for other goal areas such as safety and environment, there tend to be one or two core measures that vary slightly across projects.

Many grantee-reported safety performance measures are count data. Common examples include number of traffic fatalities, number of crashes, and number of injuries. Similar to the travel time example, grantees customize these performance measures to their projects. For example, one grantee quantifies bicycle and pedestrian injuries and another measures the number of mainline crashes. Other measures address rates, such as crashes and vehicle/pedestrian conflict percent reduction rates.

³ FAST Act § 6004; 23 U.S.C. 503(c)(4)(G)(i-iii).

⁴ FAST Act § 6004; 23 U.S.C. 503(c)(4)(G)(iv-viii).

The two most common types of transportation-related emissions performance measures used by grantees relate to reduced emissions or fuel savings/consumption. Some examples include reduction in greenhouse gas (GHG) emissions per passenger mile; a decrease in carbon monoxide (CO), carbon dioxide (CO₂), nitrogen dioxide (NO₂), sulfur dioxide (SO₂), ozone (O₃), and particulate matter (PM) 2.5; and lower fuel consumption by transit vehicles.

Grantees also provide performance measures for enhancing access to transportation alternatives, delivering integrated real-time information, improving equity, and enhancing system performance and operational efficiencies. Table 9 in [Appendix C](#) presents a summary of these performance measures.

The most common measure grantees provide for optimizing system performance is number/reduction of vehicle trips, which takes on different forms depending on the scope of the project. Grantees also use many integrated real-time information performance measures, including several on the volume and availability of various types of data. Specific examples are volume data; availability of real-time roadway and traffic condition information; and accuracy of information.

INITIAL FINDINGS AND INSIGHTS FROM GRANTEES

The purpose of this report is to summarize program findings for grants awarded in FYs 2016 and 2017 related to grantee effectiveness in meeting their projected deployment plans. All grantees from these years are at various stages of the planning process, and some have begun testing technologies necessary for deployment. Through the required annual and quarterly reports, as well as the Early Deployer Cohort Program, grantees have identified preliminary issues and challenges of interest to FHWA, other grantees, and deployers more generally. These early findings, lessons learned, and grantee recommendations presented in this first program report fall into three key categories:

- Institutional
- Project schedule/scope (Project management)
- Technical

This section describes some of the challenges identified by grantees, providing specific examples, and includes grantee recommendations or lessons learned for others deploying advanced technologies (i.e., in cases where grantees provided this information in their quarterly reports or annual reports). This report does not present FHWA recommendations.

Finally, the annual report template asks grantees to describe any aspects of their project that they consider cutting edge, noteworthy, or innovative. Some of these reported innovations are highlighted below.

Institutional Issues

To date, grantees have reported institutional issues as the most common challenge. Given the early stages of each of the projects, this is consistent with issues that grantees may face in the planning phases. Grantees reported institutional challenges such as: coordinating among large numbers of stakeholders and jurisdictions; navigating Federal, State, and stakeholder processes; staff and contractor turnover; and getting the right expertise. Each of these is described in greater detail below.

Stakeholder/Agency Coordination

Several grantees described the challenges posed by coordinating across agencies, jurisdictions, and stakeholders. These challenges included:

- One grantee was coordinating with nine partner agencies, developing intergovernmental agreements (IGAs) for all, and proceeding with each agency's unique legal and review/approval process. These coordination challenges, including the process of IGA review and approval, required additional time and affected the project's schedule.
- One grantee experienced unexpected delay with the execution of often-complicated, multiple participant off-system right-of-way agreements.

Lessons Learned and Recommendations from Grantees (Stakeholder/Agency Coordination):

- Multiple grantees emphasized the importance of coordination and organization across agencies and stakeholders (public and private) early in the project. Having consensus on project objectives, decision-making framework, and a communications plan at the onset would have simplified initial challenges.
- One grantee found it valuable to identify a small group of key individuals empowered to make decisions and convenes regularly to review current issues.
- One grantee found that acquisitions guidelines permitted holding early stakeholder discussions on autonomous vehicle operation insurance premiums and requirements far in advance of procurement advertisement. If appropriate, future grantees may be able to share autonomous vehicle insurance requirements with vendors in early coordination efforts to undertake market research on prospective firms and to enable vendors to determine the feasibility of obtaining required premiums.

Institutional Processes and Procurement

Grantees have adhered to institutional processes, especially those related to procurement, although there are often challenges with first or early real-world deployments of new technology. While government entities often strive to develop and institute procurement rules that keep up with technology, grantees have had to find ways to work within acquisitions standards that predate advanced technologies. Specific examples of these challenges include:

- Two grantees (both deploying AV technologies) reported to FHWA that AVs on the market did not comply with Buy America and Federal Motor Vehicle Safety Standards (FMVSS).
- One grantee reported an unexpected 30-month delay in complying with State contracting requirements with the project's service contractors during the procurement process.
- One grantee indicated that ATCMTD-encouraged public-private partnerships required them to take innovative approaches to meet procurement requirements that restrict contracting until a funded project is in place.
- One grantee experienced delays with the execution of its autonomous vehicle shuttle contract, as the awarded vendor had difficulty in providing the required insurance premiums under the required procurement timeline.

