Texas Department of Transportation

COOPERATIVE AUTOMATED TRANSPORTATION PROGRAM PLAN

July 2022

CONTENTS

Interactive

EXECUTIVE SUMMARY

INTRODUCTION

TxDOT initiated the development of the CAT Strategic and CAT Program Plan ins May 2019, setting in motion the agency's CAT Program for coordinating CAT efforts across all TxDOT Divisions and Districts. The CAT Strategic Plan establishes TxDOT's CAT vision, mission, and goals, and identifies thirty-five strategies, across eight organizational focus areas, aimed to advance those goals.

While the CAT Strategic Plan focuses on high-level, forward-looking priorities, the CAT Program Plan provides a work plan with specific operational initiatives recommended to achieve the goals of the CAT program.

Together, these plans intend to serve as the foundation for decisions and investments that align with the agency's mission, vision, and goals for the use of CAT technology.

WHO WILL USE THIS PLAN?

TxDOT, as well as the broad community of technology providers, stakeholders, and agency partners will use this plan to promote the development, deployment, and implementation of CAT statewide.

PROGRAM PLAN DEVELOPMENT

The CAT Strategic Plan has identified numerous strategic initiatives that should be undertaken to prepare TxDOT for the emergence of CAT; anticipate the impacts of CAT on the transportation network, and; position the agency as a leader in emerging technologies and innovation.

The CAT Program Plan delves further into each strategy to provide recommended initiatives that will steer the design and development of incremental, near-term CAT-related projects and actions. The CAT Program Plan will serve as a roadmap for strategy implementation, with initiatives recommended to achieve the strategies outlined in the CAT Strategic Plan.

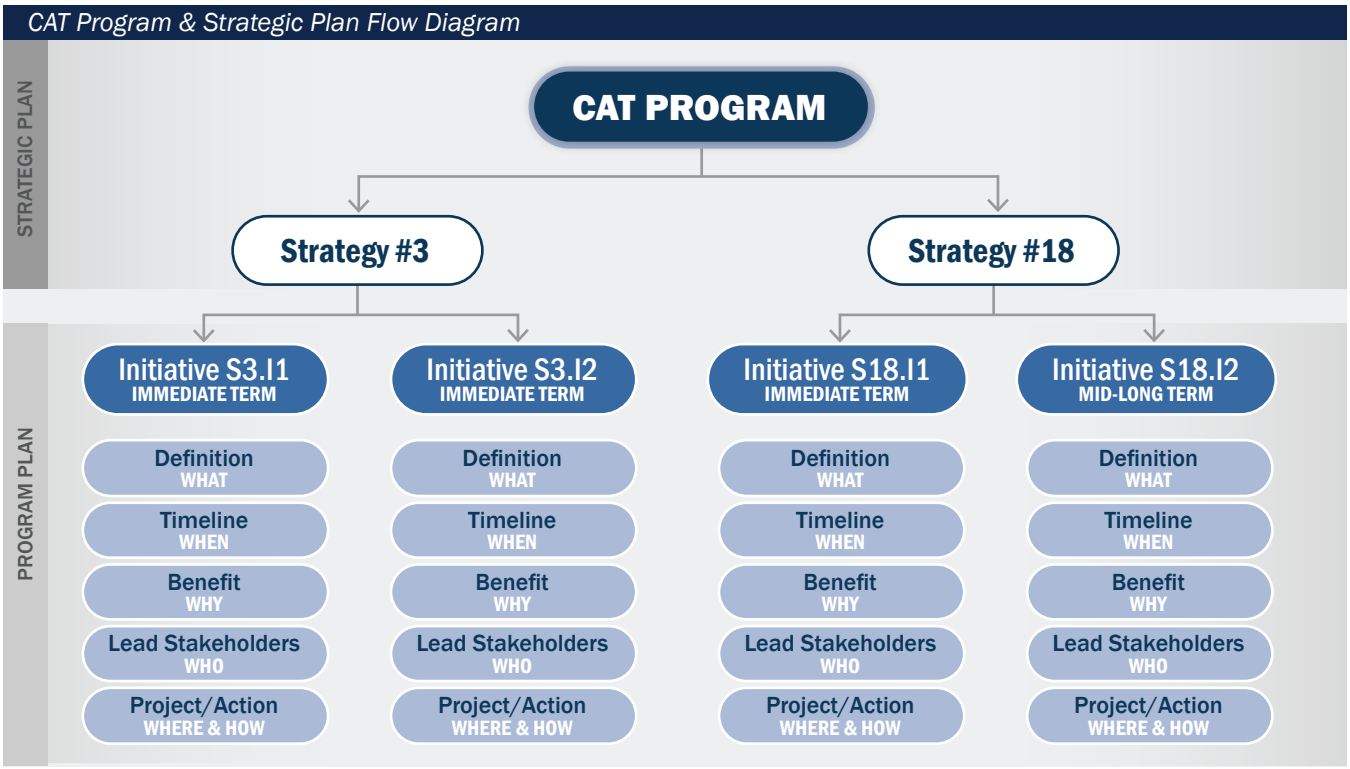
The plan outlines a CAT Organization which is intended and designed to accelerate and initiate CAT activities in alignment with the strategies. As programs and initiatives develop and evolve to deployment, the operational management will shift to appropriate divisions and districts for implementation and related operational activities. The CAT Organization will continue to spin-out these initiatives as they reach readiness for implementation.

TxDOT's CAT Program Plan provides 56 initiatives that seek to:

- Identify relevant projects or actions; and sequencing recommended to achieve each CAT strategy;
- Guide the evaluation of potential CAT projects;
- Provide performance metrics that may be used to measure progress and growth of TxDOT's CAT Program.

Each initiative aligns with, and is designed to achieve, one of the CAT Strategies put forth in the CAT Strategic Plan. Recommended projects and actions have also been developed for each initiative to suggest targeted efforts that may advance the initiative. The flow chart below depicts the development and organization of CAT initiatives, as well as the information detailed for each initiative. The initiative summary shown on the following page provides a list of all initiatives included in this plan, their lead stakeholders and the timeframes for their initiation.

CAT Program & Strategic Plan Flow Diagram



CAT PROGRAM ROAD MAP

	Initiatives		Lead Stakeholder	TIMEFRAME Immediate	Near	Mid-Long
POLICY	S1.I1	Establish a CAT Organization	ADM	●		
	S2.I1	Establish Open Channels of Communication and Information Exchange	CAT Organization	●		
	S3.I1	Identify CAT Security and Privacy Issues	CAT Organization	●		
	S3.I2	Develop and Adopt a Robust Security and Privacy Policy Framework	ITD	●		
	S4.I1	Identify and Remove Legislative Barriers	GOV		●	
	S5.I1	Update TxDOT Planning Processes that Influence	TPP		●	
	S5.I2	Develop Statewide Design Standards and Deployment Framework	CAT Organization		●	
	S5.I3	Assess and Develop Customized Strategies for Rural and Urban CAT Implementation	CAT Organization			●
	S6.I1	Coordinate Standard CAT Requirements with OEMs	CAT Organization		●	
	S6.I2	Ensure Existing Manuals and Standards Incorporate CAT	CAT Organization		●	
	S7.I1	Document Potential CAT Impacts on Border Crossings	CAT Organization			●
FISCAL RESPONSIBILITY	S8.I1	Identify and Make an Inventory of CAT Infrastructure	CAT Organization	●		
	S8.I2	Include CAT in Future Asset Management Practices	CAT Organization & MNT		●	
	S9.I1	Investigate and Document Utilizing Public Private Partnerships for CAT Implementation	CAT Organization	●		
	S9.I2	Facilitate Public Private Partnership	PFD	●		
	S10.I1	Monitor the Availability of CAT Grants	CAT Organization	●		
	S11.I1	Plan for Funding CAT Activities	ADM		●	
	S12.I1	Investigate and Document Potential Revenue Impacts Due to CAT	CAT Organization		●	
	S12.I2	Mitigate Potential Revenue Impacts	CAT Organization			●
COLLABORATION	S13.I1	Advance CAT Program at Internal Conferences	CAT Organization	●		
	S13.I2	Expand and Establish Leadership at External Conferences	CAT Organization		●	
	S14.I1	Establish CAT Challenge	CAT Organization		●	
	S14.I2	Build CAT Consortium	CAT Organization		●	
	S15.I1	Form TxDOT CAT Academy	CAT Organization			●
	S16.I1	Develop CAT Communication and Outreach Plan	CAT Organization	●		
	S16.I2	Host Recurring Internal and External CAT Forums	CAT Organization			●

	Initiatives		Lead Stakeholder	TIMEFRAME Immediate	Near	Mid-Long
INFRASTRUCTURE READINESS	S17.I1	Pilot CAT Technologies across Texas	CAT Organization	●		
	S17.I2	Establish Innovation Area(s)	CAT Organization			●
	S18.I1	Upgrade TxDOT Signals	TRF	●		
	S18.I2	Upgrade Traffic Management Systems	TRF			●
	S19.I1	Establish Priority Corridor Network Connectivity	ITD	●		
	S20.I1	Investigate and Document Urban Versus Rural Needs	CAT Organization		●	
	S20.I2	Integrate Future Communication Build-Out in Construction Projects	ITD & TRF		●	
	S21.I1	Plan for Complete Network Connectivity	CAT Organization		●	
	S22.I1	Evaluate Statewide Electric Vehicle Charging Needs	CAT Organization			●
	S22.I2	Facilitate Municipal EV Charging Partnerships	CAT Organization			●
	S23.I1	Research and Test CAV Fleet Scenarios	CAT Organization			●
SYSTEMS READINESS	S24.I1	Identify and Prioritize CAT Data Use Cases	CAT Organization	●		
	S25.I1	Understand and Prepare for the Challenges of CAT Data	CAT Organization	●		
	S25.I2	Modernize Existing Data Management Strategies	CAT Organization		●	
	S26.I1	Be “At the Table” for CAT Data Standards Development	CAT Organization	●		
	S26.I2	Harmonize CAT Data Standards for Texas	ITD	●		
	S27.I1	Create a CAT Clearinghouse	STR		●	
	S27.I2	Connect CAT Data to a Centralized Data Lake	CAT Organization		●	
MULTIMODAL	S28.I1	Develop Design Toolkit for Vulnerable Road Users	CAT Organization		●	
	S29.I1	Study Multimodal CAT Applications	CAT Organization		●	
	S29.I2	Explore Multimodal Partnership and Pilot Opportunities	CAT Organization			●
	S30.I1	Develop Next Generation Mobility Hub Concepts	RTI			●
MAINTENANCE & OPERATIONS	S31.I1	Explore CAT Opportunities to Enhance TxDOT Maintenance & Operations	CAT Organization	●		
	S32.I1	Study CAT Influence on TSMO Practices	CAT Organization	●		
	S32.I2	Use Real-Time CAT Data for Improved Operations and Management	CAT Organization		●	
	S32.I3	Integrate CAT into Regular Operations and Maintenance	CAT Organization		●	
	S33.I1	Synchronize CAT and Current Connected Work Zone Practices	CAT Organization		●	
PROCUREMENT	S34.I1	Proactively Update Active Procurement Lists	CAT Organization		●	
	S34.I2	Provide Flexible Bid Codes	CAT Organization		●	
	S35.I1	Support Effective and Flexible CAT Procurement Practices	CAT Organization		●	

KEY CONSIDERATIONS

This CAT Program Plan identifies actionable initiatives aligned with each strategy and focus area to break down incremental efforts that may be taken to achieve CAT strategies. Additionally, a roadmap depicting the timeline for launching proposed CAT initiatives is provided as a roadmap for implementation from immediate to long terms. In total, 56 initiatives have been developed for TxDOT's consideration. Top initiatives for immediate consideration in each focus area include:

- Policy: **Establish a CAT Organization** for clear and strong leadership (S1.I1)
- Fiscal Responsibility: **Plan for Funding CAT Activities** to work towards establishing a dedicated funding mechanism for transportation technology (S11.I1)
- Collaboration: **Develop CAT Communication and Outreach Plan** to develop understanding and support for CAT technologies (S16.I1)
- Infrastructure Readiness: Continue to **Pilot CAT Technologies** to prove the benefits of CAT applications across Texas (S17.I1)
- Systems Readiness: **Understand and Prepare for the Challenges of CAT Data** to protect and prepare TxDOT for a data-driven transportation future (S25.I1)
- Maintenance & Operations: **Explore CAT Opportunities to Enhance TxDOT Maintenance & Operations** to align CAT efforts with TxDOT's most pressing operational needs (S31.I1)

The initiatives in this Program Plan aim to guide TxDOT in taking a holistic approach to the planning and implementation of CAT across the State of Texas. Additionally, it provides a project evaluation framework for comparing potential CAT efforts, as well as quantifiable performance metrics to measure and monitor the achievement of initiatives and the overall CAT Program.

1 INTRODUCTION

The Texas Department of Transportation (TxDOT) aspires to deliver mobility, enable economic opportunity, and enhance the quality of life for all Texans. Additionally, in May 2019, TxDOT adopted a significant objective to end all fatalities on Texas roads by 2050, known as the "Road to Zero." Cooperative Automated Transportation (CAT) technologies have demonstrated their potential to substantially improve the movement of people and goods with numerous benefits, such as increases in safety, mobility, and access, to name a few. TxDOT initiated the development of a CAT Strategic Plan and a CAT Program Plan to guide thoughtful, strategic investments in CAT technologies that will help the agency achieve its vision and Road to Zero goal. The CAT Strategic Plan includes a collection of high-level, forward-looking strategies that seek to prepare the agency for the emergence of CAT technology; maximize the potential benefits of CAT; and, position the agency as a leader in emerging technologies and innovations. The CAT Program Plan will serve as a roadmap for strategy implementation, with initiatives recommended to achieve the strategies outlined in the CAT Strategic Plan. Having both a Strategic Plan and Program Plan will create alignment across TxDOT Divisions.

Purpose of the Plan

The purpose of this Program Plan is to:

- Identify specific initiatives and sequencing recommended to achieve each CAT strategy
- Guide the evaluation of potential CAT projects
- Provide performance metrics that may be used to measure progress and growth of TxDOT's CAT Program

TxDOT will use this Program Plan to pursue the integration of CAT into the agency's project lifecycle, from planning and design through operations and maintenance, as well as to inform the development of near-term CAT projects.

Terminology

The following terms are used regarding elements of the CAT Strategic Plan and CAT Program Plan:

- **Program:** A program is a set of related initiatives that are managed in a coordinated manner to obtain benefits not available from managing them individually. TxDOT's CAT Program encompasses coordinated efforts to integrate CAT technologies into the agency's transportation system.
- **Strategy:** A strategy is a high-level approach to achieving CAT Program goals. Strategies are provided in the CAT Strategic Plan.
- **Initiative:** An initiative is a concept put forth to advance specific CAT strategies. Initiatives may be broken down into one or more contributing projects or actions. Near-term initiatives recommended to achieve each CAT strategy are provided in this CAT Program Plan.
- **Project:** A project is a temporary endeavor undertaken to create a unique product, service or result. CAT projects are singular efforts, which may be split into phases, that have allocated funding and are designed to achieve specific deliverables or outcomes. CAT projects include efforts to integrate CAT into TxDOT's planning processes and operations, as well as location-specific CAT technology deployments. Examples of CAT projects include the following:
  - Connected Vehicle Priority System Deployment
  - Traffic Incident Management Application Deployment
  - CAT Data Dashboard
  - Innovation Corridor Deployment
- **Action:** An action is a task or step that must be undertaken to advance an initiative. Example CAT Actions are:
  - Create a Statewide Slogan for CAT Initiatives
  - Update Smart Work Zone Guidance
  - Create/Maintain a CAT Material Producer List and Prequalified Product List
- **CAT "Connect" Brief:** CAT "Connect" Briefs are succinct memorandums that investigate and document various knowledge gaps to better understand, plan for, and implement CAT efforts.

Evolution of CAT Program at TxDOT

TxDOT initiated the development of the CAT Strategic and CAT Program Plan in May 2019, setting in motion the agency's CAT Program for coordinating CAT efforts across all TxDOT Divisions. The CAT Strategic Plan establishes TxDOT's CAT vision, mission, and goals, and identifies thirty-five strategies, across eight organizational focus areas, aimed to advance those goals.

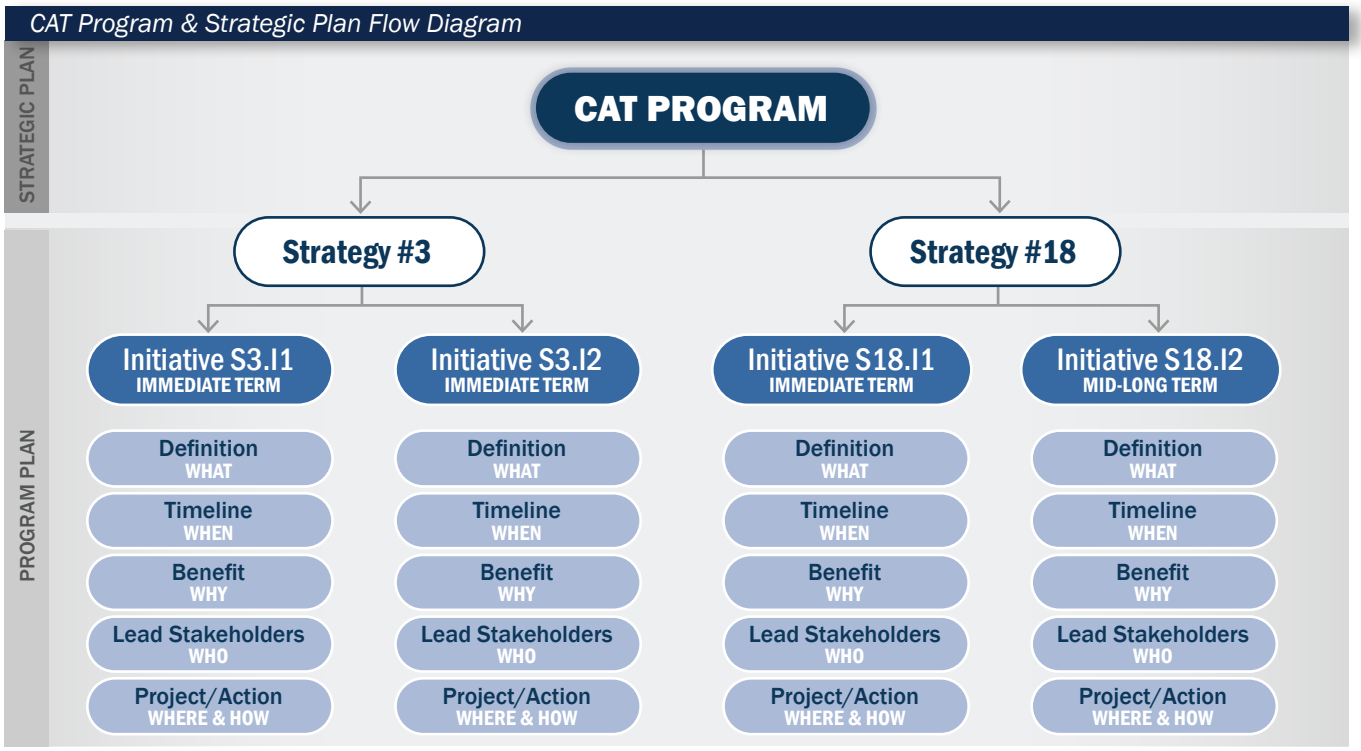
The CAT Program Plan delves further into each strategy to provide recommended initiatives that will steer the design and development of incremental, near-term CAT projects. Together, these plans intend to serve as the foundation for decisions and investments that align with the agency's mission, vision, and goals for the use of CAT technology.

Figure 1: Evolution of CAT Program at TxDOT

II
CAT PROGRAM INITIATIVES

The CAT Initiatives provided in this section build upon the Strategies put forth in the CAT Strategic Plan. Each Initiative aligns with and is designed to achieve one of the CAT Strategies. Recommended Projects and Actions have been developed for each Initiative to suggest targeted efforts that may advance the Initiative.

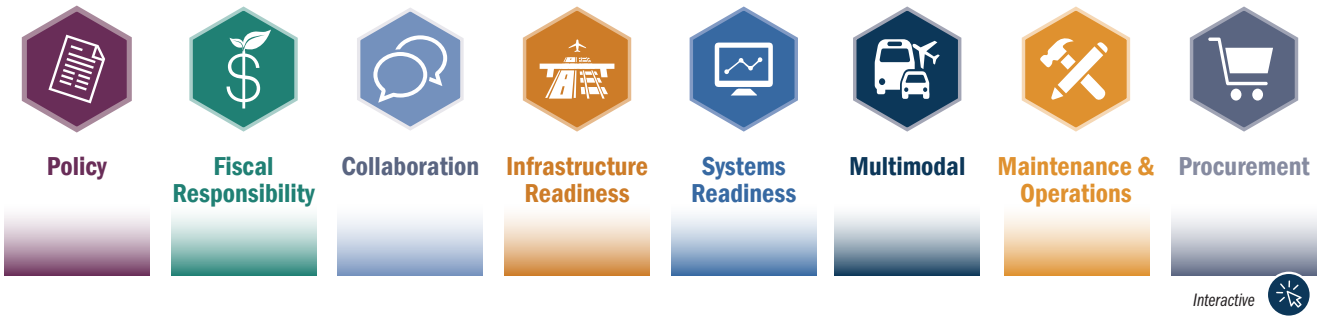
CAT Program & Strategic Plan Flow Diagram



How to Read this Program Plan

The 56 CAT Initiatives described in this section are organized by Focus Area and Strategy.

Focus Areas



Information provided for each Initiative includes:

Indexing & Codes

Indexing and Codes for each initiative, project, and action for easy reference.
Example:
S1.I1: Strategy 01 --> Initiative 01
S1.I1.P1: Strategy 01 --> Initiative 01 --> Project 01
S1.I2: Strategy 01 --> Initiative 02
S1.I2.A1: Strategy 01 --> Initiative 02 --> Action 01

Description

Brief description of the recommended initiative

Expected Benefits

Benefits of each initiative

Timeline to Initiate

A recommended timeframe for starting to execute the Initiative that aligns with TxDOT's planning processes

IMMEDIATE	NEAR	MID-LONG TERM
0-2 years	**2-4 years**	**4-10 years**
Letting Schedule	Statewide Transportation Improvement Program	Unified Transportation Program

Lead Stakeholders / Support Stakeholders

TxDOT Divisions and Districts that will lead and support each Initiative and its Projects/Actions. A complete list of TxDOT's Divisions is provided below

ALD	Alternative Delivery	MNT	Maintenance
AVN	Aviation	MRD	Maritime
BRG	Bridge	MTD	Materials and Tests
CIV	Civil Rights	OCC	Occupational Safety
CMD	Communications	PEPS	Professional Engineering Procurement Services
CMP	Compliance	PRO	Procurement
CST	Construction	PFD	Project Finance, Debt & Strategic Contracts
CSD	Contract Services	PTN	Public Transportation
DES	Design	RRD	Rail
ENV	Environmental Affairs	RTI	Research and Technology
FIN	Financial Management	ROW	Right of Way
FOD	Fleet Operations	STR	Strategic Planning
GCD	General Counsel	SSD	Support Services
GOV	Government Affairs	TRF	Traffic Safety
HRD	Human Resources	TPP	Transportation Planning and Programming
ITD	Information Technology	TPD	Transportation Programs
AUD	Internal Audit	TRV	Travel Information

Recommended CAT Project(s) or Action(s)

Recommended CAT Project(s) or Action(s) for advancing the Initiative

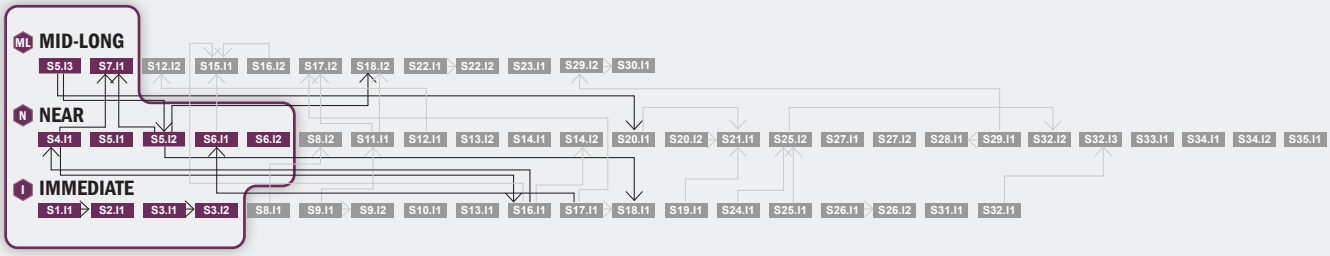
Initiative Dependencies

Initiative dependents shown in gray with at least partial reliance on the highlighted initiative

CAT Initiative Roadmap

A CAT Program Roadmap is provided at the end of this section to depict all 56 Initiatives, accompanying Projects/Actions, their timelines to initiate, and Initiative dependencies. Initiative dependencies are shown with arrows at the top of the Roadmap and indicate at least partial reliance on the completion of the precedent Initiative or Initiatives. This roadmap shall serve as a tool to assist the CAT Organization in coordinating and implementing CAT Projects and Actions.

POLICY INITIATIVES



CAT Program Road Map

I S1.I1 Establish A CAT Organization

- » S1.I1.A1: Instate the CAT Organization
- » S1.I1.P1: CAT "Connect" Brief: The TxDOT CAT Organization and Staffing Needs
- » S1.I1.P2: CAT Organization Annual Report
- » S1.I1.A2: Expand Current CAV Work Group to Form a Joint CAV-CAT Work Group
- » S1.I1.P3: CAT Organization Policy Manual

I S2.I1: Establish Open Channels of Communication and Information Exchange

- » S2.I1.P1: CAT "Connect" Brief: TxDOT Emerging Technology Planning Matrix
- » S2.I1.P2: CAT "Connect" Brief: Emerging Technology Initiatives Summary Sheet
- » S2.I1.A1: Appoint a CAT Technical Work Group
- » S2.I1.A2: Organize an Emerging Technology Initiatives Meeting Series
- » S2.I1.A3: Report: Prioritized Updates to Emerging Transportation Technology Plan

I S3.I1: Identify CAT Security and Privacy Issues

- » S3.I1.P1: CAT "Connect" Brief: CAT Security and Privacy Concerns
- » S3.I1.P2: Security Credential Management Systems Vendor RFI
- » S3.I1.P3: CAT "Connect" Brief: TxDOT's Security Baseline and Benchmark Study

I S3.I2: Develop and Adopt a Robust Security and Privacy Policy Framework

- » S3.I2.A1: Prepare and Adopt CAT Data Security and Privacy Policy Framework

N S4.I1: Identify and Remove Legislative Barriers

- » S4.I1.P1: CAT "Connect" Brief: Legal Concerns with CAT Implementation
- » S4.I1.A1: Engage General Counsel for Support

N S5.I1: Update TxDOT Planning Processes that Influence CAT

- » S5.I1.P1: CAT "Connect" Brief: Accommodating CAT in TxDOT's Planning Processes

N S5.I2: Develop Statewide Design Standards and Deployment Framework

- » S5.I2.P1: CAT "Connect" Brief: CAT Impact on Standard Operation
- » S5.I2.P2: CAT Implementation Playbook and Deployment Framework
- » S5.I2.P3: Statewide CAT Standards

ML S5.I3: Assess and Develop Customized Strategies for Rural and Urban CAT Implementation

- » S5.I3.P1: CAT "Connect" Brief: Planning for CAT – Rural Versus Urban Applications

N S6.I1: Coordinate Standard CAT Requirement with OEMs

- » S6.I1.A1: Deploy Infrastructure Standards Feedback Portal

N S6.I2: Ensure Existing Manuals and Standards Incorporate CAT

- » S6.I2.P1: CAT "Connect" Brief: Evaluation of CAT Impact on Manuals and Standards
- » S6.I2.A1: Report: CAT Updates to TxDOT Manuals and Standards

ML S7.I1: Document Potential CAT Impacts on Border Crossings

- » S7.I1.P1: CAT "Connect" Brief: CAT and Border Crossing Impacts
- » S7.I1.P2: CAT "Connect" Brief: Border Crossing Guide for Automated Freight

Interactive

S1.I1: ORGANIZE AROUND A CAT PROGRAM

DESCRIPTION: The success of the CAT Program is contingent upon how well the initiatives get executed. To ensure strong leadership and effective collaboration across TxDOT, the agency should resource and organize dedicated staff to lead and coordinate the execution of CAT activities in Texas.

The CAT Organization should have clear lines of reporting and responsibility to TxDOT Administration and provide leadership, visibility, and accountability when guiding the CAT Program. The CAT Organization should also be responsible for:

- Reporting to TxDOT Administration on CAT progress.
- Coordinating regularly with Districts, Divisions, partners, and consultants involved with various CAT initiatives.
- Vetting potential CAT projects and deciding which projects should move forward to be evaluated, through discussion with MPOs, TxDOT District leadership, local officials, TxDOT planning staff, and others as deemed appropriate.

The CAT Organization may include liaisons from key stakeholders such as DES, ITD, MNT, STR, TPP, TRF Divisions that lead and represent the CAV Work Group. A joint CAV-CAT Work Group of Subject Matter Experts (SMEs) representing a diverse range of TxDOT Districts and Divisions should be created to encourage cross-divisional collaboration. The Work Group should share information on CAT technologies, including research and grant applications, deployments, resources, and data sharing opportunities. Additionally, to help mitigate silos, these work group members / liaisons should meet at least once a week to coordinate the implementation of the current and selection of planned CAT projects.

CAT ORGANIZATION: resourced, dedicated staff leading CAT strategies across the State
CAV-CAT WORK GROUP: group of subject matter experts across TxDOT Districts and Divisions that collaborate to share CAV and CAT resources, data and lessons learned
CAT TECHNICAL WORK GROUP: group of CAT effort leaders and project managers that coordinate ongoing CAT implementation efforts

EXPECTED BENEFITS: Organizing around CAT will assist in instituting fundamental changes within the agency to ensure the effective implementation of CAT initiatives. Dedicating resources and staff will provide sustainable support and leadership of CAT initiatives that allow TxDOT to manage efforts effectively. Dedicated staff will help convey the strategic vision and value of the CAT efforts, further providing a singular contact for legislators, partner agencies, internal staff, and consultants on CAT related matters.

INITIATIVE DETAILS:

Timeline to Initiate:
Immediate Term (0-2 years)

Lead Stakeholder(s):
ADM

Support Stakeholder(s):
FIN, HRD, STR, TPD, TPP, and TRF

RECOMMENDED PROJECT(S)/ ACTION(S):

S1.I1.P1: CAT "Connect" Brief: The TxDOT CAT Organization and Staffing Needs

PROJECT: This brief should provide a summary of the organizational and reporting structure necessary to organize around CAT. TxDOT or a Consultant should define the roles, responsibilities, and reporting structure. The brief should also include a staffing needs assessment and recommendations for resourcing the organization.

GOAL: Provide TxDOT with a reference document for CAT Program organization with defined roles and responsibilities for dedicated staff.

EXPECTED OUTCOME: CAT "Connect" Brief (1-2 page) document.

S1.I1.A1: Instate the CAT Organization

ACTION: TxDOT should establish and resource the CAT Program Organization under TxDOT Administration. Staff should be gradually instated per recommendations from the CAT "Connect" Brief: The TxDOT CAT Program Organization and Staffing Needs.

GOAL: Establish a resourced and dedicated organization framework for CAT efforts and leadership.

S1.I1.P2: CAT Organization Annual Report

PROJECT: TxDOT should prepare a report annually to establish and provide CAT Program performance measures achieved by the organized staff. Additionally, the annual report should include a CAT Effort Summary template to report information on ongoing CAT efforts across Texas, such as project team, status, budget, schedule, and benefits.

GOAL: Provide information on CAT Organization performance and a template for reporting CAT efforts undertaken across Texas.

EXPECTED OUTCOME: Technical Report (5-15 page) and a Report Template (1-2 page) for CAT Effort Summaries.

S1.I1.A2: Expand Current CAV Work Group to Form a Joint CAV-CAT Work Group

ACTION: The CAT Organization should reassess and expand the functionality of the CAV Work Group to include CAT Subject Matter Experts (SMEs) across Divisions and Districts. The CAT Organization should work with TxDOT Administration to formalize the scope and functions of the joint CAV-CAT Work Group within the TxDOT Enterprise Governance structure. A charter should be established to define its membership, activities and reporting structure up through the Tactical Steering Committee (TSC) to the Executive Steering Committee (ESC).

GOAL: Support balanced representation of Divisions and Districts across TxDOT.

S1.I1.P3: CAT Organization Policy Manual

PROJECT: TxDOT should prepare a CAT Organization Policy Manual to provide information regarding the policies and standard operating procedures related to the organization of resources and staff.

GOAL: Establish guidelines and best practices in the workplace.

EXPECTED OUTCOME: CAT Organization Policy Manual.

S2.I1: ESTABLISH OPEN CHANNELS OF COMMUNICATION AND INFORMATION EXCHANGE

DESCRIPTION: TxDOT should establish a CAT Technical Work Group with direct lines of communication across the emerging technology planning efforts, to support the ability to harmonize goals and exchange information across related projects and plans. The CAT Technical Work Group will be responsible for regularly coordinating emerging technology planning efforts with the joint CAV-CAT Work Group to ensure TxDOT's multiple innovation-based plans have consistent messaging. The CAT Technical Work Group will comprise of project managers and consultants handling various agency transportation technology efforts (ETTP, FNTOP, CAT, etc.).

The CAT Organization should organize regular meetings between the joint CAV-CAT Work Group and the CAT Technical Work Group to discuss emerging transportation technology trends and coordinate the implementation of CAT initiatives and emerging technology plans.

EXPECTED BENEFITS: Establishing a CAT Technical Work Group will ensure that the most up-to-date information is conveyed about on-going CAT projects and emerging technology plans.

INITIATIVE DETAILS:

Timeline to Initiate:
Immediate Term (0-2 years)

Lead Stakeholder(s):
CAT Organization

Support Stakeholder(s):
CAV Work Group, CMD Districts, STR, TPP, and TRF

RECOMMENDED PROJECT(S)/ ACTION(S):

S2.I1.P1: CAT "Connect" Brief: TxDOT Emerging Technology Planning Matrix

PROJECT: This brief should provide an implementation summary of all the emerging technology plans that are being prepared by the agency. Before approving the plans, TxDOT will develop an emerging technology planning matrix to ensure the plans work in unison and do not conflict.

GOAL: Provide TxDOT with a reference document for aligning all emerging technology plans being prepared by the agency.

EXPECTED OUTCOME: Project Planning Matrix and CAT "Connect" Brief (1-2 page) summary document.

S2.I1.P2: CAT "Connect" Brief: Emerging Technology Initiatives Summary Sheet

PROJECT: This brief should provide a list of all ongoing and upcoming emerging technology efforts along with reference information such as project team, status, budget, schedule, etc.

GOAL: Provide TxDOT and external stakeholders such as peer agencies, cities, MPOs, and the general public with a reference document on CAT related efforts undertaken across Texas.

EXPECTED OUTCOME: Technical Report and a summary sheet (1-2 page) per project.

S2.I1.A1: Appoint a CAT Technical Work Group

ACTION: The CAT Organization should appoint a CAT Technical Work Group, comprising of project managers from various TxDOT Divisions and Districts, as well as consultants handling various agency transportation technology efforts across Texas.

GOAL: Enhance coordination and reporting of active CAT activities across Texas.

S2.I1.A2: Organize an Emerging Technology Initiatives Meeting Series

ACTION: The CAT Organization should host a monthly meeting series between the joint CAV-CAT Work Group and the CAT Technical Work Group to discuss and provide updates on various emerging technology initiatives.

GOAL: Enhanced communication and exchange of information between TxDOT Divisions and Districts regarding the implementation of emerging technology initiatives.

S2.I1.A3: Report: Prioritized Updates to Emerging Transportation Technology Plan

ACTION: The CAT Organization should create a report highlighting the necessary updates required to the Emerging Transportation Technology Plan, based on the development of the CAT industry.

GOAL: Provide updates and inputs to the Emerging Transportation Technology Plan to keep it current.

S3.I1: IDENTIFY CAT SECURITY AND PRIVACY ISSUES

DESCRIPTION: CAT technologies will utilize a variety of technology platforms and software that would generate a large amount of data. Before adopting a robust security and policy framework with regards to CAT data collection, storage, use, and distribution, TxDOT should identify and document the current landscape of networking challenges and cybersecurity risks associated with CAT technology. Through the documentation, TxDOT will have a better understanding of the current state of data within the agency and the best practices to reduce the risk of compromise to the confidentiality, integrity, and availability of agency systems.

EXPECTED BENEFITS: Documenting CAT security and privacy issues will provide TxDOT a better understanding of the risks and needs associated with the implementation of CAT technology. The documentation will equip TxDOT to make decisions required to enhance agency-wide information security and privacy programs.

INITIATIVE DETAILS:

Timeline to Initiate:
Immediate Term (0-2 years)

Lead Stakeholder(s):
CAT Organization

Support Stakeholder(s):
CMD, GCD, ITD, and TRF

RECOMMENDED PROJECT(S)/ ACTION(S):

S3.I1.P1: CAT "Connect" Brief: CAT Security and Privacy Concerns

PROJECT: This brief should provide a summary of the evaluation of security and privacy concerns within the agency as a result of implementing CAT technology. The document will include a SWOT analysis of the agency's preparedness for CAT technology.

GOAL: Provide TxDOT with a reference document outlining the key areas of CAT security and privacy concernscy.

EXPECTED OUTCOME: Technical Report and CAT "Connect" Brief (1-2 page) summary document.

S3.I1.P2: Security Credential Management Systems Vendor RFI

PROJECT: The CAT Organization and ITD should develop and release a request for information (RFI) from network service providers/vendors regarding their security credential management systems.

GOAL: Release a vendor RFI to obtain the latest available security credential management systems in preparation for future acquisition.

EXPECTED OUTCOME: RFI Document.

S3.I1.P3: CAT "Connect" Brief: TxDOT's Security Baseline and Benchmark Study

PROJECT: This brief should include a summary of the Security Credential Management Systems RFI submittals as well as a summary of TxDOT's security baseline. It should also provide a roadmap of improvements necessary to promote confidentiality, integrity, and the availability of data, in keeping with current security system market availability.

GOAL: Benchmark TxDOT's security network against market standards

EXPECTED OUTCOME: Technical Report and CAT "Connect" Brief (1-2 page) document.

S3.I2:DEVELOP AND ADOPT A ROBUST SECURITY AND PRIVACY POLICY FRAMEWORK

DESCRIPTION: Establishing and maintaining a culture of information security and privacy can reduce the likelihood of cybersecurity or privacy violations. The CAT Organization should work with the Information Technology Division and General Counsel Division to implement cybersecurity and privacy frameworks. The collaboration will allow the agency to identify risks to systems, deploy protections to address possible threats, detect malicious actors attempting to circumvent the protections, have a repeatable method for responding to detected breaches, and be able to restore systems in the event of a hardware failure, cyberattack, or inability to access facilities physically.

EXPECTED BENEFITS: Robust security and privacy policies will prepare TxDOT for potential threats posed by groups or individuals who may maliciously exploit CAT applications and will also help TxDOT address public concerns over security and privacy.

INITIATIVE DETAILS:

Timeline to Initiate:

Immediate Term (0-2 years)

Lead Stakeholder(s):

ITD

Support Stakeholder(s):

CAT Organization, CMD, Districts, GCD, TRF, and TRV

RECOMMENDED PROJECT(S)/ ACTION(S):

S3.I2.A1: Prepare and Adopt CAT Data Security and Privacy Policy Framework

ACTION: The CAT Organization should work with the Information Technology Division and General Counsel to prepare and adopt a policy framework necessary to support CAT technologies. The policy framework should consider the management of data (collection, storage, and sharing), security credentials, advanced threat detection and prevention, vulnerability management, security logging, and monitoring, and incident response plan capabilities to protect public safety and privacy.