Due to lessons learned from early grantee experience, FHWA provided additional clarification to the FY 2019 NOFO regarding the FMVSS.⁵ Specifically, the 2019 NOFO states that:

“If an applicant is proposing to deploy autonomous vehicles or other innovative motor vehicle technology, the application should demonstrate how all vehicles will comply with applicable safety requirements, including those administered by the National Highway Traffic Safety Administration (NHTSA) and Federal Motor Carrier Safety Administration (FMCSA)...If the vehicles may not comply, the application should either (1) show that the vehicles and their proposed operations are within the scope of an exemption or waiver that has already been granted by NHTSA, FMCSA, or both agencies or (2) directly address whether the project will require exemptions or waivers from the FMVSS, Federal Motor Carrier Safety Regulations (FMCSR), or any other regulation and, if the project will require exemptions or waivers, present a plan for obtaining them.”

Likewise, for Buy America, 2019 NOFO states:

⁵ 2019 ATCMTD Notice of Funding Opportunity: <https://www.grants.gov/web/grants/view-opportunity.html?oppId=316761>

“Proposals should clearly address and explain if the proposed project will or may require a waiver under the Buy America Act.”

In addition, on September 25, 2019, FHWA issued a [memorandum](#) clarifying the Federal-aid procedures for procurement of operational improvements using Federal-aid highway program funding.⁶

Lessons Learned and Recommendations from Grantees (Institutional Process):

Grantees offered several recommendations related to easing the procurement process for agencies and teams. Some specific examples included:

- Grantees suggested that FHWA contract administration staff should develop a primer package of resources for emerging technology projects like CVs. The grantees suggested that such a welcome packet for recipients include links to key resources, support teams, and software projects to help the receiving party get a strong lay of the land before deciding on a procurement structure and strategy.
- Grantees believe that recipients should review Federal source code guidelines and strongly consider mandating a minimum percentage of software code acquired (i.e. through procurement) or developed with public dollars be made open source for other deployer communities.

Cost/Scope Issues

Issues related to project cost have resulted in multiple grantees working with FHWA to adjust the size and scope of their projects to fit within their budgetary constraints. A few grantees reported difficulty in estimating costs due to innovative technologies, lack of historical cost data, or not having project elements fully defined. Some specific issues were:

- One grantee reported that it had underestimated the number of easements that were required for the project (+65), with each easement ranging from \$1,000 to \$28,500 (and most costing more than \$10,000). There were also additional unanticipated costs to get electric service to each roadside unit (RSU).
- Another grantee indicated that it was considering a potential decrease in the number of on-board units (OBUs) that will be installed as part of the project. The grantee is evaluating the impact and mitigation.

⁶ Federal Highway Administration. (September 25, 2019). *Procurement and Authorization of Federal-Aid Operational Improvements*: <https://ops.fhwa.dot.gov/plan4ops/resources/memorandum/itsprocurementmemo092519.htm>

Lessons Learned and Recommendations from Grantees (Cost/Scope Issues):

Grantees did not provide lessons learned or recommendations regarding costs/scope issues. FHWA plans to compile and include this information in future program reports.

Technical Issues

While all grantees are still in the planning phases of their projects, three grantees closer to deployment provided updates in their annual and quarterly reports on several technology-related issues that they encountered. Some of these technical issues may be unique to specific projects, but others are likely to provide valuable insight for other grantees and future deployers. Grantees identified two themes related to technology and standards maturity and availability, and integration and interoperability. Other technical issues identified by FHWA and grantees, as well as actions being taken to resolve them, are also described in this section.

Technology and Standards Maturity and Availability

Multiple grantees encountered issues with technology maturity and availability, noting that connected vehicle technology is not as mature or stable as advertised. One grantee conveyed the private vendor community is less mature in its technology development than advertised. This caused the grantee to dedicate extra time to device bench testing, integration work, and foundation building, which it is still working on with the assistance of the FHWA Turner-Fairbank Highway Research Center. Many of the applications the grantee wants to deploy on top of the base layer CV technology are still undeveloped by vendors, and are not available in an open source format. Furthermore, integrating onboard equipment into a vehicle data bus has been technically challenging, and the grantee is vetting solutions that different companies are offering.

A few specific examples of technology and standards maturity are detailed below:

- One grantee chose not to pursue dynamic traffic signal phasing, timing, and preemption using Dedicated Short Range Communication (DSRC), a wireless communication technology, because focusing on that less-mature application would have consumed a significant portion of budget and schedule.
- The same applicant indicated that standard practices for deploying infrastructure components have not been developed, since the technology has never been deployed in their State and has not been significantly deployed elsewhere in the country. As an example, the grantee noted that determining the appropriate pole on which to mount the RSUs was challenging. On a traditional project, published standards would clarify the size and type of pole and cabinet to be used. For technologies that have not been deployed, however, the requirements have more room for interpretation regarding the type of pole (steel, wood, or composite), the height of pole, and type of cabinet (ground mounted, pole mounted, or integrated).