GOAL: Address internal and external data privacy concerns and garner trust in the measures taken to protect the public and TxDOT.

S4.I1: IDENTIFY AND REMOVE LEGISLATIVE BARRIERS

DESCRIPTION: As CAT technologies begin testing phases, TxDOT should consider the legal and administrative requirements for these technologies to operate within the state. Through this effort, TxDOT should monitor and analyze federal and state rulemaking in the form of a legal brief. The statutory summary would include a current policy assessment (strengths, gaps, and weaknesses) and review of relevant laws that may affect the Texas Transportation Code, CAT and CAV operations on Texas highways, cybersecurity, etc.

EXPECTED BENEFITS: Reviewing current legal requirements will provide the most up-to-date information on state and federal rulemaking, ensuring a clear understanding of policy implications on funding, pilot testing, and deployment.

INITIATIVE DETAILS:

Timeline to Initiate:
Near Term (2-4 years)

Lead Stakeholder(s):
GOV

Support Stakeholder(s):
CAT Organization, Districts, GCD, STR, and TRF

RECOMMENDED PROJECT(S)/ ACTION(S):

S4.I1.P1: CAT "Connect" Brief: Legal Concerns with CAT Implementation

PROJECT: This brief should provide a detailed review of state and federal rulemaking that impacts CAT implementation. Through this effort, legislation from other states could be reviewed to identify legislative actions that support CAT testing and deployment.

GOAL: Provide TxDOT with a legal brief reference document that identifies state and federal rulemaking that could impact CAT implementation.

EXPECTED OUTCOME: CAT "Connect" Brief (1-2 page) summary document.

S4.I1.A1: Engage General Council for Support

ACTION: The CAT Organization should regularly engage General Counsel Division on CAT technology advancements.

GOAL: Garner legislative support for the research and deployment of CAT technologies across Texas.

S5.I1: UPDATE TXDOT PLANNING PROCESSES THAT INFLUENCE CAT

DESCRIPTION: TxDOT should review and revise the current planning process documentation to integrate CAT technologies by making CAT deployments a strategic priority as part of the annual Unified Transportation Planning. The TxDOT planning processes should prioritize CAT consideration for projects in all funding categories, including Congestion, Mitigation/Air Quality Improvement, Metropolitan and Urban Area Corridor Projects, and Safety funding categories.

EXPECTED BENEFITS: Updating planning documentation will ensure the effective integration of CAT deployments into the current TxDOT planning process.

INITIATIVE DETAILS:

Timeline to Initiate:
Near Term (2-4 years)

Lead Stakeholder(s):
TPP

Support Stakeholder(s):
CAT Organization, Districts, FIN, and STR

RECOMMENDED PROJECT(S)/ ACTION(S):

S5.I1.P1: CAT "Connect" Brief: Accommodating CAT in TxDOT's Planning Processes

PROJECT: This brief should provide a summary of the updates required within the current planning process to accommodate CAT deployments.

GOAL: Ensure CAT deployments adhere to TxDOT's project development and planning processes.

EXPECTED OUTCOME: Technical Report and CAT "Connect" Brief (1-2 page) document.

S5.I2: DEVELOP STATEWIDE DESIGN STANDARDS AND DEPLOYMENT FRAMEWORK

DESCRIPTION: TxDOT should update planning, engineering, and construction practices to accommodate the expansion of CAT technologies. TxDOT should develop a statewide guidance framework for defining, planning for, and implementing statewide CAT projects that reference relevant CAT design standards and policies. This guidance would include procedures for uniform deployment of CAT projects and consistent implementation of CAT design standards.

EXPECTED BENEFITS: Developing CAT design standards would help achieve statewide planning and implementation consistency across varying CAT projects.

INITIATIVE DETAILS:

Timeline to Initiate:
Near Term (2-4 years)

Lead Stakeholder(s):
CAT Organization

Support Stakeholder(s):
DES, Districts, MTD, RTI, and TRF

RECOMMENDED PROJECT(S)/ ACTION(S):

S5.I2.P1: CAT "Connect" Brief: CAT Impact on Standard Operations

PROJECT: This brief should identify standard operating procedures across TxDOT Divisions that may be affected by ongoing and planned CAT efforts, as well as the level of CAT impact on those procedures, in preparation for making modifications as needed.

GOAL: Identify and prepare for the impact of CAT applications on internal policies and operations.

EXPECTED OUTCOME: CAT "Connect" Brief (1-2 page) document.

S5.I2.P2: CAT Implementation Playbook and Deployment Framework

PROJECT: TxDOT or a Consultant should create a CAT Implementation Playbook that includes a framework for deploying CAT technologies, process workflows, and operational impacts.

GOAL: Provide implementation guidance to TxDOT Divisions and Districts.

EXPECTED OUTCOME: Technical Report

S5.I2.P3: Statewide CAT Standards

PROJECT: TxDOT or a Consultant should initiate the development of statewide CAT standards to help Districts with the uniform deployment of CAT projects. These standards may build upon designs and specifications used for past and ongoing CAT efforts. Codifying these standards will ensure consistency among CAT projects and help inform future updates to the TxDOT design manuals and standards.

GOAL: Develop CAT standards necessary for uniform statewide deployment.

EXPECTED OUTCOME: Statewide CAT Standards and Specifications

S5.I3: ASSESS AND DEVELOP CUSTOMIZED STRATEGIES FOR RURAL AND URBAN CAT IMPLEMENTATION

DESCRIPTION: Deployment of technological advancements like autonomous vehicles can vary dramatically between different geographic areas. There are still many questions surrounding how CAT will differ between urban and rural areas or Districts. TxDOT should investigate and document the differences and provide comparative CAT application scenarios. Scenarios can help the agency test multiple CAT applications within an urban or a rural setting.

EXPECTED BENEFITS: Achieve planning and implementation consistency across CAT projects that span rural and urban Districts with varying scales.

INITIATIVE DETAILS:

Timeline to Initiate:
Mid-long Term (>4 years)

Lead Stakeholder(s):
CAT Organization

Support Stakeholder(s):
Districts, STR, TPP, and TRF

RECOMMENDED PROJECT(S)/ ACTION(S):

S5.I3.P1: CAT "Connect" Brief: Planning for CAT – Rural Versus Urban Applications

PROJECT: This brief should summarize the differences between rural and urban CAT implementation, including actions related to the CAT application selection process, identifying sustainable funding sources, and implementing mode-specific strategies within rural and urban areas.

GOAL: Assess CAT application needs for rural and urban areas.

EXPECTED OUTCOME: Technical Report and CAT "Connect" Brief (1-2 page) document.

S6.I1: COORDINATE STANDARD CAT REQUIREMENTS WITH OEMS

DESCRIPTION: Several pilots have been initiated by OEMs or technology companies on Texas roadways; each is an opportunity for TxDOT and its partners to learn effective strategies for deploying new transportation technologies. Partnering with OEMs and automated driving system developers would help TxDOT to understand and prepare for the CAT standards required for the technologies being tested.

EXPECTED BENEFITS: Coordinating with OEMs would help TxDOT gather inputs and assess necessary updates to design and installation standards to accommodate the expansion of the CAT.

INITIATIVE DETAILS:

Timeline to Initiate:
Near Term (2-4 years)

Lead Stakeholder(s):
CAT Organization

Support Stakeholder(s):
CMD, DES, ITD, MTD, RTI, and TRF

RECOMMENDED PROJECT(S)/ ACTION(S):

S6.I1.A1: Deploy Infrastructure Standards Feedback Portal

ACTION: The CAT Organization should develop a feedback portal where OEMs and automated driving system developers can provide inputs to typical infrastructure design and installation standards. The feedback portal will act as a repository of CAT standards (design and installation) that would regularly be updated based on inputs from OEMs and other industry partners.

GOAL: Promote coordination and collaboration between TxDOT and OEMs.

S6.I2: ENSURE EXISTING MANUALS AND STANDARDS INCORPORATE CAT

DESCRIPTION: With the increase in CAT technology pilots occurring in Texas and around the country, it becomes necessary to ensure that existing manuals and standards incorporate CAT. TxDOT should assess updates required for physical and digital infrastructure standards to accommodate the expansion of CAT technologies. TxDOT should catalog and update design standards and manuals impacted by CAT applications and publish them on a rolling basis.

EXPECTED BENEFITS: Aligning existing manuals and TxDOT standards with requirements for CAT implementation ensures that Texas roadways can support and streamline future CAT projects and maximizes the safe adoption of CAT.

INITIATIVE DETAILS:

Timeline to Initiate:
Near Term (2-4 years)

Lead Stakeholder(s):
CAT Organization

Support Stakeholder(s):
BRG, CMD, CST, DES, Districts, ITD, MNT, MTD, ROW, and TRF

RECOMMENDED PROJECT(S)/ ACTION(S):

S6.I2.P1: CAT "Connect" Brief: Evaluation of CAT Impact on Manuals and Standards

PROJECT: This brief should provide a summary of existing manuals and standards to incorporate CAT technologies. The CAT Organization should explore the impact of CAT applications on the following areas:

- Design and maintenance standards for bridges, pavement, signage, and pavement markings;
- Installation standards for roadside equipment;
- Traffic design standards related to lane configuration;
- Work zone standards.

GOAL: Identify the impact of CAT applications on design manuals and standards.

EXPECTED OUTCOME: CAT "Connect" Brief (1-2 page) document.

S6.I2.A1: Report: CAT Updates to TxDOT Manuals and Standards

ACTION: The CAT Organization should develop a report that identifies priority updates to TxDOT manuals and standards for streamlining CAT implementation. The report should highlight a phased approach to updating manuals and standards impacted by CAT deployment.

GOAL: Evaluate necessary updates required to ensure quick deployment of CAT infrastructure.

S7.I1: DOCUMENT POTENTIAL CAT IMPACTS ON BORDER CROSSINGS

DESCRIPTION: The risk of the rapid evolution of CAT technologies on border crossings is unknown. TxDOT should investigate border crossing policies and procedures that may be affected by the implementation of CAT technology. The investigation should:

- Identify policy constraints due to CAT deployment;
- Identify stakeholders and type of coordination necessary for international and state border crossing;
- Examine the border crossing procedures for air, water, and ground-borne freight and passenger travel that utilizes CAT technology.

EXPECTED BENEFITS: Studying these implications will allow TxDOT to prepare for and begin to address policy changes that would support the deployment of CAT technology at the border crossings.

INITIATIVE DETAILS:

Timeline to Initiate:
Mid-long Term (>4 years)

Lead Stakeholder(s):
CAT Organization

Support Stakeholder(s):
AVN, Districts, GCD, GOV, MRD, PTN, RTI, TPP, and TRF

RECOMMENDED PROJECT(S)/ ACTION(S):

S7.I1.P1: CAT "Connect" Brief: CAT and Border Crossing Impacts

PROJECT: This brief should provide a summary of the border crossing policies and procedures that may be affected by the implementation of CAT technology.

GOAL: Provide TxDOT a better understanding of necessary policy changes required to support the deployment of CAT technology at the border crossing.

EXPECTED OUTCOME: CAT "Connect" Brief (5-15 page) document.

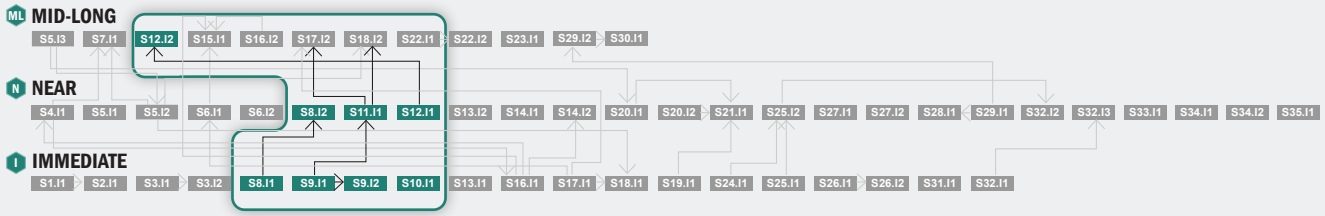
S7.I1.P2: CAT "Connect" Brief: Border Crossing Guide for Automated Freight

PROJECT: This brief should provide a summary of the border crossing procedures for automated freight (mainly trucks). TxDOT or a Consultant should provide a step-by-step guide for automated trucks to cross international and state borders to ensure they follow safety and security regulations.

GOAL: Develop a detailed border crossing guide to ensure the safety of people and goods.

EXPECTED OUTCOME: CAT "Connect" Brief (1-2 page) document.

FISCAL RESPONSIBILITY INITIATIVES



CAT Program Road Map

I S8.I1 Identify and Make an Inventory of CAT Infrastructure

- S8.I1.P1: CAT "Connect" Brief: What is CAT Infrastructure
- S8.I1.P2: Statewide CAT Infrastructure Inventory

N S8.I2: Include CAT in Future Asset Management Practices

- S8.I2.P1: CAT "Connect" Brief: CAT and TxDOT Asset Management Practices
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I S9.I1: Investigate and Document Utilizing Public Private Partnerships for CAT Implementation

- S9.I1.P1: CAT "Connect" Brief: CAT-Public-Private-Partnership (CPPP) Barriers and Opportunities
- S9.I1.A1: Create Private-Public-Partnership Subcommittee within the Texas CAV Task Force

I S9.I2: Facilitate Public Private Partnerships

- S9.I2.P1: CAT "Connect" Brief: Encouraging CAT Public-Private-Partnership
- S9.I2.A1: Develop Public-Private-Partnership Application Mechanism/Portal

I S10.I1: Monitor the Availability of CAT Grants

- S10.I1.P1: CAT "Connect" Brief: Synthesis of Available Grant Funding for CAT
- S10.I1.A1: Establish a Periodic TxDOT District Innovation Call

N S11.I1: Plan for Funding CAT Activities

- S11.I1.P1: CAT "Connect" Brief: How Can TxDOT Fund Innovation?
- S11.I1.P2: Develop Internal CAT Funding Plan/Framework
- S11.I1.A1: Hold Internal CAT Funding Workshop with TxDOT and Division Leadership

N S12.I1: Investigate and Document Potential Revenue Impacts Due to CAT

- S12.I1.P1: CAT "Connect" Brief: The Intersection of CAT, Electric Vehicles, and Mobility-as-a-Service
- S12.I1.P2: CAT "Connect" Brief: Will CAT Impact Revenue?
- S12.I1.P3: Analysis of Revenue Impacts of CAT (RTI - Formal Research)

ML S12.I2: Mitigate Potential Revenue Impacts

- S12.I2.P1: Alternative Revenue Pilot Project
- S12.I2.P2: Develop Formal CAT Business (Revenue Mitigation) Plan

Interactive

S8.I1: IDENTIFY AND MAKE AN INVENTORY OF CAT INFRASTRUCTURE

DESCRIPTION: In order to establish a CAT infrastructure baseline, TxDOT should first identify and understand what it should consider "CAT Infrastructure". The agency may then prepare for the integration of those assets into existing asset management practices. Potential CAT infrastructure includes both physical and digital assets such as: CAT Communication (Fiber, Wireline, Wireless, V2I, V2V); CAT Devices & Data Needs (Radios, IT Infrastructure); Vehicle Performance/Needs (Ex. Pavement Markings); and User Needs (Traveler Information / DMS / SPAT messages).

EXPECTED BENEFITS: Defining CAT infrastructure will allow TxDOT to better understand the state of its existing CAT assets in preparation for potential improvements to asset management practices.

INITIATIVE DETAILS:

Timeline to Initiate:
Immediate Term (0-2 years)

Lead Stakeholder(s):
CAT Organization

Support Stakeholder(s):
CST, Districts, ITD, MNT, ROW, TPP, and TRF

RECOMMENDED PROJECT(S)/ ACTION(S):

S8.I1.P1: CAT "Connect" Brief: What is CAT Infrastructure

PROJECT: This brief should define CAT infrastructure. TxDOT or a Consultant would investigate CAT needs, identify infrastructure related to CAT implementation, and develop a CAT infrastructure matrix including asset type, life cycle, cost, etc.

GOAL: Define CAT infrastructure and characteristics.

EXPECTED OUTCOME: CAT "Connect" Brief (1-2 page) document.

S8.I1.P2: Statewide CAT Infrastructure Inventory

PROJECT: Utilizing the work published in S8.I1.P1, TxDOT should develop a current inventory of CAT infrastructure. The inventory data set of CAT infrastructure should include attributes such as age, location, District, etc. to aid in determining the remaining usable life. This data could be mined from existing asset management databases but should be confirmed.

GOAL: Develop a benchmark inventory of existing CAT infrastructure and characteristics.

EXPECTED OUTCOME: Applicable Data Dictionary, Data Set, and GIS file.

S8.I2: INCLUDE CAT IN FUTURE ASSET MANAGEMENT PRACTICES

DESCRIPTION: Utilizing the Inventory of CAT Infrastructure deliverables, TxDOT should integrate findings and prepare to inventory CAT infrastructure on an annual basis. A regularly updated inventory of CAT infrastructure should be available to interested Districts and Divisions to facilitate the understanding of and improvement of statewide CAT infrastructure.

EXPECTED BENEFITS: Highlighting CAT infrastructure provides an annual snapshot or benchmark and provides information that could be used to plan for procurement and funding. Cataloging CAT assets will save TxDOT staff time, facilitating planning, maintenance and information sharing.

INITIATIVE DETAILS:

Timeline to Initiate:
Near Term (2-4 years)

Lead Stakeholder(s):
CAT Organization and MNT

Support Stakeholder(s):
CST, Districts, ITD, ROW, TPP, and TRF

RECOMMENDED PROJECT(S)/ ACTION(S):

S8.I2.P1: CAT "Connect" Brief: CAT and TxDOT Asset Management Practices

PROJECT: This brief should provide recommendations for including CAT infrastructure in existing Asset Management Practices. TxDOT or a Consultant would review TxDOT's current asset management practices and provide recommendation for integrating CAT infrastructure. Recommendation could include changes to the data dictionary, classification practices and reporting.

GOAL: Ensure that CAT infrastructure asset data can be easily mined and used by the CAT Organization or responsible staff.

EXPECTED OUTCOME: CAT "Connect" Brief (1-2 page) document.

S8.I2.A1: Update Asset Management Planning Documents

ACTION: TxDOT should build on S8.I2.P1 recommendation by updating any existing asset management planning or procedural documents and practices.

GOAL: Policy and procedural inclusion of recommended CAT Infrastructure Asset Management Recommendations.

EXPECTED OUTCOME: Update of written policies and procedures.

S9.I1: INVESTIGATE AND DOCUMENT UTILIZING PUBLIC PRIVATE PARTNERSHIPS FOR CAT IMPLEMENTATION

DESCRIPTION: TxDOT should investigate the impacts and influence that Public Private Partnerships (PPPs) could have on CAT and document helpful findings that can be shared statewide. TxDOT should also compile documentation regarding the agency's PPP processes and agreements to help inform and streamline future CAT PPPs.

EXPECTED BENEFITS: Provides supporting information for developing additional PPPs for CAT.

INITIATIVE DETAILS:

Timeline to Initiate:
Immediate Term (0-2 years)

Lead Stakeholder(s):
CAT Organization

Support Stakeholder(s):
FIN, ALD, PFD and STR

RECOMMENDED PROJECT(S)/ ACTION(S):

S9.I1.P1: CAT "Connect" Brief: CAT-Public-Private-Partnership (CPPP) Barriers and Opportunities

PROJECT: This brief should outline barriers and opportunities for CAT partnerships. The brief should investigate TxDOT's current PPP practices and determine barriers from both Public and Private viewpoints. Determining these barriers may require one-on-one interviews with TxDOT and private CAT vendors/consultants. For example, OEMs are traditionally hesitant to provide information. From these interviews, TxDOT or a Consultant will highlight potential opportunities with attributes.

GOAL: Determine barriers and opportunities for CAT-PPP.

EXPECTED OUTCOME: Technical Memorandum (5-15 page) and CAT "Connect" Brief (1-2 page) document.

S9.I1.A1: Create Private Public Partnership Subcommittee within the Texas CAV Task Force

ACTION: TxDOT should build on S9.I1.P1 recommendation by establishing a specialized subcommittee with the Texas CAV Task Force to aid in the development of CAT-PPP.

GOAL: Create more opportunity for the development of CAT-PPP.

EXPECTED OUTCOME: Regular discussion and consideration for the development of CAT-PPP.

EXPECTED TIME COMMITMENT: Inclusion in Texas CAV Task Force time commitment.

S9.I2: FACILITATE PUBLIC PRIVATE PARTNERSHIPS

DESCRIPTION: TxDOT should develop a platform for executing PPPs that supports an ongoing exchange of information, thereby accelerating CAT implementation and expanding upon the alternative project delivery mechanisms established by the Alternative Delivery Division.

EXPECTED BENEFITS: This initiative will provide processes for the development of CAT-PPPs. It will provide TxDOT with a tool to communicate TxDOT goals and objectives, and share common partnership requirements to save TxDOT financial resources and staff effort when pursuing PPPs for CAT.

INITIATIVE DETAILS:

Timeline to Initiate:

Immediate Term (0-2 years)

Lead Stakeholder(s):

ALD

Support Stakeholder(s):

CAT Organization, CSD, Districts, PFD, FIN, PRO, STR, and TRF

RECOMMENDED PROJECT(S)/ ACTION(S):

S9.I2.P1: CAT "Connect" Brief: Encouraging CAT Public-Private-Partnership

PROJECT: This brief will provide recommendations on how to encourage and accelerate PPPs based on public and private stakeholder interviews.

GOAL: Investigate and determine recommended actions to encourage CAT-PPPs.

EXPECTED OUTCOME: CAT "Connect" Brief (1-2 page) document.

S9.I2.A1: Develop Public-Private-Partnership Application Mechanism/Portal

ACTION: TxDOT should develop a CAT-PPP application interface or web portal. The CAT-PPP application portal would provide access to up-to-date PPP resources and support an ongoing exchange of information.

GOAL: Create a tool that streamlines CAT-PPP application and approvals processes.

EXPECTED OUTCOME: Develop a platform or portal for CAT-PPP applications and processing.

S10.I1: MONITOR THE AVAILABILITY OF CAT GRANTS

DESCRIPTION: TxDOT has dedicated staff and resources for the development of grant applications in the Federal Affairs Division. TxDOT should further investigate and document available technology and innovation grants for distribution and awareness. Providing opportunities for collaboration between the Divisions and District level staff could also aid in discovering potential projects and elements.

EXPECTED BENEFITS: Investigating and documenting the current grant landscape as it relates to technology and innovation will provide the Federal Affairs Division with clear direction to fund innovation and the CAT Program, alleviating financial impacts of CAT innovation on TxDOT budgets.

INITIATIVE DETAILS:

Timeline to Initiate:
Immediate Term (0-2 years)

Lead Stakeholder(s):
CAT Organization

Support Stakeholder(s):
CSD, ENV, FIN, GOV, and TPP

RECOMMENDED PROJECT(S)/ ACTION(S):

S10.I1.P1: CAT "Connect" Brief: Synthesis of Available Grant Funding for CAT

PROJECT: This brief should provide a synthesis of available grants funding for the CAT Program and innovations projects. TxDOT or a Consultant will provide a detailed overview of current TxDOT grant practices, current innovation and technology grants, opportunities for innovation, CAT Program elements to be included in larger capital grants, and recommendations for successfully obtaining grant funding for the CAT Program. The brief should include key terms and provide tabular summaries and recommendations.

GOAL: Provide TxDOT with a reference document for successfully obtaining grant funding for innovation and the CAT Program.

EXPECTED OUTCOME: CAT "Connect" Brief (1-2 page) document.

S10.I1.A1: Establish a Periodic TxDOT District Innovation Call

ACTION: The CAT Organization should organize and facilitate a periodic call between the Federal Affairs Division and District staff with innovation backgrounds to collaborate and provide direction regarding potential grant applications.

GOAL: Internal collaboration between Districts and the Federal Affairs Division for the successful application of grants for innovation projects and CAT Program elements.

EXPECTED OUTCOME: District staff will collaborate and inform Division staff of potential innovation projects that can be included in the agency's regular grant applications or could target innovation specific grants.

S11.I1: PLAN FOR FUNDING CAT ACTIVITIES

DESCRIPTION: Establish a dedicated funding mechanism for transportation technology initiatives and allocate funding to support and drive CAT projects. Direct Federal, State Highway or Non-Traditional Funds towards projects within all funding categories with an emphasis on implementing CAT technologies and initiatives.

EXPECTED BENEFITS: Dedicating funding to the CAT Program will develop confidence in TxDOT staff that TxDOT is behind innovation and the advancement of the Program. The CAT Program will further establish TxDOT's legacy as a national leader committed to innovation.

INITIATIVE DETAILS:

Timeline to Initiate:
Near Term (2-4 years)

Lead Stakeholder(s):
ADM

Support Stakeholder(s):
CAT Organization, Districts, FIN, and TPP

RECOMMENDED PROJECT(S)/ ACTION(S):

S11.I1.P1: CAT "Connect" Brief: How Can TxDOT Fund Innovation?

PROJECT: This brief should answer the question: "How can TxDOT fund innovation?" The brief will develop a synthesis of how other State DOTs fund CAT related activities and provide an overview of how TxDOT funds innovation now. The document will also provide recommendations and include findings from the "Internal CAT Funding Workshop".

GOAL: Identify ways that TxDOT can fund the CAT Program.

EXPECTED OUTCOME: CAT "Connect" Brief (1-2 pages) summary document.

S11.I1.P2: Develop Internal CAT Funding Plan/Framework

PROJECT: Assigning funds to CAT projects will require a funding framework and organized process. TxDOT or a Consultant should develop a CAT Funding Priority Plan and Framework. The Plan would outline goals, objectives and an evaluation framework for proposed CAT deployment evaluation.

GOAL: Formal CAT Funding Plan and Framework for CAT project priority funding.

EXPECTED OUTCOME: Formal CAT Funding Plan, One-Page Summary Document and Presentation.

S11.I1.A1: Hold Internal CAT Funding Workshop with TxDOT and Division Leadership

ACTION: TxDOT should hold an internal workshop to discuss funding the CAT Program. Potential agenda items include a morning presentation/review of the CAT Program and discussion of ways other States are funding innovation. The afternoon session could include a question and answer session with TxDOT Administration and District leadership to determine ways the CAT Program can be funded.

GOAL: Determine ways to fund CAT activities.

EXPECTED OUTCOME: Establishing potential ways to fund the CAT Program with action items for TxDOT Administration and District Leadership.

S12.I1: INVESTIGATE AND DOCUMENT POTENTIAL REVENUE IMPACTS DUE TO CAT

DESCRIPTION: The State of Texas and TxDOT should explore the impacts of CAT technologies on existing revenue streams, and opportunities for additional revenue generation through CAT implementation. TxDOT should consider future impacts on fuel consumption, vehicle electrification, vehicle registration/ ownership, and traffic law enforcement and explore alternative funding mechanisms.

EXPECTED BENEFITS: The proliferation of CAT could interrupt existing streams of TxDOT revenue. Investigating potential revenue impacts will provide support for changes to revenue practices.

INITIATIVE DETAILS:

Timeline to Initiate:
Near Term (2-4 years)

Lead Stakeholder(s):

CAT Organization

Support Stakeholder(s):

FIN, GOV, RTI, STR, and TPP

RECOMMENDED PROJECT(S)/ ACTION(S):

S12.I1.P1: CAT "Connect" Brief: The Intersection of CAT, Electric Vehicles, and Mobility-as-a-Service

PROJECT: This document should provide information on how CAT, electric vehicles and mobility-as-a-service will work together to meet the mobility needs of the future. The brief may likely include a review of current literature on the three topics and provide potential scenarios where all three can work together.

GOAL: Understand how CAT, electric vehicles and mobility as a service will work together.

EXPECTED OUTCOME: CAT "Connect" Brief (1-2 page) document.

S12.I1.P2: CAT "Connect" Brief: Will CAT Impact Revenue?

PROJECT: This brief should investigate the potential impacts of CAT on statewide gas tax revenues. The reports should also review current research on alternative revenue concepts. Findings will surmise the potential impact CAT may have on gas tax revenues.

GOAL: Develop findings on the potential impacts of CAT on revenues.

EXPECTED OUTCOME: CAT "Connect" Brief (1-2 page) document.

S12.I1.P3: Analysis of Revenue Impacts of CAT (RTI - Formal Research)

PROJECT: This project would investigate both the potential impacts of CAT on State revenue and complete an analysis that projects revenue loss or gain. The project would likely be divided into two phases. Phase 1 would be a literature review and recommended methodology and/or revenue equation by penetration rate. Phase 2 would include the development of multiple scenarios and relating loss or gain in revenues to the implementation of CAT.

GOAL: Determine the potential impacts of CAT on State Revenues.

EXPECTED OUTCOME: Phase 1&2 Technical Memorandum, Formal Research Report, and Presentation.

S12.I2: MITIGATE POTENTIAL REVENUE IMPACTS

DESCRIPTION: The State of Texas and TxDOT should to be prepared for changes in revenue due to CAT. This includes analyzing and piloting alternative revenue collection methods and developing a business case for CAT.

EXPECTED BENEFITS: Piloting alternative revenue methods will help TxDOT prepare for potential revenue impacts and ensure TxDOT is prepared to mitigate disruptions to existing revenue streams. Additionally, it will help to mitigate any future disruption to agency revenues and allow the agency to capitalize on new revenue generation opportunities and financially plan for shifting revenue streams.

INITIATIVE DETAILS:

Timeline to Initiate:
Near Term (0-2 years)

Lead Stakeholder(s):
CAT Organization

Support Stakeholder(s):
FIN, GOV, STR, and TPP

RECOMMENDED PROJECT(S)/ ACTION(S):

S12.I2.P1: Alternative Revenue Pilot Project

PROJECT: As part of a formal RTI research project, TxDOT should investigate multiple alternative revenue pilots and determine potential feasibility as well as transitioning recommendations.

GOAL: Determine the feasibility of potential alternative revenue methods to replace gas tax revenues.

EXPECTED OUTCOME: Formal Research Report, Summary Report, and Presentation.

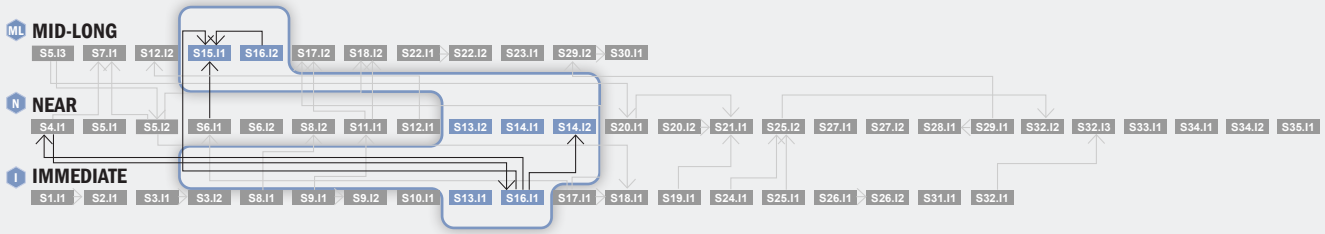
S12.I2.P2: Develop a Formal CAT Business (Revenue Mitigation) Plan

PROJECT: TxDOT should develop a formal business plan to further support the implementation of the CAT Program. The business plan should outline the benefits of CAT by penetration rate as well as projected costs to TxDOT for infrastructure and oversight. The Business plan should assess current TxDOT revenue streams that may be inhibited by CAT. For instance, AVs may drive EV adoption, which would cause a reduction in gas consumption and its associated gas tax revenue. Because CAT technologies will also likely impact revenues from parking and traffic enforcement and vehicle inspection and registration methodologies, these impacts should also be considered in the business plan, and communicated to the relevant departments and agencies accordingly. The Business plan should also consider cost savings and efficiencies realized in the department from internal CAT use.

GOAL: Support the CAT Program through an official business plan outlining the benefits and costs of implementation.

EXPECTED OUTCOME: Formal Planning Document, One-Pagers, Summary Report, and Presentation.

COLLABORATION INITIATIVES



CAT Program Road Map

S13.I1: Advance CAT Program at Internal Conferences

- S13.I1.P1: CAT "Connect" Brief: Synthesis of Current CAT Related Events
- S13.I1.A1: Prepare CAT Informational Materials

S13.I2: Expand and Establish Leadership at External Conferences

- S13.I2.A1: Continue and Expand Mobility Summit Conference
- S13.I2.A2: Assemble a List of Conferences to Showcase TxDOT's CAT Initiatives

S14.I1: Establish CAT Challenge

- S14.I1.A1: Organize CAT Data Challenge

S14.I2: Build CAT Consortium

- S14.I2.A1: Organize CAT Consortium
- S14.I2.P1: CAT "Connect" Brief: CAT Research Topics
- S14.I2.P2: CAT "Connect" Brief: Peer Agency Lessons Learned on Deploying CAT Technologies

S15.I1: Form TxDOT CAT Academy

- S15.I1.P1: CAT "Connect" Brief: CAT Training Needs
- S15.I1.A1: Identify CAT Subject Matter Experts (SMEs) that Receive Specialized Training
- S15.I1.A2: Organize CAT Training Workshop with Certification

S16.I1: Develop CAT Communication and Outreach Plan

- S16.I1.P1: CAT "Connect" Brief: CAT Brand Guide and Materials
- S16.I1.P2: CAT "Connect" Brief: CAT Social Media Strategy Document
- S16.I1.A1: Create a Statewide Slogan for CAT Initiatives
- S16.I1.A2: Develop CAT Informational Resources for Legislators, TxDOT Staff, and Partner Agencies
- S16.I1.A3: Develop TxDOT CAT Webpage

S16.I2: Host Recurring Internal and External CAT Forums

- S16.I2.A1: Organize CAT Perception Focus Groups
- S16.I2.A2: Conduct CAT Informational Webinars

Interactive

S13.I1: ADVANCE CAT PROGRAM AT INTERNAL CONFERENCES

DESCRIPTION: The CAT Organization should consider opportunities to expand TxDOT's internal conferences to educate staff about the agency's CAT initiatives. Various conferences may be expanded to incorporate CAT, including Traffic Safety, Texas Aviation, Construction and Materials, Transportation Planning, etc.

EXPECTED BENEFITS: Educating TxDOT staff about the CAT Program at various internal conferences will foster workforce interest and promote understanding and acceptance of CAT technologies.

INITIATIVE DETAILS:

Timeline to Initiate:

Immediate Term (0-2 years)

Lead Stakeholder(s):

CAT Organization

Support Stakeholder(s):

CMD, Districts, ENV, MNT, STR, TPP, and TRF

RECOMMENDED PROJECT(S)/ACTION(S)

S13.I1.P1: CAT "Connect" Brief: Synthesis of Current CAT Related Events

PROJECT: This brief should summarize upcoming TxDOT conferences, webinars, and workshops that could provide opportunities to incorporate CAT subject matter, increasing the dissemination of CAT-related information to agency staff. The brief should also identify potential CAT topics and informational materials appropriate for each event based on the event type.

GOAL: Provide TxDOT with a reference document that identifies events relevant to showcase CAT initiatives.

EXPECTED OUTCOME: CAT "Connect" Brief (1-2 page) document.

S13.I1.A1: Prepare CAT Informational Materials

ACTION: The CAT Organization should work with the Communications Division to prepare informational materials for CAT technologies that may be disseminated at internal conferences. The materials should cover ongoing statewide CAT initiatives, timeframes for the availability of emerging transportation technologies, CAT's expected benefits and affected populations, and concerns related to the statewide deployment of the technologies.

GOAL: Inform TxDOT staff about agency-wide CAT initiatives.

S13.I2: EXPAND AND ESTABLISH LEADERSHIP AT EXTERNAL CONFERENCES

DESCRIPTION: TxDOT should continue hosting the annual Mobility Summit conference, which features the CAT industry and vendor participation. TxDOT should participate and highlight critical efforts through external conferences hosted by organizations such as ITE (Institute of Transportation Engineers), TRB (Transportation Research Board), AASHTO (American Association of State Highway Transportation Officials), WASHTO (Western Association of State Highway and Transportation Officials), Intelligent Transportation Society of America, etc.

EXPECTED BENEFITS: Promoting CAT at external conferences allows the agency to foster workforce interest, expand opportunities to study national best practices, and to enhance workforce skills related to CAT technologies.

INITIATIVE DETAILS:

Timeline to Initiate:
Near Term (2-4 years)

Lead Stakeholder(s):
CAT Organization

Support Stakeholder(s):
CAV Work Group, CMD, RTI, and STR

RECOMMENDED PROJECT(S)/ACTION(S)

S13.I2.A1: Continue and Expand Mobility Summit Conference

ACTION: The CAT Organization should work with Texas Innovation Alliance (TIA) to feature CAT initiatives during the Texas Mobility Summit. The conference will provide an opportunity to connect with transportation decision-makers around the country, learn about CAT technologies that address different mobility needs, and promote future partnerships to conduct pilot testing on Texas roadways.

GOALS: Strengthen links between transportation leadership – policymakers, public agencies, research, industry, and community organizations – to advance shared CAT solutions.

S13.I2.A2: Assemble a List of Conferences to Showcase TxDOT's CAT Initiatives

ACTION: The CAT Organization should work with Communications and Strategic Planning Divisions, to develop a list of international and national CAT-related conferences that TxDOT should attend.

GOALS: Promote TxDOT's CAT initiatives at national and global platforms. Contribute to and learn from various outside agency best-practices.

S14.I1: ESTABLISH CAT CHALLENGE

DESCRIPTION: In 2015, USDOT launched a Smart City Challenge focused on developing ideas for an integrated, first-of-its-kind smart transportation system that would use data, applications, and technology to help people and goods move quicker, cheaply, and efficiently. TxDOT should host a similar challenge for research institutions, academia, vendors, and other stakehodlers annually. The Challenge will help TxDOT develop partnerships with academic institutions, including technical schools, universities, and colleges, to promote innovation and incorporate aspects of CAT technology into their curricula.

EXPECTED BENEFITS: Organizing a CAT challenge will promote innovation and collaboration on CAT projects.

INITIATIVE DETAILS

Timeline to Initiate:

Near Term (2-4 years)

Lead Stakeholder(s):

CAT Organization

Support Stakeholder(s):

CAV Work Group, CMD, CSD, Districts, MTD, PRO, RTI, and TRF

RECOMMENDED PROJECT(S)/ACTION(S)

S14.I1.A1: Organize CAT Data Challenge

ACTION: The CAT Organization should annually host a CAT Data Challenge focused around using CAT technologies to address the most pressing transportation problems across Texas. The Challenge will call for the use of CAT technologies to deliver bold new solutions to meet the needs of residents of all ages and abilities.

GOALS: Leverage CAT expertise to develop innovative transportation solutions.

S14.I2: BUILD CAT CONSORTIUM

DESCRIPTION: TxDOT should collaborate with research institutes and other transportation agencies to form a CAT Consortium, a collective that comes together to share knowledge and resources in the pursuit of CAT advancement. The Consortium will allow members to share their expertise, resources, and lessons learned from implementing pilot CAT projects. TxDOT should leverage FHWA funded studies to strengthen existing relationships with peer transportation agencies and potentially coordinate resources for joint ventures.

EXPECTED BENEFITS: Leading a CAT Consortium will allow TxDOT to maintain a pulse on the latest advancement and news in CAT technology by creating an ecosystem that actively shares resources and knowledge. Furthermore, it offers TxDOT an opportunity to cultivate interest and talent among future members of the workforce.

INITIATIVE DETAILS:

Timeline to Initiate:

Near Term (2-4 years)

Lead Stakeholder(s):

CAT Organization

Support Stakeholder(s):

CAV Work Group, CMD, GCD, GOV, ITD, RTI, and TRF

RECOMMENDED PROJECT(S)/ACTION(S)

S14.I2.A1: Organize CAT Consortium

ACTION: The CAT Organization should form a CAT Consortium comprising of research institutions, academia, and peer agencies. TxDOT should use this platform to strengthen existing relationships with peer transportation agencies to share lessons-learned, expertise, and potentially coordinate resources for joint ventures.