- Another applicant reported that the pilot program established for the Connected Vehicle Pilot Demonstration (CVPD) has not been available to subsequent deployers, so the team had to investigate requirements of a production Security Credential Management System (SCMS) and vendors that could provide the service.⁷
- One grantee reported that several DSRC vendors were unable to fulfill the small orders submitted to them when the grantee sought two of every RSU and OBUs known to be available in the U.S. market. Two vendors stopped responding to inquiries by the City’s purchasing staff and appeared unable to complete the orders submitted to them.

Lessons Learned and Recommendations from Grantees (Technology and Standards Maturity and Availability):

- Grantees stated that vendor involvement in deployments is critical to success. Continuous engagement with industry, specifically vendors, to outline desired functionality, applications, and/or use cases has proven the best method for driving development. Engage technology vendors/manufacturers to provide hands-on demonstration and training for equipment deployment to validate and verify technology capabilities and readiness.
- Because of the newness of technologies involved in ATCMTD deployments, grant recipients say that entities involved should be flexible and may need to consider adjusting existing practices or standards as appropriate. Recipients believe that it is key to have the necessary parties in the discussion early on, having ownership defined, and establishing final decision authority.
- Grantees recommend that recipients perform on-site pilots or laboratory setting tests of all equipment prior to deployment.

Interoperability

A couple of grantees mentioned technical issues related to interoperability, as described below:

- One grantee noted that it was not able to find a set of CV devices that worked within the City’s existing intelligent transportation systems (ITS) infrastructure, particularly for integration with the traffic signal controller. As a result, the program manager added technical testing to the scope of work approved by FHWA to identify a working model.
- Through testing, one grantee learned that there were a number of nuances between manufacturers of OBUs, and that nothing was seamlessly “plug and play” or “fully interoperable.”

⁷ SCMS is a proof-of-concept message security solution for vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication, designed to facilitate trusted and secure communication.

Other Technical Issues

Two grantees mentioned other specific technical issues:

- During the planning phase of the project, the project team explored the use of the Agile Process, a particular approach to project management that is used in software development. While switching to this process did not significantly impact the project schedule, the grantee indicated that the Agile Process could have been explored earlier and presented to FHWA prior to the start of concept exploration.
- Deployment of CV equipment may require additional considerations from partner maintaining agencies outside of their typical arrangements. For example, if a maintaining agency's network design includes multiple virtual local area networks (VLAN) to separate device types, the grantee suggested that it may need to be revised in order to ensure communication between the controller and RSU at an intersection for broadcasting signal phase and timing (SPaT) information to motorists.

Lessons Learned and Recommendations from Grantees (Other Technical Issues):

- Recipients say that grantees should coordinate with maintaining agencies well in advance of the design phase to understand and be able to incorporate network design, limitations, etc. into the project(s).
- If considering Agile software development processes, grant recipients might explore and present these processes prior to the start of concept exploration.

Innovation

In their annual reports, grantees highlighted innovative or noteworthy project components. These are presented in Table 7 (see next page), according to whether the innovation related to technology, process, or data.

Table 7. Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) grantee project innovations.

Technology Innovation	Process Innovation	Data Innovation
<ul style="list-style-type: none"> • Use of new technology to provide enhanced traveler information in a region that spans the U.S.-Canada border • Exploration of the use of unmanned aerial systems to monitor traffic and roadway conditions • Development of an On-Board Unit (OBU) emulator software, capable of utilizing internal sensors and hardware within a mobile phone to transmit and receive messages necessary for Connected Vehicle (CV) applications (also serves as a platform for third-party developers to submit CV applications to run, as well as enable users to determine what applications are important to them) 	<ul style="list-style-type: none"> • New and innovative ways to improve and enhance the systems that Federal Highway Administration had invested in the earlier pilots and proof of concepts • Use of vehicle intelligence software to monitor each component of the vehicle in real-time, and to perform predictive maintenance across the fleet, thus enabling staff to make service decisions before any equipment failure impacts the riders • Use of a scenario-based approach for the concept of operations, an approach which included stakeholder workshops to walk through the scenarios and stakeholder surveys to prioritize the proposed applications for scoping purposes 	<ul style="list-style-type: none"> • Integration of existing traveler round trip information with an existing port truck appointment system (which has never been attempted)