GOALS: Leverage CAT expertise to develop innovative transportation solutions.

S14.I2.P1: CAT "Connect" Brief: CAT Research Topics

PROJECT: This brief should summarize a list of CAT research areas that the members of the CAT Consortium will explore in detail. The list may include a summary of innovative funding mechanisms, deployment-ready technologies, CAT design and installation standards, etc.

GOALS: Provide consortium members with a list of CAT research topics for effective collaboration.

EXPECTED OUTCOME: CAT "Connect" Brief (5-10 page) document.

S14.I2.P2: CAT "Connect" Brief: Peer Agency Lessons Learned on Deploying CAT Technologies

PROJECT: This brief should provide a summary of the lessons learned by various agencies regarding experience with the deployment of CAT technologies and promoting CAT within their own agencies. This information will support agencies in their ability to prepare for CAT and to support research, development, and implementation efforts on their systems.

GOALS: Provide TxDOT necessary information to leverage ongoing activities and resources to prepare for CAT.

EXPECTED OUTCOME: CAT "Connect" Brief (5-10 page) document.

S15.I1: FORM TXDOT CAT ACADEMY

DESCRIPTION: TxDOT should create a CAT Academy to provide on-the-job training for Divisions and Districts to implement CAT projects efficiently. Training may include work with RSUs, fleet vehicle OBUs, IT and data management systems, etc. This academy should be leveraged to conduct internal educational efforts to increase existing personnel's knowledge base through training sessions on data, current trends, new technologies, and other issues as needed.

EXPECTED BENEFITS: Creating a CAT Academy will provide workforce development opportunities and allow TxDOT to attract and retain expertise. Growth of a well-trained, experienced workforce will support TxDOT's efforts to accelerate the deployment of CAT initiatives and establish itself as a leader in this realm.

INITIATIVE DETAILS

Timeline to Initiate:
Mid-long Term (>4 years)

Lead Stakeholder(s):
CAT Organization

Support Stakeholder(s):
CAV Work Group, HRD, ITD, RTI, and TRF

RECOMMENDED PROJECT(S)/ACTION(S)

S15.I1.P1: CAT "Connect" Brief: CAT Training Needs

PROJECT: As part of the series of CAT "Connect" Briefs, this brief should summarize courses and modules covered as part of the training. The brief should include details about CAT topics, course content, reading materials, and project development guidelines.

GOALS: Provide a detailed CAT training and course catalog.

EXPECTED OUTCOME: CAT "Connect" Brief (5-10 page) document.

S15.I1.A1: Identify CAT Subject Matter Experts (SMEs) that Receive Specialized Training

ACTION: The CAT Organization should work with Divisions and Districts to identify subject matter experts (SMEs) that receive specialized training, participate in industry forums, and assist with training other staff. SMEs can also promote CAT across the agency, given their in-depth knowledge of new systems.

GOALS: Leverage SMEs to promote training staff across the agency.

S15.I1.A2: Organize CAT Training Workshop with Certification

ACTION: CAT Organization should host a CAT Training Workshop quarterly. A certificate would be provided to the candidate upon successful completion of the training. CAT Organization should ensure that the curriculum is continuously updated to provide the most up-to-date training.

GOALS: Conduct a CAT Training Workshop to provide workforce development opportunities.

S16.I1: DEVELOP CAT COMMUNICATION AND OUTREACH PLAN

DESCRIPTION: The development and implementation of CAT Technologies are rapidly evolving. TxDOT should ensure that the impacts on day-to-day operations get accurately communicated with stakeholders and the general public. TxDOT must take necessary steps to educate, engage, and involve specific stakeholder groups to build support for their CAT initiatives. Potential steps include the following:

- Develop internal and external stakeholder communications plans with consistent messaging (technology availability, benefits, impacts, policy, and adoption timeline).
- Develop an evaluation plan to identify community-specific outreach needs.
- Identify CAT liaison(s) or SMEs within each TxDOT Division to streamline the dissemination of system changes/upgrades information as a result of implementing CAT technologies.
- Assign CAT liaison(s) or SMEs with the responsibility to provide information on why system changes are required, workflow impacts and improvements, training opportunities, and routinely posted schedules for system changes and system resources (i.e., primers, user manuals).

EXPECTED BENEFITS: Frequent internal and external communication promotes understanding and supports the acceptance of CAT technologies. Additionally, developing an outreach plan ensures an equitable engagement process and builds public trust.

INITIATIVE DETAILS:

Timeline to Initiate:
Immediate Term (0-2 years)

Lead Stakeholder(s):
CAT Organization

Support Stakeholder(s):
CAV Work Group, CMD, GOV, and TRV

RECOMMENDED PROJECT(S)/ACTION(S)

S16.I1.P1: CAT "Connect" Brief: CAT Brand Guide and Materials

PROJECT: This brief should provide clear standards on branding CAT initiatives. The guidelines will enable TxDOT and consultants to be coherent and consistent across all visual and written communications. The Communications Division will be responsible for the oversight of the CAT brand guidelines.

GOALS: Provide a CAT brand guideline for consistency in visual and written communications.

EXPECTED OUTCOME: CAT "Connect" Brief (5-10 page) document.

S16.I1.P2: CAT "Connect" Brief: CAT Social Media Strategy Document

PROJECT: The CAT Organization should work with the Communications Division to develop a CAT social media marketing strategy, including the release of a call to action to become aware of CAT activities in Texas.

GOALS: Identify social media marketing and information-sharing strategies for CAT projects.

EXPECTED OUTCOME: CAT "Connect" Brief (5-10 page) document.

S16.I1.A1: Create a Statewide Slogan for CAT Initiatives

ACTION: The success of CAT depends significantly on a culture shift, and a creative slogan may help. Similar to initiatives such as "Don't Mess with Texas" and "End the Streak", the CAT Program should create a slogan or calling card to aid in transitioning TxDOT culture to CAT and Innovation. Currently, the thinking is to utilize the current TxDOT mission and CAT elements, such as connected vehicles in a movement to "Connect Texas."

GOALS: Promote a culture shift using a creative slogan.

S16.I1.A2: Develop CAT Informational Resources for Legislators, TxDOT Staff, and Partner Agencies

ACTION: The CAT Organization should work with the Communications Division and the joint CAV-CAT Work Group to develop CAT informational flyers and materials catered for legislators, internal staff, and partner agencies.

GOALS: Communicate CAT initiatives to various stakeholders.

S16.I1.A3: Develop TxDOT CAT Webpage

ACTION: The CAT Organization should work with the Communications Division, Information Technology Division, and CAV-CAT Work Group to develop a webpage for the CAT Program on TxDOT's website. The webpage will act as the premier resource for CAT information in Texas, including up-to-date details on CAT projects, technologies, budget tracking, etc. The CAT Organization will develop and publish CAT information and communication materials on TxDOT's website.

GOALS: Centralize and share CAT Program information on the TxDOT website.

S16.I2: HOST RECURRING INTERNAL AND EXTERNAL CAT FORUMS

DESCRIPTION: TxDOT should conduct CAT outreach to inform internal staff and the public about ongoing and planned CAT initiatives and the expected benefits/risks of CAT technologies. Hosting monthly Brown Bag Sessions with TxDOT staff and the general public can solicit understanding of CAT technologies, facilitate acceptance and support, and ensure that all stakeholders and constituents are actively engaged in CAT preparedness and adoption efforts. TxDOT should develop and maintain email distribution lists of participants attending CAT discussion forums.

EXPECTED BENEFITS: Conducting regular outreach ensures that all stakeholders and constituents are actively engaged in CAT preparedness and adoption efforts.

INITIATIVE DETAILS:

Timeline to Initiate:
Mid-long Term (>4 years)

Lead Stakeholder(s):
CAT Organization

Support Stakeholder(s):
CAV Work Group, CMD, GOV, and TRF

RECOMMENDED CAT PROJECT(S)/ACTION(S)

S16.I2.A1: Organize CAT Perception Focus Groups

ACTION: The CAT Organization should work with the Communications Division and Texas CAV Task Force to organize targeted focus group meetings with members of the public and specific legislators. The focus group meeting(s) will solicit information on the external understanding of CAT and gauge the effectiveness of potential strategies to increase confidence and support for CAT.

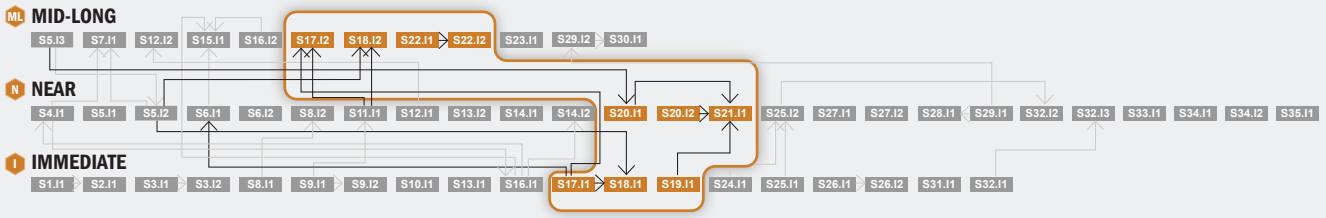
GOALS: Gauge the current understanding of CAT and effectiveness of communication strategies.

S16.I2.A2: Conduct CAT Informational Webinars

ACTION: The CAT Organization should work with the Communications Division and Texas CAV Task Force to host a series of CAT informational webinars for TxDOT internal and external stakeholders. TxDOT should identify a list of external stakeholders such as MPOs, Cities, Non-Profits, and General Public and develop a webinar to cater to their needs and understanding of CAT technologies.

GOALS: Garner support from internal and external stakeholders for CAT implementation.

INFRASTRUCTURE READINESS INITIATIVES



CAT Program Road Map

S17.I1: Pilot CAT Technologies across Texas

- S17.I1.P1: CAT "Connect" Brief: CV Pilot Selection Methodology
- S17.I1.P2: Automated Vehicle Pilots

S17.I2: Establish Innovation Corridor(s)

- S17.I2.P1: CAT "Connect" Brief: Innovation Corridor Selection Methodology
- S17.I2.P2: Deploy Innovation Corridor Project(s)
- S17.I2.P3: Establish Innovation Area Design Competition

S18.I1: Upgrade TxDOT Signals

- S18.I1.P1: Traffic Signal Standards Updates
- S18.I1.P2: I2V System Standardization
- S18.I1.P3: Detection Systems Testing and Deployment
- S18.I1.A1: Standardize I2V and Advanced Detection Systems Deployment at Signals

S18.I2: Upgrade Traffic Management Systems

- S18.I2.P1: CAT Freeway Management Application Deployments

S19.I1: Establish Priority Corridor Network Connectivity

- S19.I1.P1: CAT "Connect" Brief: Corridor Connectivity Prioritization Methodology
- S19.I1.P2: Priority Corridor Communications Implementation

S20.I1: Investigate and Document Urban Versus Rural Needs

- S20.I1.P1: CAT "Connect" Brief: District Communications Needs and Priorities Survey
- S20.I1.P2: Urban and Rural CAT Deployment Toolkit

S20.I2: Integrate Future Communications Build-Out in Construction Projects

- S20.I2.P1: Develop CAT Communications Checklist for Rural/Urban Construction Projects
- S20.I2.P2: Develop Typical Standard for Future Backhaul Conduit
- S20.I2.P3: Develop Typical Standard for Cellar Communications (5G & Small Cell)
- S20.I2.A1: Create Updated Engineering Design Process for Communications Checklist

S21.I1: Plan for Complete Network Connectivity

- S21.I1.P1: District Network Gap Analysis
- S21.I1.P2: District Connectivity Master Plans
- S21.I1.P3: Statewide Network Construction and Integration
- S21.I1.A1: Private Communications Provider Working Group/Panel

S22.I1: Evaluate Statewide Electric Vehicle Charging Needs

- S22.I1.P1: CAT "Connect" Brief: Electric Charging Future Needs Study

S22.I2: Facilitate Municipal EV Charging Partnerships

- S22.I2.P1: Execute Charging Partnerships
- S22.I2.P2: Electric Vehicle Charging Market Research

S23.I1: Research and Test CAV Fleet Scenarios

- S23.I1.P1: CAV Facility Study (Dedicated Lanes and Mixed Fleet)
- S23.I1.P2: Innovation Corridor CAT Lane Pilot

Interactive

S17.I1: PILOT CAT TECHNOLOGIES ACROSS TEXAS

DESCRIPTION: TxDOT should continue to deploy advanced transportation technology pilot programs across the state. Locations with identified safety needs that could be addressed by CAT technology should be prioritized. Some consideration should also be given to the existing vehicle fleets in the deployment area, especially for the application of connected vehicle related technologies.

EXPECTED BENEFITS: Advanced CAT technology pilots should bring immediate safety improvements to the roads on which they are deployed. Beyond the localized safety impacts, pilot programs will aide TxDOT in developing institutional expertise that is required for the widespread adoption of advanced CAT technologies. The effectiveness of specific applications can be evaluated to help further prioritize future deployment. Also, TxDOT staff will identify and develop the required skills needed to implement and maintain cutting edge technologies while also developing relationships with third-party vendors and vehicle manufacturers to better understand future CAT needs.

INITIATIVE DETAILS:

Timeline to Initiate:
Immediate Term (0-2 years)

Lead Stakeholder(s):

CAT Organization

Support Stakeholder(s):

Districts, FIN, GCD, ITD, PRO, RTI, TPP, and TRF

RECOMMENDED PROJECT(S)/ACTION(S)

S17.I1.P1: CAT "Connect" Brief: CV Pilot Selection Methodology

PROJECT: TxDOT should establish a methodology for selecting technology pilot programs that prioritize safety impacts, while considering expected costs to implement and potential permanence of the deployed infrastructure.

GOAL: Strategically select CV pilot deployment applications and locations for testing to ensure that technology implementation aligns with CAT Program goals. Build and test advanced CAT technology demonstrations.

EXPECTED OUTCOME: CV Pilot Program Selection Evaluation Process Memo, Pilot Evaluation Application Form and Checklist, Pilot Project Deployments.

S17.I1.P2: Automated Vehicle Pilots

PROJECT: TxDOT should facilitate the safe testing and operation of automated vehicles on TxDOT roads in coordination with OEMs, ADS developers, and other automated vehicle vendors.

GOAL: Strategically select AV pilot deployment applications and locations for testing to ensure that technology implementation aligns safely and harmoniously with CAT Program goals.

EXPECTED OUTCOME: Safe Automated Driving Testing Requirements, Automated Transit Shuttle Requirements, Automated Freight and Platooning Guidelines.

S17.I2: ESTABLISH INNOVATION CORRIDOR(S)

DESCRIPTION: Working with local agencies through the Texas Innovation Alliance, TxDOT should select corridor locations for concentrated early deployment of CAT technologies. The corridor should include a variety of different transportation scenarios, including highway, traffic signals, pedestrian, bicycle, mobility-on-demand services, and transit operations. Furthermore, the corridor should have strategic safety and operational needs, such as emergency evacuation routes or locations with abnormal crash rates or congestion. In coordination with private industry, the selected corridor should also have the potential for deployment of automated and connected vehicle fleets.

EXPECTED BENEFITS: Widespread deployment of a variety of CAT technologies has the potential to compound the benefits to safety and operations that will be expected from a single pilot test. Incorporation of a plurality of CAT technologies can more completely present the potential for CAT to improve transportation throughout Texas.

INITIATIVE DETAILS

Timeline to Initiate:
Mid-Long Term (>4 years)

Lead Stakeholder(s):
CAT Organization

Support Stakeholder(s):
Districts, ENV, STR, RTI, TPP, and TRF

RECOMMENDED PROJECT(S)/ACTION(S)

S17.I2.P1: CAT "Connect" Brief: Innovation Corridor Selection Methodology

PROJECT: TxDOT should develop a methodology for the selection of the Innovation Corridor(s), prioritizing safety impacts. Other considerations may include existing backhaul communications networks, operational deficiencies, or other strategic priorities outside of the CAT Program.

GOAL: Strategically select an innovation corridor that will effectively demonstrate the potential of CAT technologies while improving safety and operations.

EXPECTED OUTCOME: Innovation Corridor Selection Criteria.

S17.I2.P2: Deploy Innovation Corridor Project(s)

PROJECT: TxDOT should develop one or more CAT deployment projects for the Innovation Corridor. Projects may feature fiber optic communication networks, V2I communications, TMC data management technologies and other innovations.

GOAL: Develop projects for deployment along the Innovation Corridor.

EXPECTED OUTCOME: Innovation Corridor Project Definition

S17.I2.P3: Establish Innovation Area Design Competition

PROJECT: As the Innovation Corridor is constructed, further innovation may be achieved through an open-ended design competition amongst the private industry, research entities, and academia. Without the need to commit to any funding or even selecting any applicants, but with the freedom to choose multiple winners, TxDOT can leverage vast industry expertise to periodically improve and expand upon its Innovation Corridor.

GOAL: Further innovation with input from the diverse pool of industry expertise available.

EXPECTED OUTCOME: Innovation Corridor Improvement Proposals and Proposal Selection Process.

S18.I1: UPGRADE TXDOT SIGNALS

DESCRIPTION: As CAT Signals pilots validate the viability of connected signals applications, TxDOT should move to standardize V2I communications and advanced applications for deployment at TxDOT signals statewide. TxDOT can improve detection of all road users at traffic signals with advanced detection methods and integrate those detection systems with I2V communications systems deployed at signals.

EXPECTED BENEFITS: Upgrades of TxDOT signal infrastructure for CAT will allow for the next generation of safety and operational improvements to become familiar, as TxDOT expands institutional, technical expertise and establish leadership in connected infrastructure on the national and international stage.

INITIATIVE DETAILS:

Timeline to Initiate:
Immediate Term (0-2 years)

Lead Stakeholder(s):

TRF

Support Stakeholder(s):

CAT Organization, Districts, ITD, MTD, and TPP

RECOMMENDED PROJECT(S)/ACTION(S)

S18.I1.P1: Traffic Signal Standards Updates

PROJECT: TxDOT should update Statewide and District Traffic Signal Design Standard documents to include provisions for CAT technology upgrades. Cabinet size should be considered to accommodate any additional equipment required for CAT technologies, including network equipment, and advanced signal controller equipment requirements.

GOAL: Prepare TxDOT traffic signal infrastructure for the future by proactively updating design standards.

EXPECTED OUTCOME: Traffic Signal Cabinet Design Standard Update, Traffic Signal Controller Requirements Update for CAT.

S18.I1.P2: I2V System Standardization

PROJECT: Update TxDOT Statewide and District Traffic Signal Design Standard documents to include provisions for I2V capabilities. As appropriate, once pilot tests have demonstrated the utility and practical application, including standardized I2V communications requirements at signal locations. SPaT broadcasting and specifications for various applications can be standardized based on intersection location.

GOAL: Prepare TxDOT traffic signal infrastructure for the future by proactively updating design standards.

EXPECTED OUTCOME: I2V Infrastructure Standards, Pre-approved I2V Infrastructure Vendor List, I2V Application Guidelines.

S18.I1.P3: Detection Systems Testing and Deployment

PROJECT: TxDOT should update Statewide and District Traffic Signal Design Standard documents to include provisions for advanced detection and geolocation of all road users at signals. Standards should prioritize the ability to reliably, accurately, and precisely locate pedestrians, bicyclists, e-scooter riders, and other vulnerable road users to assist with CAT applications to improve the safety of those very same vulnerable road users.

GOAL: Maximizing the future safety of all road users via improved and more comprehensive detection at all traffic signals.

EXPECTED OUTCOME: Detection Systems Testing Report, Traffic Signal Detection Technical Requirements, Pre-Approved Detection Vendor List

S18.I1.A1: Standardize I2V and Advanced Detection Systems Deployment at Signals

ACTION: As technical requirements and design standards are established, and connected vehicles become more common on Texas roadways, TxDOT should standardize advanced CAT technology deployments with all traffic signal construction, including advanced detection, I2V communications, and advanced signal controllers.

GOAL: With the maturation of technical capabilities, and the proliferation of CAV technologies, TxDOT will be prepared to capitalize on advanced technologies to improve travel safety and efficiency across the state.

S18.I2: UPGRADE TRAFFIC MANAGEMENT SYSTEMS

DESCRIPTION: As CAT technology testing, pilot programs, and systems mature, TxDOT should move to upgrade overall traffic management infrastructure for CAT readiness. Freeway management applications such as speed harmonization and advanced traveler information systems can be deployed at larger scales, corridor-wide, district-wide, and eventually statewide. Improved Traffic Management Center technologies to better manage and act upon CAT data will also be required to leverage the potential of these technologies fully.

EXPECTED BENEFITS: Widespread deployment of CAT Traffic Management Systems will improve safety and operations on TxDOT roadways while solidifying institutional expertise and leadership on the national stage.

INITIATIVE DETAILS:

Timeline to Initiate:

Mid-Long Term (4 years & beyond)

Lead Stakeholder(s):

TRF

Support Stakeholder(s):

CAT Organization, Districts, ITD, and MTD

RECOMMENDED PROJECT(S)/ACTION(S)

S18.I2.P1: CAT Freeway Management Application Deployments

PROJECT: TxDOT should expand the deployment of connected infrastructure along freeways and major arterials to allow for the implementation of CAT applications.

GOAL: Expand and mature traffic management systems for CAT, improving safety and operations on Texas freeways.

EXPECTED OUTCOME: System Requirements, Design Standards, Concept of Operations documentation for Various CAT Freeway Management applications, Design and Construction of Traffic Management Infrastructure.

S19.I1: ESTABLISH PRIORITY CORRIDOR NETWORK CONNECTIVITY

DESCRIPTION: TxDOT should continue to close the gaps in existing communication networks by strategically prioritizing transportation corridors for implementation of fiber-optic backhaul communications. Complete statewide network connectivity cannot happen immediately, but by identifying specific corridors that could most readily benefit from robust backhaul communications implementation, TxDOT can efficiently allocate resources in a manner that maximizes the impact of the investment and furthers the goals of the CAT Program.

EXPECTED BENEFITS: Intelligent expansion and improvement of TxDOT communication networks can be achieved through corridor prioritization, ensuring effective and efficient allocation of TxDOT funds and resources.

INITIATIVE DETAILS:

Timeline to Initiate:

Immediate Term (0-2 years)

Lead Stakeholder(s):

ITD

Support Stakeholder(s):

CAT Organization, CST, DES, ROW, STR, TPP, and TRF

RECOMMENDED PROJECT(S)/ACTION(S)

S19.I1.P1: CAT "Connect" Brief: Corridor Connectivity Prioritization Methodology

PROJECT: This brief should outline a statewide methodology for prioritization of communications network implementation, considering existing assets, existing communications, projected congestion, future planned construction, and the ability to combine fiber optic networks with roadway construction projects.

GOAL: Intelligently plan the gradual and efficient expansion of TxDOT networks.

EXPECTED OUTCOME: CAT "Connect" Brief (2-4 pages) document.

S19.I1.P2: Priority Corridor Communications Implementation

PROJECT: TxDOT should design, construct and integrate corridor communications networks based on a decided upon corridor prioritization plan.

GOAL: Implement backhaul communications where it will have the most significant impact.

EXPECTED OUTCOME: Corridor Communications Design, Network Integration Plans.

S20.I1: INVESTIGATE AND DOCUMENT URBAN VERSUS RURAL NEEDS

DESCRIPTION: Because Texas is such a vast and varied state, there likely is no one-size-fits-all for CAT technologies. This is especially true about the communications needed to communicate data to and from the TMCs. To better understand potential solutions, TxDOT should engage with all Districts to establish current best practices and evaluate paths forward for expansion of network expansion. The initiative will support TxDOT's Connected Network Strategy that will form the foundational underpinnings of all other technology strategies in flight for TxDOT.

EXPECTED BENEFITS: A better understanding of the needs and capabilities of various solutions will facilitate the appropriate expansion of the communications networks that are so essential to the maturation of CAT Programs throughout Texas. TxDOT will be empowered to establish priorities for communications infrastructure across the diverse communities and Districts.

INITIATIVE DETAILS:

Timeline to Initiate:
Near Term (2-4 years)

Lead Stakeholder(s):

CAT Organization

Support Stakeholder(s):

Districts, ITD, STR, TPP, and TRF

RECOMMENDED PROJECT(S)/ACTION(S)

S20.I1.P1: CAT "Connect" Brief: District Communications Needs & Priorities Survey

PROJECT: Using District stakeholder input, TxDOT should explore and report upon priorities for communications. Include an inventory of existing established best practices. Consider also input from private communication industry experts regarding the potential for private-public partnerships.

GOAL: Understand various needs and practical applications for communications network deployments across Texas.

EXPECTED OUTCOME: Urban Network Feasibility Study and Alternatives Analysis Report, CAT "Connect" Brief: District Communications Needs and Priorities.

S20.I1.P2: Urban and Rural CAT Deployment Toolkit

PROJECT: Based on lessons learned from deployed CAT projects and other efforts, TxDOT or a Consultant should develop an Urban/Rural CAT Deployment Toolkit. This Toolkit (potentially web-based) should provide an overview of CAT Deployments and Applications for Urban and Rural scenarios as well as typical design standards for the scenarios.

GOAL: Provide guidance to Districts for the deployment of CAT Projects to address both Urban and Rural needs.

EXPECTED OUTCOME: Summary Report and Presentation.

S20.I2: INTEGRATE FUTURE COMMUNICATIONS BUILD-OUT IN CONSTRUCTION PROJECTS

DESCRIPTION: TxDOT should require consideration for installing backhaul communication infrastructure for all construction projects, regardless of the presence of existing or proposed TxDOT assets requiring connection at the time of construction. In alignment with statewide and District communication network planning efforts, and with incorporation into Unified Transportation Planning (UTP) efforts, TxDOT should establish requirements for practical communications design and construction standards based on rural and urban construction. If not establishing immediate communications connections, future connections should be facilitated during roadway construction to minimize future costs.

EXPECTED BENEFITS: Expedite the expansion of TxDOT networks and mitigation of future costs of that expansion by combining communications infrastructure updates with traditional roadway construction. The expanded conduit and communications infrastructure will help to provide vast opportunities for private-public partnerships that will help to provide broadband to Texans everywhere and further TxDOT network connectivity.

INITIATIVE DETAILS:

Timeline to Initiate:
Near Term (2-4 years)

Lead Stakeholder(s):

ITD and TRF

Support Stakeholder(s):

CAT Organization, CST, DES, Districts, MTD, and TPP

RECOMMENDED PROJECT(S)/ACTION(S)

S20.I2.P1: Develop CAT Communications Checklist for Rural/Urban Construction Projects

PROJECT: TxDOT should provide design checklists for both urban and rural roadway construction focused on the incorporation of all relevant and applicable CAT communications requirements, including minimum consideration for network connectivity for all signals and devices (cellular or fiber optic), along with V2I communication for pilot deployments or as deployments become standardized.

GOAL: Provide a guide for TxDOT design and construction to assist with successfully expanding network connections for TxDOT roads.

EXPECTED OUTCOME: Urban Network Design Checklist, Rural Network Design Checklist.

S20.I2.P2: Develop Typical Standard for Future Backhaul Conduit

PROJECT: TxDOT should update TxDOT Statewide and District roadway and signal design standards to include standard communications and spare conduits to accommodate the installation of fiber optic communication cables. TxDOT should require justification for the exclusion of conduit such as the existence of cellular network connections or infeasible future network completion.

GOAL: Incorporate communications conduit infrastructure into all practically possible roadway and signal construction, thus facilitating the complete connection of TxDOT roads to TMCs.

EXPECTED OUTCOME: Design Standards Update Memo, Updated Design Standards (as applicable), Typical Communications Ductbank Detail Drawings

S20.I2.P3: Develop Typical Standard for Cellar Communications (5G & Small Cell)

PROJECT: TxDOT should update Statewide and District roadway and signal design standards to include applicable requirements for cellular communication connections, including 5G and Small Cell communication requirements. Standardize testing and installation of communications equipment to ensure the reliability of all established connections.

GOAL: Incorporate wireless communications infrastructure into roadway and signal construction where fiber-optic networks are not practically possible, thus facilitating the complete connection of TxDOT roads to TMCs.

EXPECTED OUTCOME: Design Standards Update Memo, Updated Design Standards (as applicable), Typical Communications Ductbank Detail Drawings.

S20.I2.A1: Create Updated Engineering Design Process for Communications Checklist

ACTION: TxDOT should create and update as necessary a design checklist for communications design incorporation, applicable to all TxDOT Construction, which assists with the application of all updated design standards and possible exceptions laid out in the Urban and Rural standards for both fiber/conduit and wireless design.

GOAL: This checklist should help to ensure consistent application of the communication infrastructure design standards.

S21.I1: PLAN FOR COMPLETE NETWORK CONNECTIVITY

DESCRIPTION: Though complete connection of TxDOT roads cannot happen overnight, the proliferation of CAT technologies and realization of the full safety and operational benefits of those technologies cannot be completed without ubiquitous network connectivity. For that reason, TxDOT should have a plan in place for this complete connectivity along all its roadways, prioritizing high-speed fiber-optic connections where possible. Relying on studies of various District communication needs, and building from priority corridor communications implementation and ongoing TxDOT connected network plans, TxDOT should continue the expansion of communications networks.

EXPECTED BENEFITS: Widespread CAT applications cannot be executed without the robust communications infrastructure in place. Therefore, complete network connectivity is a precursory requirement for bringing the fullest array of potential benefits of CAT technology to all of Texas.

INITIATIVE DETAILS:

Timeline to Initiate:
Near Term (2-4 years)

Lead Stakeholder(s):
CAT Organization

Support Stakeholder(s):
CST, Districts, ITD, ROW, TPP, and TRF

RECOMMENDED PROJECT(S)/ACTION(S)

S21.I1.P1: District Network Gap Analysis

PROJECT: TxDOT should assess its existing communications networks by mapping existing assets in GIS, evaluating where existing network connections are and assessing planned construction. TxDOT should regularly update this analysis to serve as an ongoing tool.

GOAL: Take inventory of and document existing TxDOT assets and network connectivity.

EXPECTED OUTCOME: GIS inventory of TxDOT communications assets, District Gap Analysis Memo(s),

S21.I1.P2: District Connectivity Master Plans

PROJECT: Expanding from the Network Gap Analyses, a network master plan should be developed for establishing reliable, high bandwidth backhaul communication networks to all TxDOT signals, ITS devices, and any other planned or existing connectable infrastructure. Long-term plans for total connectivity should also be created, establishing a high-level assessment of alternatives for connecting all Interstate, highway, FM, and local roads.

GOAL: Plan at the District level for the expansion of backhaul network communications.

EXPECTED OUTCOME: District Connectivity Master Plan Report, Long-Term Network Completion Feasibility Study

S21.I1.P3: Statewide Network Construction and Integration

PROJECT: TxDOT should execute District Connectivity Master Plans via existing or expanded maintenance contracts, in addition to planned construction, or via individual construction projects. All design and construction shall comply with established network standards and best practices.

GOAL: Complete the planned expansion of TxDOT networks.

EXPECTED OUTCOME: Individual network design packages

S21.I1.A1: Private Communications Provider Working Group/Panel

ACTION: TxDOT should engage regularly with the private communications industry via a working group or panel discussion. Establish partnerships to help expand networks in Texas. Discuss policy relating to a public-private partnership, fiber or duct bank sharing, 5G and small-cell network implementation and use, and any other mutual interests as determined by the panel.

GOAL: Leverage overlapping interests to help expand networks to the mutual benefit of TxDOT and private industry.

S22.I1: EVALUATE STATEWIDE ELECTRIC VEHICLE CHARGING NEEDS

DESCRIPTION: Electric-powered vehicles are increasingly popular as costs for the vehicles come down and battery technology improvements increase vehicle range. To ensure that Texas is appropriately equipped and prepared for the expected electrification of vehicle fleets, TxDOT should study the current and projected needs for electric vehicle charging infrastructure, including specific considerations for impacts from freight electrification, passenger vehicle charging needs, and mobility-on-demand fleets. Expected Outcome: Through studying electric vehicle charging needs, TxDOT will better understand future needs and remain poised to maximize CAT benefits.

INITIATIVE DETAILS:

Timeline to Initiate:

Mid-Long Term (>4 years)

Lead Stakeholder(s):

CAT Organization

Support Stakeholder(s):

ENV, RTI, and TPP

RECOMMENDED PROJECT(S)/ACTION(S)

S22.I1.P1: CAT "Connect" Brief: Electric Charging Future Needs Study

PROJECT: This brief will provide information on the current state of electric vehicle charging infrastructure, electric vehicle charging demand and future needs. Consider the capabilities of the electric vehicles to travel across and throughout Texas. Explore current industry practices pertaining to electric vehicle charging locations and electric grid demands, and determine if specific accommodations should be considered for freight charging, MoD fleets, and personal vehicles.

GOALS: Understand the current state of electric vehicle charging demand and availability and study future needs. Ultimately TxDOT's goal is to determine, if any, what role the agency should play in the proliferation of electric vehicles charging into the future.

EXPECTED OUTCOME: CAT "Connect" Brief: Electric Charging Future Needs Study.

S22.I2: FACILITATE MUNICIPAL EV CHARGING PARTNERSHIPS

DESCRIPTION: TxDOT will work with cities and municipalities to help facilitate partnerships with businesses and provide for future electric vehicle charging needs. While TxDOT will not be directly involved in the business of providing EV charging infrastructure statewide, the agency should maintain a strategic interest as the location of charging stations may come to have a significant impact on commercial and passenger traffic throughout Texas.

EXPECTED BENEFITS: Provide a model for paying for electric vehicle charging stations at locations where people want to be, will already be, and facilitate local commerce. Guide future TxDOT policy for meeting electric vehicle charging needs.

INITIATIVE DETAILS:

Timeline to Initiate:
Mid-Long Term (4 years & beyond)

Lead Stakeholder(s):
CAT Organization

Support Stakeholder(s):
Districts and TPD

RECOMMENDED PROJECT(S)/ACTION(S)

S22.I2.P1: Execute Charging Partnerships

PROJECT: Execute partnerships for electric vehicle charging in cities across Texas. Facilitate the expansion of electric vehicle charging infrastructure by providing planning support, right-of-way access, construction funding, or other resources available to TxDOT. Explore possibility for high-voltage charging stations at existing gas stations, leveraging existing fueling locations for future needs.

GOAL: Guide the appropriate and most widely beneficial expansion of electric vehicle charging infrastructure throughout TxDOT.

EXPECTED OUTCOME: Individual Municipal and Private Charging Partnerships.

S22.I2.P2: Electric Vehicle Charging Market Research

PROJECT: Survey Texans to better understand their perceptions, desires, and reservations relating to electric vehicles, electric vehicle charging. Study private business attitudes toward providing charging to customers and employees.

GOAL: Understand the desires of Texans toward vehicle electrification and charging infrastructure.

EXPECTED OUTCOME: Summary Report (10-15 pages) document

S23.I1: RESEARCH AND TEST CAV FLEET SCENARIOS

DESCRIPTION: TxDOT should research and test a variety of fleet scenarios for connected and automated vehicles. Before CAVs become a daily reality, TxDOT should prepare for the implications of mixed-fleet travel. The interaction of connected and automated vehicles with traditional vehicles will impact travel in TxDOT for decades after the first CAV arrives on Texas roads. Various levels of fleet penetration and multiple combinations of connected and automated technologies in vehicles may have very different impacts on travel for all road users.

EXPECTED BENEFITS: Understanding a variety of possible outcomes and scenarios, and testing solutions on TxDOT roads will give TxDOT the ability to confidently and competently plan for and transition to the future of transportation.

INITIATIVE DETAILS:

Timeline to Initiate:
Mid-Long Term (>4 years)

Lead Stakeholder(s):

CAT Organization

Support Stakeholder(s):

FOD, RTI, TOD, TPP, TRF, and TRV

RECOMMENDED PROJECT(S)/ACTION(S)

S23.I1.P1: CAV Facility Study (Dedicated Lanes and Mixed Fleet)

PROJECT: TxDOT should research the expected transportation impacts of connected and automated vehicles in mix-fleet scenarios as compared to CAV-dominated and universal CAV fleet penetration scenarios. Explore the possible social, environmental, economic, and operational impacts for a variety of these scenarios.

GOALS: Anticipate the impacts of mixed CAV fleet scenarios on Texas transportation, and plan for solutions to maximize overall benefits as possible.

EXPECTED OUTCOME: CAV Facilities Study Report, CAT "Connect" Brief: CAV Facilities Findings.

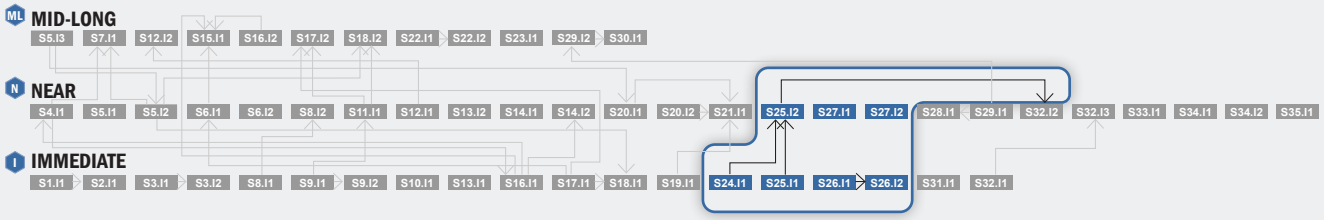
S23.I1.P2: Innovation Corridor CAT Lane Pilot

PROJECT: Using the constructed CAT infrastructure concentrated along innovation corridors, and possibly adapting existing toll lanes, TxDOT should implement and test a dedicated CAT lane. Study operations before and after implementation to determine all impacts of travel associated with the CAT lane implementation. CAT Lane should only be considered if there is already a recognizable presence of CAVs on the road under typical operational scenarios, or if a CAV fleet can be practicably deployed to the pilot location without disproportionately disrupting regular operations.

GOALS: Understand and extrapolate the benefits and costs of separating CAV traffic from traditional traffic to guide future policies regarding mixed-fleet traffic.

EXPECTED OUTCOME: CAT Lane Concept of Operations, CAT Lane Pilot Study Design, and Construction, CAT Lane Preliminary Findings Report.

SYSTEMS READINESS INITIATIVES



CAT Program Road Map

I S24.I1: Identify and Prioritize CAT Data Use Cases

- S24.I1.P1: CAT "Connect" Brief: How Can TxDOT Utilize CAT Data?
- S24.I1.A1: CAT Data Use Case Workshop

I S25.I1: Understand and Prepare for the Challenges of CAT Data

- S25.I1.P1: CAT "Connect" Brief – What are the Challenges of CAT Data?
- S25.I1.P2: CAT "Connect" Brief – A Guide to Being CAT Data Ready

N S25.I2: Modernize Existing Data Management Strategies

- S25.I2.P1: Develop CAT Data Management Framework
- S25.I2.P2: CAT Data Management Systems Concept of Operations
- S25.I2.P3: CAT "Connect" Brief: CAT Data Integration with LoneStar
- S25.I2.A1: Procure CAT Data Management Systems

I S26.I1: Be "At the Table" for CAT Data Standards Development

- S26.I1.A1: TxDOT Participation in Multiple National/ International Forums
- S26.I1.P1: CAT "Connect" Brief: What are the Minimum CAT Data Standards and Needs for TxDOT?