Source: FHWA

CHAPTER 4. GRANTEES' CONCLUSIONS

This program-level report presents grantees' initial insights from ATCMTD Program. The FAST Act established the ATCMTD Program to develop model deployments to improve safety, efficiency, system performance, and infrastructure return on investment. The USDOT awarded eight projects in Fiscal Year (FY) 2016, and 10 projects each in FY 2017 as well as FY 2018, representing a diverse set of advanced technologies being deployed across the U.S. Some of the key technology deployments include connected vehicles (CVs), automated vehicles, adaptive traffic signal control, advanced traveler information systems, integrated corridor management (ICM), green technology (e.g., electric vehicles, light-emitting diode (LED)), and infrastructure and monitoring technologies. The projects span a range of modes/service models—vehicle, freight, transit, pedestrian/bicycle, and mobility on demand. FHWA has provided the grantees with support to facilitate their deployments and to assist them in meeting their reporting requirements. The law requires each grantee to submit annual reports that describe the impacts of their deployments.¹ To date, the grantees are too early in their deployments to report on impacts. As a result, this program report summarizes the performance measures that grantees are using, as described in their annual reports and evaluation plans. The performance measures tend to focus most heavily in the areas of improved mobility and safety, as well as reduced emissions. For the reduced traffic congestion/improved travel time reliability goal area, common performance measures include travel time reliability, travel time, and delay reduction, although grantees do tailor performance measures to their specific projects. Many of the safety measures reported by grantees are count data, including measures such as number of traffic fatalities, number of crashes, and number of injuries. The two most common types of transportation-related emissions measures reported by grantees are a form of reduced emissions or fuel savings/consumption. Grantees also provide performance measures for enhancing access to transportation alternatives, delivering integrated real-time information, improving equity, and enhancing system performance and operational efficiencies.

This report also highlights the grantees' challenges, lessons learned, and recommendations in their quarterly and annual reports, and evaluation plans. At this early stage, key challenges revolve around:

- Institutional issues (stakeholder/agency coordination; institutional processes, and procurement);
- Cost/scope issues; and
- Technical issues (technical/application maturity and availability; interoperability)

In their lessons learned and recommendations, grantees' suggestions include:

- Conduct stakeholder coordination early in the process.
- Engage with vendors and manufacturers in advance of the design phase to discuss desired functionality, application use cases, etc.

¹ FAST Act § 6004; 23 U.S.C. 503(c)(4)(F).

- Test all equipment (e.g., using an on-site pilot or laboratory setting tests) prior to deployment.
- Be flexible, as existing practices or standards may need to be adjusted to accommodate the deployment of these new technologies.

Future program reports may provide findings on the mobility, safety, environmental, and system performance impacts of the grantees' technology deployments, and will continue to report on grantees' insights on the challenges and lessons learned of their deployments.

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 the Federal Highway Administration (FHWA) intends to use the information from the grantees' annual reports to prepare the required Program Level Reports on the effectiveness of the Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) grantees in meeting their projected deployment plans. This template was first issued to the grantees on February 11, 2019.

Reporting Requirement:

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 4 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**

PART 1 of 4: INTRODUCTION AND OVERVIEW

Project Title:
Grant Award Recipient:
Annual Report Period <i>[insert date range]</i> :
Prepared by: <i>[name, agency and title]</i>
<p><i>NOTE: Responses to questions 1 through 3 should reflect 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 through 3 should be the same as the previous annual report.</i></p> <p>1. Please provide a <i>high-level</i> description of your project, including intended beneficiaries. (Please limit to approximately 350 words or less.) <i>Note: in Part 4 of 4, Q 1, you will be asked to note any major deviations or changes in scope due to either project-driven outcomes or other unforeseen challenges.</i></p>
<p>2. Please indicate which ATCMTD-targeted technologies your project covers (Check all that apply).</p> <ul style="list-style-type: none"> <input type="checkbox"/> Advanced traveler information systems <input type="checkbox"/> Advanced transportation management technologies <input type="checkbox"/> Infrastructure maintenance, monitoring, and condition assessment <input type="checkbox"/> Advanced public transportation systems <input type="checkbox"/> Transportation system performance (monitoring) data collection, analysis and dissemination <input type="checkbox"/> 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 <input type="checkbox"/> Integration of intelligent transportation systems using Smart Grid or similar energy distribution and charging systems <input type="checkbox"/> Electronic pricing and payment systems

<input type="checkbox"/> Advanced mobility and access technologies, such as dynamic ridesharing and information systems to support human services for elderly, disabled, or disenfranchised individuals. <input type="checkbox"/> Other (Describe) _____
<p>3. What are your project's goals? (<i>Check all that apply.</i>) 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.</p> <input type="checkbox"/> Improved safety <input type="checkbox"/> Reduced congestion and/or improved mobility (e.g., travel time reliability) <input type="checkbox"/> Reduced environmental impacts (e.g., emissions and/or energy) <input type="checkbox"/> Improved system performance/optimized multimodal system performance <input type="checkbox"/> Enhanced access to transportation alternatives <input type="checkbox"/> Effectiveness of providing integrated real-time transportation information to the public to make informed travel decisions <input type="checkbox"/> Reduced costs <input type="checkbox"/> Institutional or administrative benefits (e.g., increased inter-agency coordination) <input type="checkbox"/> Other benefits (please specify: _____) <input type="checkbox"/> Other goals (Please specify: _____)

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 (PMs) 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, etc.)
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.	

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, etc.)
Effectiveness of providing integrated real-time transportation information to the public to make informed travel decisions	1. 2. 3. Etc.	
Reduced costs	1. 2. 3. Etc.	
Institutional or administrative benefits	1. 2. 3. Etc.	
Other benefits: Please specify:		
Other benefits: Please specify:		
Other goals [ADD IF NEEDED] Please specify:		

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.	

Goal Area	Findings (tied to performance measures; also include any anecdotal evidence)	Notes/Considerations
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.	
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.	

PART 4 of 4: WRAP UP

<p>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 <i>major</i> 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.</p>
<p>2. Are there any aspects of your project that you consider cutting edge, noteworthy, or innovative? If yes, please describe.</p>
<p>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?</p>
<p>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, etc.), research (e.g., performance measurement), or other lessons learned.</p>
<p>5. What recommendations can you provide regarding future deployment strategies in this/these area(s)?</p>
<p>6. Do you have any final comments or feedback?</p>

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

This section provides a summary of each of the Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) projects, including grant amount, project goals, and technologies being deployed.

The United States Government does not endorse products or manufacturers. Trademarks or manufacturers' names appear in this report solely because they are considered essential to the objective of this report. They are included for informational purposes only and are not intended to reflect a preference, approval, or endorsement of any one product or entity.

FISCAL YEAR 2016 PROJECTS

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

- 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 eco-drive applications.

Los Angeles DOT Implementation of Advanced Technologies to Improve Safety & Mobility with the Promise Zone *(Los Angeles DOT: Los Angeles, California)*

- Grant Amount: \$3,000,000
- Project Goals: This project uses advanced technology on LA's 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.

City of San Francisco ATCMTD Initiative *(San Francisco Municipal Transportation Agency: San Francisco, California)*

- 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: 1) New highway high occupancy vehicle lanes for transit/carpools, 2) Transit signal priority and emergency vehicle preemption, 3) Electronic, autonomous shuttles, 4) Curb space for pick-up/drop-off by carpools and ridesourcing services, 5) Multimodal intelligent traffic signal systems located roadside and in-vehicle, 6) A connected, electronic toll system for the congestion pricing program.

Denver Smart City Program (*City and County of Denver: Denver, Colorado*)

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

A Connected Region: Moving Technological Innovations Forward in the NITTEC Region (*Niagara Frontier Transportation Authority: Erie and Niagara Counties, New York*)

- 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 Niagara Frontier Transportation Authority.
- Technologies Being Deployed: Connected vehicle (CV) applications supporting in-vehicle dissemination of alerts, advisories, and parking, traffic, and weather information, improved traffic signal system, parking management analytics engine, decision support system.

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

- Grant Amount: \$5,997,500
- Project Goals: This project creates a smart mobility corridor with connected vehicle 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 signal phase and timing (SPaT), pedestrian warning systems on the local street network; and real-time road weather performance data.

SmartPGH (*City of Pittsburgh: Pittsburgh, Pennsylvania*)

- 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 will improve real-time information access and optimize transit operations.

- **Technologies Being Deployed:** Conversion of nearly 40,000 City of Pittsburgh streetlights to light-emitting diode (LED) technology with integrated control systems and installation of supplemental sensor technology, including pedestrian detection and air quality monitoring along Smart Spine corridors. Additionally, Pittsburgh will deploy real-time adaptive traffic signals and DSRC units on buses for transit signal priority, advanced traveler information systems, and optimized mobility.

ConnectSmart: Connecting TSMO and Active Demand Management (*Texas DOT: Houston, Texas*)

- **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:** The ConnectSmart model platform will integrate various mobility technologies including various regional existing advanced traveler information systems and data sources to provide predictive multi-/inter-modal travel time, cost, and reliability information. This information will be delivered to travelers to give them live information and incentivize better mobility decisions, give stakeholders access to data to improve operations and connect transportation supply and demand.

FISCAL YEAR 2017 PROJECTS

Loop 101 Mobility Project (*Arizona DOT: Maricopa County, Arizona*)

- **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 integrated corridor management (ICM), public transportation, SMARTDrive, and other connected traffic management and real-time information technologies.
- **Technologies Being Deployed:** A decision support system (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 (ITS) (*Alameda County Transportation Commission: Alameda County, California*)

- **Grant Amount:** \$9,720,000
- **Project Goals:** This project improves traffic flow and goods movement to and within the Port of Oakland, reduce congestion, improve safety, provide improved traveler information, and reduce 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 traffic management center, traffic sensors, advanced traveler information, traffic messaging, trucking information for mobile apps, rail grade warning, and terminal queue information.

Connecting the East Orlando Communities (*Florida DOT: Orlando, Florida*)

- Grant Amount: \$11,946,279
- Project Goals: This project improves pedestrian and bicycle safety, enhance multimodal transportation, provide integrated real-time information for travelers and connect/integrate data sources created and utilized by Florida DOT.
- Technologies Being Deployed: An innovative pedestrian and bicycle collision avoidance system, roadside units, 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: Ada County, Idaho*)

Note: This project is 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, onboard units, radar technology for bicycle and vehicle detection, traffic software, and accessible pedestrian signals.

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

- 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, vehicle-to-infrastructure (V2I) communications, vehicle preemption, digital kiosks, DSRC, and Internet of Things gateway.