I S26.I2: Harmonize CAT Data Standards for Texas

- S26.I2.P1: CAT "Connect" Brief: Can TxDOT Keep up with CAT Data?
- S26.I2.A1: Adopt Statewide Data Standards & Protocols

N S27.I1: Create a CAT Clearinghouse

- S27.I1.P1: CAT Project Portal
- S27.I1.P2: CAT Portal Outreach Materials
- S27.I1.P3: CAT "Connect" Minute E-mail

N S27.I2: Connect CAT Data to a Centralized Data Lake

- S27.I2.A1: Include CAT Data in TxDOT's Data Lake

Interactive

S24.I1: IDENTIFY AND PRIORITIZE CAT DATA USE CASES

DESCRIPTION: TxDOT should develop CAT Data Use Cases to aid in the development of appropriate CAT Data Management Practices and Policies. TxDOT should seek to understand how the agency can utilize CAT data as well as develop department-wide standard data use cases.

EXPECTED BENEFITS: Developing sound CAT data management practices and policies support agile project management through the implementation of CAT. Well-established and prioritized data use procedures will facilitate uniformity, transferability, and collaborative use of CAT Data throughout Texas.

INITIATIVE DETAILS:

Timeline to Initiate:

Immediate Term (0-2 years)

Lead Stakeholder(s):

CAT Organization

Support Stakeholder(s):

Districts, ITD, MNT, MTD, RTI, SSD, TPP, and TRF

RECOMMENDED PROJECT(S)/ACTION(S)

S24.I1.P1: CAT "Connect" Brief: How Can TxDOT Utilize CAT Data?

PROJECT: This brief will: 1) document the type of data generated by CAT implementation, and 2) document the types of data that TxDOT uses currently. Once these data uses are documented, TxDOT or a Consultant should consider developing a Data Use Matrix by pairing data generation with TxDOT data use.

GOAL: Determine the type of data generated by CAT and determining how TxDOT can benefit from the use of that data.

EXPECTED OUTCOME: Technical Memorandum (5-15 pages) and CAT "Connect" Brief (1-2) summary document.

S24.I1.A1: CAT Data Use Case Workshop

ACTION: TxDOT should hold an internal workshop to discuss CAT data use cases. Potential agenda items include a morning presentation/review of the CAT Program, and the types of data that CAT implementation will generate. The afternoon session could potentially include a question and answer session with TxDOT Division and District leadership to determine ways the data can be utilized.

GOAL: Establish use cases and determine ways to maximize the utilization of CAT data.

S25.I1: UNDERSTAND AND PREPARE FOR THE CHALLENGES OF CAT DATA

DESCRIPTION: Based on the state of the practice efforts, CAT data could provide TxDOT with unique challenges such as storage, data collection, user management, analytical needs, data sharing, and standardization. TxDOT should investigate these challenges thoroughly and prepare accordingly. The vast potential for these technologies to improve travel could be limited by a failure to understand and meet the challenges presented by the management of CAT data.

EXPECTED BENEFITS: Understanding and preparing for CAT data and the ability to use that data supports agile project management. Understanding the challenges presented by CAT data management protects TxDOT from potential setbacks in the expansion of CAT, thus helping to accelerate TxDOT's preparedness for the transportation future.

INITIATIVE DETAILS:

Timeline to Initiate:
Immediate Term (0-2 years)

Lead Stakeholder(s):
CAT Organization

Support Stakeholder(s):
ITD, SSD, TPP, and TRF

RECOMMENDED PROJECT(S)/ACTION(S)

S25.I1.P1: CAT "Connect" Brief – What are the Challenges of CAT Data?

PROJECT: This brief should investigate and document the challenges of CAT data. This includes outlining any potential issues related to CAT data, including privacy, security, size, and format.

GOAL: Understand the challenges of CAT data.

EXPECTED OUTCOME: Technical Memorandum (5-15 pages) and CAT "Connect" Brief (1-2 page) summary document.

S25.I1.P2: CAT "Connect" Brief – A Guide to Being CAT Data Ready

PROJECT: TxDOT or a Consultant should prepare a guide for being CAT Data ready, including best practices for accommodating CAT data challenges, use cases and other relevant topics.

GOAL: Informational document that can be used by TxDOT staff to prepare for accommodating CAT data.

EXPECTED OUTCOME: CAT "Connect" Brief (1-2 page) summary document.

S25.I2: MODERNIZE EXISTING DATA MANAGEMENT STRATEGIES

DESCRIPTION: With the changing landscape of transportation data, TxDOT should modernize department data management strategies in preparation of CAT data. Existing systems are generally not equipped to handle the vast quantities of data that will be generated from widespread CAV presence and connected infrastructure. Appropriate processing and dissemination of CAT data will require upgraded strategies to quickly, securely, and reliably manage data.

EXPECTED BENEFITS: Preparing for the management of CAT data supports agile project management. Appropriate data management is essential for the successful implementation of CAT technologies as it will ensure the proper data is available quickly and reliably as it is needed, improving the effectiveness of TMCs, thus improving efficiency and safety of roadway operations. Efficiently managed CAT data will also facilitate improved planning, maintenance and public information sharing.

INITIATIVE DETAILS

Timeline to Initiate:
Near Term (2-4 years)

Lead Stakeholder(s):
CAT Organization

Support Stakeholder(s):
Districts, ITD, TPP, and TRF

RECOMMENDED PROJECT(S)/ACTION(S)

S25.I2.P1: Develop CAT Data Management Framework

PROJECT: To prepare for accepting and using CAT data, TxDOT should develop a CAT data management framework. This framework should outline vision and strategy, governance, processes, organization, and needed infrastructure.

GOAL: Develop a reference framework for CAT data management.

EXPECTED OUTCOME: Formal Planning Document, One-Pagers, Summary Report, and Presentation.

S25.I2.P2: CAT Data Management Systems Concept of Operations

PROJECT: TxDOT or a Consultant should develop a working CAT Data Concept of Operations, including vision, goals and objectives, project concepts, operational scenarios, and functional requirements.

GOAL: Document CAT Data Management as a systems engineering process for ITS purposes.

EXPECTED OUTCOME: Concept of Operations Report Document.

S25.I2.P3: CAT "Connect" Brief: CAT Data Integration with LoneStar

PROJECT: TxDOT or a Consultant should investigate and prepare to integrate CAT Data with the existing traffic management software – LoneStar. The project would review current LoneStar documentation and develop recommendations on using CAT Data with the LoneStar software.

GOAL: Determine CAT Data integration opportunities with LoneStar.

EXPECTED OUTCOME: Technical Memorandum (5-15 pages) and CAT "Connect" Brief (1-2 page) summary document.

S25.I2.A1: Procure CAT Data Management Systems

ACTION: TxDOT should lead the design and procurement of CAT Data management systems required to support CAT data management functionality, as identified in the CAT Data Management Systems Concept of Operations.

GOAL: Procure data management systems to meet the needs of CAT Data.

S26.I1: BE "AT THE TABLE" FOR CAT DATA STANDARDS DEVELOPMENT

DESCRIPTION: TxDOT should strive to be a significant player in the development of CAT and CAT Data Standards. TxDOT should provide opportunities for staff to participate in national and international CAT & CAV forums. Through the development of CAT Data Management Systems, TxDOT will amass experience and establish best practices that can be shared on the national and international stage.

EXPECTED BENEFITS: Allows TxDOT to exchange information and influence CAT Standards development on the national stage. TxDOT can benefit by learning from the experience of others while establishing leadership and sharing data standards to ensure CAT technologies are interoperable within and beyond the borders of Texas.

INITIATIVE DETAILS:

Timeline to Initiate:

Immediate Term (0-2 years)

Lead Stakeholder(s):

CAT Organization

Support Stakeholder(s):

ITD, TPP, and TRF

RECOMMENDED PROJECT(S)/ACTION(S)

S26.I1.A1: TxDOT Participation in Multiple National/International Forums

ACTION: Encourage TxDOT Staff participation in national and international CV/AV data forums and committees.

GOAL: Enhance TxDOT's visibility and participation in the CAT data standards development.

S26.I1.P1: CAT "Connect" Brief: What are the Minimum CAT Data Standards and Needs for TxDOT?

PROJECT: TxDOT or a Consultant should explore and document the minimum CAT Data standards and needs for TxDOT. This would include a CAT Data Dictionary to specify terminology, as well as how CAT data is described and recorded toward the development of a CAT Data Dictionary.

GOAL: Understand minimum data standards and needs of TxDOT.

EXPECTED OUTCOME: CAT "Connect" Brief (1-2 page) summary document.

S26.I2: HARMONIZE CAT DATA STANDARDS FOR TEXAS

DESCRIPTION: To ensure consistency in the generation and use of CAT data, TxDOT should develop and adopt standards and protocols. Understanding IT capabilities as well as recruiting the experience of CAT data experts may aide in the process. Properly established standards will ensure that TxDOT systems are deployed consistently and will help to guide vendor product development to ensure compliance with TxDOT standards.

EXPECTED BENEFITS: Establish a minimum standard for receiving and processing CAT data, ensuring the interoperability of CAT systems throughout Texas.

INITIATIVE DETAILS:

Timeline to Initiate:

Immediate Term (0-2 years)

Lead Stakeholder(s):

ITD

Support Stakeholder(s):

CAT Organization, CMD, Districts, TPP, TRF, and TRV

RECOMMENDED PROJECT(S)/ACTION(S)

S26.I2.P1: CAT "Connect" Brief: Can TxDOT Keep up with CAT Data?

GOAL: TxDOT or a Consultant should answer the question, "Can TxDOT keep up with CAT Data?" This would include a review of CAT Data requirements established for national CAT deployments, industry standards and legislative standards related to the exchange of CAT data. The brief should also provide a matrix to identify gaps between current CAT data standards and TxDOT's data standards

EXPECTED OUTCOME: CAT "Connect" Brief (1-2 page) summary document.

S26.I2.A1: Develop Statewide Data Standards & Protocols

ACTION: TxDOT should develop statewide CAT Data standards and protocols, including a CAT Data Dictionary.

GOAL: Standardization of CAT Data across Texas.

S27.I1: CREATE A CAT CLEARINGHOUSE

DESCRIPTION: TxDOT should centralize all CAT initiative information such as plans, CAT "Connect" Briefs, and essential planning documents. To accomplish this, TxDOT should create a CAT clearinghouse on the proposed CAT Webpage, sharing an archive of the CAT Program and project information, applicable white papers, standards, CAT Academy resources, and updates on the latest CAT Program activities.

EXPECTED BENEFITS: Through consistent information sharing, the CAT Program can be shared easily with all TxDOT staff and interested stakeholders and facilitate the successful implementation of CAT standards, projects, and policies.

INITIATIVE DETAILS:

Timeline to Initiate:

Near Term (2-4 years)

Lead Stakeholder(s):

STR

Support Stakeholder(s):

CAT Organization, CMD, Districts, ITD, and TRF

RECOMMENDED PROJECT(S)/ACTION(S)

S27.I1.P1: CAT Project Portal

PROJECT: TxDOT should develop a CAT Project Portal as part of the TxDOT CAT Clearinghouse. The CAT Project Portal should document and provide information on all the past, present, and funded CAT projects across the State. This project would include the development of a web portal architecture/ structure and current content. Future updates would be the responsibility of the CAT Organization.

GOAL: Provide information on past, ongoing, and future Texas-based CAT projects.

EXPECTED OUTCOME: Webpage and content.

S27.I1.P2: CAT Portal Outreach Materials

PROJECT: TxDOT should develop outreach materials to promote and provide guidance on use of the TxDOT CAT Clearinghouse.

GOAL: Develop and provide CAT outreach materials.

EXPECTED OUTCOME: CAT Outreach Materials

S27.I1.P3: CAT "Connect" Minute E-mail

PROJECT: TxDOT should email regular CAT activity updates to those that wish to receive them, including CAT Organization staff, members of the CAV-CAT Work Group, members of the CAT Technical Work Group, and those that subscribe for updates via the CAT Project Portal. These CAT "Connect" Minute emails may communicate information on CAT projects, outreach materials, relevant national news, etc.

GOAL: Development of e-mail protocols and templates for information exchange.

EXPECTED OUTCOME: E-mail guidelines and templates.

S27.I2: CONNECT CAT DATA TO A CENTRALIZED DATA LAKE

DESCRIPTION: To further the goals of the CAT Program, TxDOT should aggressively distribute and make available CAT Data. To accomplish this, TxDOT should link new CAT data to the existing data lake. Through transparent sharing of CAT data on established channels of communication, TxDOT will continue to raise awareness of CAT Program efforts and expand CAT literacy throughout the agency.

EXPECTED BENEFITS: Widespread CAT data availability will allow for transparency regarding the uses of CAT data and innovative research through secure and anonymized CAT data sharing.

INITIATIVE DETAILS

Timeline to Initiate:

Near Term (2-4 years)

Lead Stakeholder(s):

CAT Organization

Support Stakeholder(s):

Districts, ITD, STR, TPP, and TRF

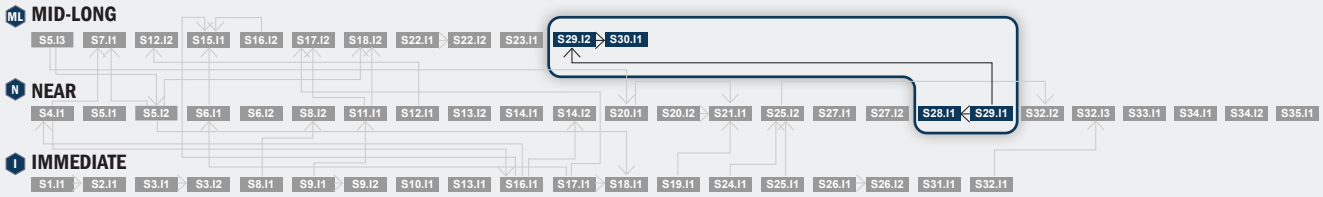
RECOMMENDED PROJECT(S)/ACTION(S)

S27.I2.A1: Include CAT Data in TxDOT's Data Lake

ACTION: TxDOT should investigate the ability to include CAT Data in their centralized data lake

GOAL: Include TxDOT CAT Data in a centralized data lake to ensure easy access and transparency of CAT data

MULTIMODAL INITIATIVES



CAT Program Road Map

N S28.I1: Develop Design Toolkit for Vulnerable Road Users

» S28.I1.P1: CAT "Connect" Brief: Accessible and Active CAT Design Toolkit

N S29.I1: Study Multimodal CAT Applications

» S29.I1.P1: CAT "Connect" Brief: Multimodal Whitepaper Series

ML S29.I2: Explore Multimodal Partnership and Pilot

» S29.I2.P1: Pilot Multimodal CV Priority System Application(s) Deployment

ML S30.I1: Develop Next Generation Mobility Hub Concepts

» S30.I1.P1: CAT "Connect" Brief: Next Generation Mobility Hub

» S30.I1.P2: Mobility Hub Feasibility and Needs Study

Interactive

S28.I1: DEVELOP DESIGN TOOLKIT FOR VULNERABLE ROAD USERS

DESCRIPTION: TxDOT should create a toolkit of design guidelines and resources meant to ensure the safety of vulnerable road users, including pedestrians, cyclists, scooter users, and people with disabilities.

EXPECTED BENEFITS: Developing a design toolkit focused on accessibility and active transportation will offer a consolidated resource to engineers, planners and design professionals. Utilizing this toolkit will increase pedestrians' visibility, and cyclists will enhance the functionality of CAT applications that detect and respond to other road users, thereby promoting overall safety.

INITIATIVE DETAILS:

Timeline to Initiate:

Near Term (2-4 years)

Lead Stakeholder(s):

CAT Organization

Support Stakeholder(s):

CIV, DES, Districts, PTN, RRD, and TRF

RECOMMENDED PROJECT(S)/ACTION(S)

S28.I1.P1: CAT "Connect" Brief: Accessible and Active CAT Design Toolkit

PROJECT: This brief will summarize a list of design standards and specifications that enhance accessibility and safety of vulnerable road users, especially in CAT deployment areas. The report may include potential topics and informational materials based on the event type.

GOAL: Provide TxDOT with a reference document that identifies design elements that increase safety for vulnerable road users in CAT deployment areas.

EXPECTED OUTCOME: CAT "Connect" Brief (5-10 page) document.

S29.I1: STUDY MULTIMODAL CAT APPLICATIONS

DESCRIPTION: CAT technologies can impact several of the modes under TxDOT jurisdiction and affect the transportation system regardless of the geographic scale of the deployment. To plan all modes of transportation effectively, TxDOT should research CAT applications and technologies that benefit various modes of travel, such as E-bike/Scooters, Rail, Truck, UAS, Maritime, and Aviation.

EXPECTED BENEFITS: Research and potential implementation of multimodal CAT application will allow TxDOT to plan for impacts to varying modes of travel and maximize benefits to all road users.

INITIATIVE DETAILS:

Timeline to Initiate:
Near Term (2-4 years)

Lead Stakeholder(s):

CAT Organization

Support Stakeholder(s):

AVN, Districts, MRD, PTN, RRD, RTI, and TPP

RECOMMENDED PROJECT(S)/ACTION(S)

S29.I1.P1: Multimodal CAT Whitepaper Series

PROJECT: In an effort to study current multimodal CAT applications, TxDOT should develop a series of whitepapers on the following topics:

- Smartphone and e-bike/scooter CV applications for pedestrians and cyclists;
- CV mobility applications that improve safety and mobility for transit vehicles and riders;
- Rail technologies that enable device connectivity, provide real-time operations data and support forecasting analysis;
- Freight platooning applications (automated truck delivery systems and automated rail/unmanned aircraft system/ ship technologies for freight, aviation, and maritime travel);
- Unmanned aircraft system technologies for ambulatory services and incidents.

GOAL: Research the potential implementation of CAT technologies with the multimodal applications.

EXPECTED OUTCOME: Mutimodal CAT Application White Papers

S29.I2: EXPLORE MULTIMODAL PARTNERSHIP AND PILOT OPPORTUNITIES

DESCRIPTION: TxDOT should consider partnerships opportunities to study and pilot CAT technologies , some of which may have been identified in the Multimodal CAT Applications White Paper Series. Steps to positioning TxDOT for multimodal CAT pilot deployments include:

- Identifying project location(s) with significant freight, transit, and pedestrian activities;
- Establishing stakeholder partnerships with freight operators, transit agencies and local governments;
- Upgrading traffic signal equipment to support CV applications such as Transit Signal Priority, Freight Signal Priority, Mobile Accessible Pedestrian Signal System, Emergency Vehicle Preemption;
- Installing roadside units at critical locations on the corridor;
- Coordinating the installation of onboard units on select trucks or buses.

TxDOT should leverage on-going initiatives such as Connected Freight Corridor, Freight Technology Plan, ETTP, and TTP 2050 to strengthen TxDOT's multimodal network.

EXPECTED BENEFITS: Collaboration between TxDOT and agencies involved in transportation operations and public safety brings tangible benefits to the transportation system users through improved mobility and safety and the participating agencies.

INITIATIVE DETAILS:

Timeline to Initiate:
Mid-Long Term (>4 years)

Lead Stakeholder(s):
CAT Organization

Support Stakeholder(s):
AVN, Districts, MRD, PTN, RRD, RTI, TPP, TRF, and TRV

RECOMMENDED PROJECT(S)/ACTION(S)

S29.I2.P1: Pilot Multimodal CV Priority System Application(s) Deployment

PROJECT: As part of the collaborative pilot testing, TxDOT should work with local transit service providers, cities, and MPOs to implement Transit Signal Priority, Freight Signal Priority, Mobile Accessible Pedestrian Signal System, and Emergency Vehicle Preemption in urban and rural settings.

GOAL: Pilot testing of multimodal CV priority system applications through multi-agency collaboration.

EXPECTED OUTCOME: CV Priority System Concept of Operations, CV Application Pilot Study Design, and Construction.

S30.I1: DEVELOP NEXT GENERATION MOBILITY HUB CONCEPTS

DESCRIPTION: Mobility hubs provide a focal point in the transportation network that aims at seamlessly integrating corridor-to-corridor, mode-to-mode transfer in activity centers, and critical points of intersecting transportation infrastructure. The CAT infrastructure supportive hubs would go beyond basic park-and-ride facilities and provide access to all modes in the region through an integrated transportation network based on rural and urban needs.TxDOT should research design concepts and pilot locations for mobility hubs that incorporate CAT infrastructure, such as EV charging facilities and AV parking and pick-up/drop-off services.