Connecting Cleveland Project (*Greater Cleveland Regional Transit Authority: Cleveland, Ohio*)

- 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 on-board equipment, real-time information and maintenance software, and an upgraded radio system.

Greenville Automated (A-Taxi) Shuttles (*County of Greenville: Greenville, South Carolina*)

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 vehicle-to-vehicle (V2V) and V2I technology, V2I infrastructure, automated vehicle data collection and analysis, and real-time traveler information.

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

- 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 pre-trip and en-route 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 vehicle 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: Virginia*)

- 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. Radio frequency identification (RFID) tag readers will automate 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 (*City of Seattle DOT: Seattle, Washington*)

- 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, closed-circuit television (CCTV), dynamic message signs, passive pedestrian detection and pedestrian demand-based signal timing, bicycle detection (V2I) and mobile application, integrated corridor management solutions, Mobility-as-a-Service software, and kiosks.

FISCAL YEAR 2018 PROJECTS

Bay Area Mobility-On-Demand Project (*Contra Costa Transportation Authority: Contra Costa County, California*)

- Grant Amount: \$8,000,000
- Project Goals: This project provides Mobility on Demand (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 & Operations Network (ACTION) (*University of Alabama: West Central Alabama, Alabama*)

- Grant Amount: \$8,034,003
- Project Goals: This project deploys CV and ITS technologies to allow the regional traffic management center 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: Wolf Creek Pass, Colorado*)

- Grant Amount: \$2,366,298
- Project Goals: This project transmits real-time information to travelers and dispatch emergency responders and incident management teams faster to improve safety on Wolf Creek Pass.
- Technologies Being Deployed: DSRC roadside units, 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.

AIITMS Deployment Program (*Delaware DOT: Delaware*)

- Grant Amount: \$4,996,949
- Project Goals: This project enables deployment of an Artificial Intelligence Enhanced Integrated Transportation Management System (AIITMS) and an artificial intelligence (AI)-enhanced next-generation traffic management center to improve transportation

systems performance for enhanced traffic safety, mobility, and air quality. Additionally, 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.

GDOT CV (*Georgia DOT: Metro Atlanta, Georgia*)

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

Multi-State Rural ICM (*Nebraska DOT: I-80 through Nebraska, Wyoming, and Utah*)

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

Oregon Smart Mobility Network (*Oregon DOT: Oregon*)

- Grant Amount: \$12,000,000
- Project Goals: This project creates a multimodal integrated network and helps ODOT with performance measurement, decision support, and active traffic, incident and weather management.
- Technologies Being Deployed: Automatic traffic recorders, bicycle and pedestrian counters Bluetooth travel time systems, road weather decision support and information dissemination, CCTV monitoring cameras, adaptive ramp metering, dynamic speed limits, freight signal priority, queue warning systems, SPaT, dynamic routing, next-generation transit signal priority, vehicle-to-everything pedestrian/bicycle, automated speed enforcement, red-light-running crash mitigation systems, unmanned aerial systems crash reconstruction, and battery back-up systems.

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

- 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 (*Texas DOT: California, New Mexico, Arizona, and Texas*)

- **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 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: Utah*)

- **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 connected vehicle technology to improve safety and mobility, and uses automated vehicle technology to help solve the first mile/last mile problem.
- **Technologies Being Deployed:** Autonomous shuttle(s), fiber sensing, CV applications (plows, signals, transit, curve speed warning, weather impact warning), and a data-sharing portal.

APPENDIX C. SUMMARY OF PERFORMANCE MEASURES FOR CURRENT PROJECTS

Table 8: Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) summary of current project performance measures for reduced traffic congestion, safety, and reduced transportation related emissions goal areas.¹

Goal Area	Reduced Traffic Congestion/Improved Travel Time Reliability	Safety	Reduced Transportation Related Emissions
General (Cross-cutting)	<ul style="list-style-type: none"> • Number of incidences involving double parking and parking in travel lanes • Vehicle hours traveled (VHT) during AM peak, PM peak, and daily VHT • Average curb occupancy rate • Average emergency vehicle response time • Number of requests received from connected vehicle (CV)-equipped vehicles at traffic intersections • Number of times traffic signals took an action compared to incoming requests • Travel time • Travel time reliability • Congested hours • Travel delay reduction • Travel time reduction (overall + to job centers) • Number of stops reduction – the number of times that a vehicle must stop when traveling through the signal network 	<ul style="list-style-type: none"> • Number of traffic fatalities • Muni collisions per 100,000 miles • Average truck speed through corridors • Detection/self-reporting of advanced warning of pedestrian crossings by CV-equipped vehicles • Number of instances snow plows would have approached intersection in yellow w/o priority active • Increased active time of snow plows actively plowing road • Reliability comparison (requests from the CV system vs. current preemption system at intersections) • Number of crashes on roadways • Incident response and clearance times 	<ul style="list-style-type: none"> • Greenhouse gas (GHG) emissions per passenger mile • Transportation sector carbon footprint (metric tons carbon dioxide equivalent) • Average vehicle occupancy • Average idling time at designated curbs • Reduction in carbon monoxide (CO), carbon dioxide (CO₂), nitrogen dioxide (NO₂), sulfur dioxide (SO₂), ozone (O₃), and particulate matter (PM 2.5) • Reduction of CO₂ equivalent • Reduction in system vehicle delay • Percentage of zero or car-light households • Non-single occupancy vehicle (SOV) mode share

¹ Measures are listed once

Table 8. Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) summary of current project performance measures for reduced traffic congestion, safety, and reduced transportation related emissions goal areas (Continuation).

Goal Area	Reduced Traffic Congestion/Improved Travel Time Reliability	Safety	Reduced Transportation Related Emissions
General (Cross-cutting, continuation)	<ul style="list-style-type: none"> • Increased intersection throughput • Reduction in system vehicle delay • Percent change in link travel times by hour • Percent change in travel time index • Percent change in planning time index • Percent change in overall vehicle delays (AM, PM, event time periods) • Percent change in emergency vehicle travel time • Percent change in vehicle delay and travel time over a 15-minute period • Percent change in vehicle delay and travel time in the 30-minute period occurring 15 minutes after the GreenWave response • Percent change to vehicle delay by approach over a one hour period of peak cyclist detections and 24-hour period • Variability in observed average corridor speeds • Observed average corridor speed • Observed average daily and peak hour corridor travel times 	<ul style="list-style-type: none"> • Effectiveness of incident response patrols • Reduction in crashes • Crash severity • Reduction in single- and multiple-vehicle crashes • Reduction in rear-end and lane departure crashes • Percent reduction in pedestrian/vehicle conflicts • Percent/vehicle crash data • Number of mainline crashes • Number of red-light running and near-miss events • Reduction in average, median and percentile speed through the horizontal curve • Frequency of weather-related crashes • Roadway crash rate and severity profile • Crash rate for crashes resulting from weather and congestion 	

Table 8. Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) summary of current project performance measures for reduced traffic congestion, safety, and reduced transportation related emissions goal areas (Continuation).

Goal Area	Reduced Traffic Congestion/Improved Travel Time Reliability	Safety	Reduced Transportation Related Emissions
Mobility on Demand	<ul style="list-style-type: none"> • Travel time savings (for users and non-users) • Alternative route trip travel time savings • Alternative mode trip travel time savings 	<ul style="list-style-type: none"> • Information dissemination during crashes • Provision of advanced queue warning • Provision of advanced crash information • User and non-user perception of safety • Feedback from user surveys 	<ul style="list-style-type: none"> • Reduced emissions (nitrogen oxides (NOX), CO2) • Fuel savings
Freight	<ul style="list-style-type: none"> • Improvements in travel time reliability, fuel efficiency and route efficiency (reported by freight partners) • Reduction in truck travel times along key port access corridors • Reduction in delay at key port intersections • Reduction in delay at at-grade rail crossings • Reduction in person hours of delay • Reduction in queue lengths 	<ul style="list-style-type: none"> • Reduction in incidents • Improvement in incident management • Improvement in emergency management • Utilization of truck weigh-in-motion • Fewer trucks on the terminal at the same time • Reduction in motor carriers exiting trucks in operational areas 	<ul style="list-style-type: none"> • Quantity of CO2 reduced by partner freight companies • Environmental data shows benefits in air quality along freight corridors • Reduction in emissions • Reduction in truck idling

Table 8. Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) summary of current project performance measures for reduced traffic congestion, safety, and reduced transportation related emissions goal areas (Continuation).

Goal Area	Reduced Traffic Congestion/Improved Travel Time Reliability	Safety	Reduced Transportation Related Emissions
Transit	<ul style="list-style-type: none"> • Improvement to transit vehicle travel time improvement • Improvement to service on-time reliability • Improvement to transit vehicle operations • Average transit service speed/delay through corridors • On time arrival percentage of buses • Transit travel time 	<ul style="list-style-type: none"> • Advanced covert alarm features • Live look-in for vehicle alarms • Interoperability with transit police 	<ul style="list-style-type: none"> • Fuel consumption of transit vehicles
Pedestrian and Bike	<ul style="list-style-type: none"> • Wait time reduction (drivers and pedestrians) • Amount of time spent idling while moving through the signal network • Percent change in pedestrian delay 	<ul style="list-style-type: none"> • Number of pedestrian and bicycle injuries • Frequency and severity of collisions involving pedestrians • Instances of a pedestrian signal extension • Overall reduction in pedestrian and bicycle crashes • Overall reduction in pedestrian and bicycle fatalities • Potential pedestrian/vehicle and bicycle/vehicle conflicts (near misses from video) • Severity of pedestrian/vehicle and bicycle/vehicle crashes 	

Source: FHWA

Table 9: Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) summary of current project performance measures for enhanced access to transportation alternatives, providing integrated real-time information, improved equity, and improved system performance goal areas.

Goal Area	Enhanced Access to Transportation Alternatives	Providing Integrated Real-time Info	Improved Equity	Improved System Performance + Operational Efficiencies
General (Cross-cutting)		<ul style="list-style-type: none"> • Volume of quality actionable data available to operators, including road conditions, incidents, etc. • Number of travelers reached • Accuracy of information • Availability of real-time roadway and traffic condition information 	<ul style="list-style-type: none"> • Number of emerging mobility services (EMS) trips originating from Communities of Concern • Percentage of EMS trips to and from Communities of Concern • Comparability of response times for trips originating from Communities of Concern • Number of trips provided to people with disabilities • Comparability of accessible vehicle response times 	<ul style="list-style-type: none"> • Number, rate, and location of automated vehicle (AV) shuttle system disengagements • Total number of AV shuttle trips • Missed hours of operation due to failure • Traffic Signal Performance • Intersection throughputs • Support the application of transportation systems management and operations (TSMO) strategies, e.g., integrated corridor management (ICM) • Vehicle trip reduction • Alternative trip increase • Routing prediction accuracy • Departure times trip travel time savings • Alternative mode trip travel time savings • Travel time reliability • Reduction in system vehicle delay • Satisfaction rate of services (feedback from user surveys) • Vehicle density • Survey results on usefulness of automated traffic signal performance measures for monitoring and managing corridor operations

Table 9: Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) summary of current project performance measures for enhanced access to transportation alternatives, providing integrated real-time information, improved equity, and improved system performance goal areas (Continuation).

Goal Area	Enhanced Access to Transportation Alternatives	Providing Integrated Real-time Info	Improved Equity	Improved System Performance + Operational Efficiencies
General (Cross Cutting, Continued)				<ul style="list-style-type: none"> • Detection outage response time • Traffic volumes • Number of truck priority actuations • Number of pedestrian system actuations by mode • Traffic signal controller responses to the approach and passage of transit signal priority-enabled buses • Median “road clearance” time • Number of mapped points per time on scene
Mobility on Demand	<ul style="list-style-type: none"> • Percentage of shared rides 	<ul style="list-style-type: none"> • Percentage of carpool requests completed 		<ul style="list-style-type: none"> • Number of carpool passenger pick-ups and drop-offs during AM/PM peak • Number of vehicles picking up and dropping off passengers at designated carpool curbs during peak periods • Data that informs/optimizes intelligent transportation systems (ITS) • Improve system efficiency and capacity • Reduce delay

Table 9: Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) summary of current project performance measures for enhanced access to transportation alternatives, providing integrated real-time information, improved equity, and improved system performance goal areas (Continuation).

Goal Area	Enhanced Access to Transportation Alternatives	Providing Integrated Real-time Info	Improved Equity	Improved System Performance + Operational Efficiencies
Freight		<ul style="list-style-type: none"> • Data environment capable of processing and making actionable decisions based on live connected vehicle data • Volumes of CV data over time • Count of CV-enabled vehicles on the roadway • Open access metrics and Application Programming Interface (API) calls • Number of connected fleet vehicles equipped, the types of datasets they are providing, and the frequency of that data being available to the traffic management center (TMC) 		<ul style="list-style-type: none"> • Percentage of uptime (fiber and network infrastructure) • Download and upload throughput and latency (lag) • Number of devices connected • Reduction in person hours of delay • Improvement in interagency communications and coordination • Reduction in turn times • More reliable/accurate data • Shared information with other U.S. ports

Table 9: Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) summary of current project performance measures for enhanced access to transportation alternatives, providing integrated real-time information, improved equity, and improved system performance goal areas (Continuation).

Goal Area	Enhanced Access to Transportation Alternatives	Providing Integrated Real-time Info	Improved Equity	Improved System Performance + Operational Efficiencies
Freight (Continued)		<ul style="list-style-type: none"> • Customer satisfaction • Number of truck parking spaces utilized • Number of users accessing the system • Publication of current turn times during the day • Waze® integration for appointment adjustment 		
Transit	<ul style="list-style-type: none"> • On time arrival percentage of buses • Percentage of zero or car-light households • Non-SOV mode share • Transit reliability 	<ul style="list-style-type: none"> • Transportation information (survey) • Traffic detection and management technology (number of real-time traffic detectors and active traffic signals) • Parking services (average parking search time) 		<ul style="list-style-type: none"> • Average weekday bike counts • Total trips provided to transit stations • On time arrival percentage of buses • Satisfaction rate of services • Transit reliability • GPS polling of 15 seconds • Headway management of vehicles/trains (other computer-aided dispatch (CAD)/automatic vehicle location (AVL) features <p>Enhanced vehicle monitoring features through the AVL/CAD computer</p>

Table 9: Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) summary of current project performance measures for enhanced access to transportation alternatives, providing integrated real-time information, improved equity, and improved system performance goal areas (Continuation).

Goal Area	Enhanced Access to Transportation Alternatives	Providing Integrated Real-time Info	Improved Equity	Improved System Performance + Operational Efficiencies
Transit (Continued)		<ul style="list-style-type: none"> • Improved Global Positioning System (GPS) polling • Availability of real-time information through phone apps and transit center screens 		

Source: FHWA

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