EXPECTED BENEFITS: Mobility hubs can play a vital role in connecting people with destinations by providing benefits such as multimodal connection, congestion relief, first/last mile connection, and community services. Next-generation mobility hubs that include additional modes and uses can provide even more benefits to Texans.

INITIATIVE DETAILS:

Timeline to Initiate:
Mid-Long Term (>4 years)

Lead Stakeholder(s):
RTI

Support Stakeholder(s):
CAT Organization, Districts, PTN, and TPP

RECOMMENDED PROJECT(S)/ACTION(S)

S30.I1.P1: CAT "Connect" Brief: Next Generation Mobility Hub

PROJECT: This brief should summarize the concepts and requirements of a next-generation mobility hub. The document will explore hubs beyond park-and-ride facilities, incorporating innovative design concepts such as parking, transit, and other future Mobility-As-A-Service (MaaS) options.

GOAL: Conceptualize mobility hubs that meet CAT needs.

EXPECTED OUTCOME: CAT "Connect" Brief (5-10 page) document.

S30.I1.P2: Mobility Hub Feasibility and Needs Study

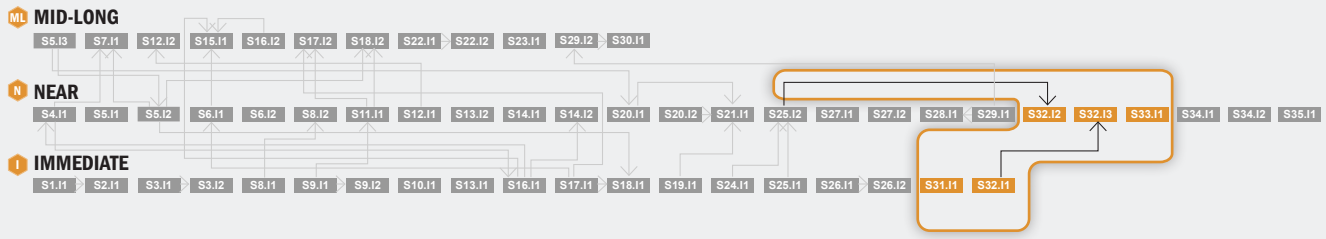
PROJECT: TxDOT should assess the Mobility Hub's infrastructure needs for urban and rural areas. The study should focus on the requirements of AV parking, EV charging, curb management, real-time data (parking occupancy, wayfinding, congestion management, etc.), and Loading/Unloading Zones within a mobility hub. Additionally, the feasibility study should identify potential locations for deploying mobility hubs that will support CAT technologies.

GOAL: Research feasibility of deploying Next Generation Mobility Hubs across Texas.

EXPECTED OUTCOME: Technical Report (10-15 page) and CAT "Connect" Brief (5-10 page) document.

FOCUS AREA

MAINTENANCE & OPERATIONS INITIATIVES



CAT Program Road Map

I S31.I1: Explore CAT Opportunities to Enhance TxDOT Maintenance & Operations

- S31.I1.A1: Maintenance & Operations CAT Opportunities Workshop
- S31.I1.P1: CAT "Connect" Brief: Maintenance & Operations CAT Opportunities
- S31.I1.P2: Deploy Maintenance & Operations CAT Project

I S32.I1: Study CAT Influence on TSMO Practices

- S32.I1.P1: CAT "Connect" Brief: TSMO Opportunities with CAT

N S32.I2: Use Real-Time CAT Data for Improved Operations and Management

- S32.I2.P1: CAT "Connect" Brief: Real-Time Monitoring and Traffic Data Collection
- S32.I2.A1: Real-Time CAT Data Dashboard

N S32.I3: Integrate CAT into Regular Operations and Maintenance

- S32.I3.P1: Develop TSMO-CAT Integration Concept of Operations
- S32.I3.P2: Update TSMO Standard Operating Procedures to Incorporate CAT Applications

N S33.I1: Synchronize CAT and Current Smart Work Zone Practices

- S33.I1.P1: CAT "Connect" Brief: CAT and Smart Work Zones
- S33.I1.P2: Deploy and Evaluate CAT/Work Zone Applications
- S33.I1.A1: Update Smart Work Zone Guidance
- S33.I1.A2: Align Connected Smart Work Zone Effort with CAT Strategic/Program Plans

Interactive

S31.I1: EXPLORE CAT OPPORTUNITIES TO ENHANCE TXDOT MAINTENANCE & OPERATIONS

DESCRIPTION: TxDOT aims to invest in CAT efforts that align with its goals and meets its operational needs. Therefore the agency should seek to deploy CAT projects that meet its most pressing Maintenance & Operations needs. Opportunities that directly meet those needs will be prioritized for execution.

EXPECTED BENEFITS: This initiative will ensure targeted CAT deployments with measurable benefits to Maintenance & Operations.

INITIATIVE DETAILS:

Timeline to Initiate:

Immediate Term (0-2 years)

Lead Stakeholder(s):

CAT Organization

Support Stakeholder(s):

Districts, ITD, MNT, RTI, STR, and TRF

RECOMMENDED PROJECT(S)/ACTION(S)

S31.I1.A1: Maintenance & Operations CAT Opportunities Workshop

ACTION: TxDOT should hold an internal workshop to discuss Maintenance & Operations activities and use cases that may be enhanced by CAT applications.

GOAL: Establish use cases and determine ways to maximize the deployment of CAT applications.

S31.I1.P1: CAT "Connect" Brief: Maintenance & Operations CAT Opportunities

PROJECT: This brief will investigate and document CAT applications used to improve Maintenance & Operations. It should also provide a snapshot of ongoing Maintenance & Operations CAT efforts around the country.

GOAL: Document available and currently deployed maintenance and operations CAT applications for consideration by TxDOT.

EXPECTED OUTCOME: CAT "Connect" Brief (1-2 page) document.

S31.I1.P2: Deploy Maintenance & Operations CAT Project

PROJECT: TxDOT should develop and deploy a Maintenance & Operations CAT project that aligns with one or more of the agency's use cases.

GOAL: Maximize the potential benefits of CAT deployments.

EXPECTED OUTCOME: Project Concept of Operations, Design, and Construction

S32.I1: STUDY CAT INFLUENCE ON TSMO PRACTICES

DESCRIPTION: The Statewide TSMO Plan that is currently underway has several overlapping goals and objectives of the CAT Program. It is important for the success of these two programs that TxDOT document how CAT will impact existing TSMO guidance and develop recommendations. The CAT Organization should investigate through one-on-one interviews and complete a comparative planning analysis to determine what has been accomplished with TSMO, and leverage possible overlaps and synergies.

EXPECTED BENEFITS: Understanding overlapping goals and objectives of the TSMO plan and possible impact will prepare TxDOT for CAT integration. Investigating these overlaps and developing recommendations could help TxDOT save time and resources and support the integration of the CAT Program.

INITIATIVE DETAILS:

Timeline to Initiate:

Immediate Term 0-2 years)

Lead Stakeholder(s):

CAT Organization

Support Stakeholder(s):

Districts and TRF

RECOMMENDED PROJECT(S)/ACTION(S)

S32.I1.P1: CAT "Connect" Brief: TSMO Opportunities with CAT

PROJECT: This brief should provide findings on a review of existing TSMO practices and determine potential impacts from CAT Projects/Deployments. Analysis of these impacts will produce recommendations for integrating CAT activities. The brief will specifically investigate the TSMO planning documents from each District and could further provide recommendations for urban and rural settings.

GOAL: Provide recommendations to aid integration of CAT projects and deployments into TSMO practices with a specific focus on District plans.

EXPECTED OUTCOME: CAT "Connect" Brief documents.

S32.I2: USE REAL-TIME CAT DATA FOR IMPROVED OPERATIONS AND MANAGEMENT

DESCRIPTION: With the successful deployment of CAT projects across the state, TxDOT will be able to capture increasing levels of real-time CAT Data. TxDOT should use this real-time CAT data to monitor traffic operations and improve current operations and management efforts. CAT data could include travel time reliability, device up time percentages, data usage, vehicles connected, and incident clearance times among many potential data sets. In the future, roadside units may also be able to capture CV/AV penetration rates allowing for the development algorithms to determine benefits based on rate of penetration.

EXPECTED BENEFITS: TxDOT will be able to make decisions using accurate real-time data which could potentially save time and resources for the operations and maintenance of the State's transportation facilities.

INITIATIVE DETAILS:

Timeline to Initiate:

Near Term (2-4 years)

Lead Stakeholder(s):

CAT Organization

Support Stakeholder(s):

Districts, ITD, TPP, and TRF

RECOMMENDED PROJECT(S)/ACTION(S)

S32.I2.P1: CAT "Connect" Brief: Real-Time Monitoring and Traffic Data Collection

PROJECT: This brief should outline potential scenarios for real-time monitoring and traffic data collection practices using CAT Data. The document would index data types and provide recommendations for dashboard modules and data presentation. Suggestions for potential equation-based algorithms will also be presented.

GOAL: Develop monitoring and data collection scenarios using CAT Data for further development. Development and implementation of CAT data scenarios could potentially save time and resources for the operations and maintenance of the State's transportation facilities.

EXPECTED OUTCOME: CAT "Connect" Brief (1-2 page) document.

S32.I2.A1: Real-Time CAT Data Dashboard

ACTION: As CV/AV penetration and the number of deployments increase, TxDOT should collect and utilize real-time CAT Data to create or improve existing real-time data dashboards.

GOAL: Using available real-time data to improve/enhance real-time monitoring and data collection should aid TxDOT in saving time and resources.

EXPECTED OUTCOME: Additional or enhanced real-time data dashboard modules.

S32.I3: INTEGRATE CAT INTO REGULAR OPERATIONS AND MAINTENANCE

DESCRIPTION: Eventually, the CAT Organization will have to investigate and document how CAT will be utilized on an ongoing and sustained basis. This will be necessary to maximize the safety and operational benefits of CAT and associated technologies. One potential tool to aid in the consistent and sustained use of CAT is to develop a CAT Integration Master Plan. Since it is somewhat uncertain how CAT will be integrated into current TxDOT operations and management practices, this document will be key to the success of the CAT Program. TxDOT must plan for integrating CAT technologies into current systems and practices.

EXPECTED BENEFITS: Planning for the full integration of CAT will provide TxDOT with time to prepare current systems and modify existing practices before significant penetration. These preparations and modifications will aid in successful and efficient integration of CAT on an ongoing basis and improve safety and operations while saving TxDOT time and resources.

INITIATIVE DETAILS:

Timeline to Initiate:
Near Term (2-4 years)

Lead Stakeholder(s):

CAT Organization

Support Stakeholder(s):

Districts, ITD, MNT, TPP, and TRF

RECOMMENDED PROJECT(S)/ACTION(S)

S32.I3.P1: Develop TSMO-CAT Integration Concept of Operations

PROJECT: TxDOT should develop a TSMO-CAT Concept of Operations to identify how the CAT Program would integrate with existing TxDOT practices, policies, and procedures. The document could potentially identify the CAT Program as a system and provide/define System Engineering Management elements and further detail CAT Project through architecture, operational scenarios (deployments), and functional requirements.

GOAL: To benefit from the ongoing and sustained integration of CAT by establishing and utilizing a CAT Concept of Operations.

EXPECTED OUTCOME: Planning Document, One-Pagers, Summary Report, and Presentation.

S32.I3.P1: Update TSMO Standard Operating Procedures to Incorporate CAT Applications

PROJECT: TxDOT or a Consultant should identify and update TSMO Standard Operating Procedures that are affected by the CAT Program.

GOAL: Maintain clear and documented instruction of operational changes related to CAT.

EXPECTED OUTCOME: Ensure smooth TSMO execution.

S33.I1: SYNCHRONIZE CAT AND CURRENT CONNECTED WORK ZONE PRACTICES

DESCRIPTION: TxDOT recently produced guidance detailing Connected Work Zone Practices. TxDOT's RTI Division recently kicked off the Connected Work Zone research project. Currently, it is unclear how the proposed CAT Program Plan and CAT Organization will integrate activities into existing Connected Work Zone practices and research. TxDOT will continue to play an important role in USDOT's Work Zone Data Exchange (WZDx) initiative. TxDOT should coordinate established guidance and current activities with the CAT Program and update any existing or proposed guidance to eliminate conflicting recommendations.

EXPECTED BENEFITS: The coordination and alignment of the CAT Program, existing Connected Work Zone guidance and research recommendations. This alignment will prevent conflicting recommendations and save TxDOT time and resources.

INITIATIVE DETAILS:

Timeline to Initiate:
Near Term (2-4 years)

Lead Stakeholder(s):
CAT Organization

Support Stakeholder(s):
CST, Districts, MTD, RTI, and TRF

RECOMMENDED PROJECT(S)/ACTION(S)

S33.I1.P1: CAT "Connect" Brief: CAT and Connected Work Zones

PROJECT: To determine the impacts of the CAT Program on Connected Work Zone practices it will be necessary for TxDOT or a Consultant to identify overlapping applications, pilots and deployments between CAT Program, Connected Work Zones guidance and recommendations. This brief should present a comparative matrix of Connected Work Zone and CAT Program applications and provide recommendations for alignment. This project may also require TxDOT to include authors in Connected Work Zone meetings and communications.

GOAL: The comparisons and documentation of CAT Program, existing Connected Work Zone guidance and research will allow for discovery of potential conflicts. Identifying potential conflicts will allow for alignment and potentially save TxDOT time and resources.

EXPECTED OUTCOME: CAT "Connect" Brief (1-2 page) document.

S33.I1.P2: Deploy and Evaluate CAT/Work Zone Applications

PROJECT: TxDOT should deploy and evaluate CAT/Work Zone Applications. Utilizing current Connected Work Zone deployments, TxDOT can leverage ongoing projects to deploy and evaluate CAT-Work Zone Applications. Some of these applications have been significantly established under the Connected Work Zone title. Deploying and evaluating these applications under the CAT Program will further establish TxDOT's commitment to improved safety and operations in work zones.

GOAL: Effectively establish current Smart Work Zone applications for integration into existing operations and maintenance practices on an on-going basis. Essentially, deploy and evaluate CAT/Work Zone applications for future use.

EXPECTED OUTCOME: Formal Report on Deployment Activities, Summary Report, and Presentation.

S33.I1.A1: Update Smart Work Zone Guidance

ACTION: Based on findings of S33.I1.P1 and Smart Work Zone deployments, TxDOT should update established Smart Work Zone guidance to reflect CAT activities.

GOALS: Align CAT Program activities and findings with existing smart work zone guidance.

EXPECTED OUTCOME: TxDOT will publish updated Smart Work Zone guidance.

S33.I1.A2: Align Connected Smart Work Zone Effort with CAT Strategic/Program Plans

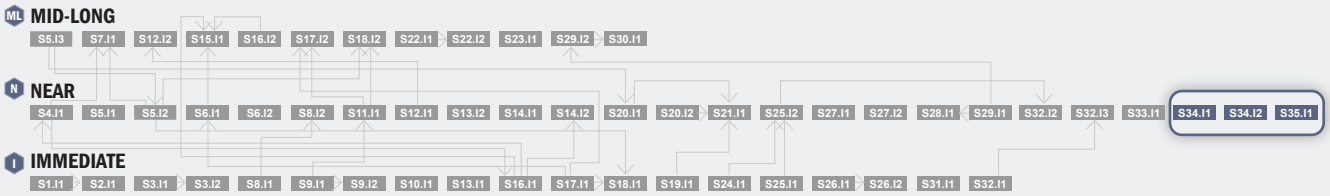
ACTION: Based on findings of S33.I1.P1 and Smart Work Zone deployments, TxDOT should coordinate current Connected Smart Work activities with CAT Program activities.

GOALS: Align CAT Program activities with current connected Smart Work Zone activities and future recommendations.

EXPECTED OUTCOME: TxDOT will coordinate CAT Program activities and connected Smart Work Zone research.

FOCUS AREA

PROCUREMENT INITIATIVES



CAT Program Road Map

N S34.I1: Proactively Update Active Procurement Lists

- S34.I1.A1: Create/Maintain a CAT Material Producer List and Prequalified Product List

N S34.I2: Provide Flexible Bid Codes

- S34.I2.A1: Develop Comprehensive CAT Bid Codes
- S34.I2.A2: Educate and Reinforce use of Special Accounts for CAT Projects

N S35.I1: Support Effective and Flexible CAT Procurement Practices

- S35.I1.P1: CAT "Connect" Brief: Technology Procurement Best Practices
- S35.I1.P2: CAT "Connect" Brief: Review of TxDOT's Technology Procurement Practices

Interactive

S34.I1: PROACTIVELY UPDATE ACTIVE PROCUREMENT LISTS

DESCRIPTION: To increase the ability for the CAT Organization to successfully plan, design, and let CAT deployments, contractors will need the ability to procure the required products and devices. These products and devices often are new and continually changing. To avoid procurement delays and further standardize CAT, TxDOT must aggressively update active procurement lists such as Material Producer List and Prequalified Product List through efficient New Product Evaluation protocols.

EXPECTED BENEFITS: Aggressively updating the Material Producer List and Prequalified Product List will benefit TxDOT in two ways. First, these updates will prevent delays in CAT Project procurement. Secondly, it will send a message to technology providers and vendors that TxDOT is prepared for innovative technologies and further establish the CAT Program.

INITIATIVE DETAILS:

Timeline to Initiate:
Near Term (2-4 years)

Lead Stakeholder(s):
CAT Organization

Support Stakeholder(s):
PRO, RTI, and TRF

RECOMMENDED PROJECT(S)/ACTION(S)

S34.I1.A1: Create/Maintain a CAT Material Producer List and Prequalified Product List

ACTION: TxDOT should consider allowing the CAT Organization to work with the current RTI evaluation process to create and maintain a CAT Organization submission determination for Product Evaluation Requests. The CAT Organization should work with existing guidance and policies to develop rapid approval mechanisms to aggressively update the Material Producer List and Prequalified Products List.

GOAL: Aggressively updating a CAT Organization led Material Producer List and Prequalified Products List to provide for improved procurement abilities to aid in the success of planning, designing, and letting CAT Projects.

EXPECTED OUTCOME: Material Producer List and Prequalified Products List that is current and able to handle CAT project procurement needs.

S34.I2: PROVIDE FLEXIBLE BID CODES

DESCRIPTION: In addition to providing efficient new product evaluation and updating producer and product lists, TxDOT should utilize the Department's internal bid code system to support the CAT Program. TxDOT has found ways to bid projects with emerging technologies and products utilizing global bid codes and force accounts. To aid the CAT Organization, TxDOT should provide flexibility to designers and engineers by developing bid codes and specifications directly for CAT Projects. Lastly, TxDOT should utilize Force accounts to furnish materials and provide skilled maintenance work for CAT projects.

EXPECTED BENEFITS: Providing CAT bid codes and/or CAT Organization Force Accounts creates the ability for designers to include items in quantity and estimate tables in PS&E packages for letting. This ability will improve the efficiency of CAT Projects potentially saving TxDOT time and resources.

INITIATIVE DETAILS:

Timeline to Initiate:
Near Term (2-4 years)

Lead Stakeholder(s):
CAT Organization

Support Stakeholder(s):
Districts, MTD, PRO, and TRF

RECOMMENDED PROJECT(S)/ACTION(S)

S34.I2.A1: Develop Comprehensive CAT Bid Codes

ACTION: To provide flexibility, the CAT Organization should work with relevant division(s) to develop a set of comprehensive CAT System bid codes. These codes and specifications could provide for full installation of CAT Systems by Deployment Focus Areas. Example “Install Freeway CAT System” or “Install Intersection CAT System”.

GOAL: Developing comprehensive installation bid codes for the CAT Program will allow for flexibility in design and bidding. This flexibility will create efficiencies and potentially save TxDOT time and resources.

EXPECTED OUTCOME: List of approved comprehensive CAT Bid Codes and Specifications.

S34.I2.A2: Educate and Reinforce use of Special Accounts for CAT Projects

ACTION: It should be considered inevitable that CAT projects will require a product that has not been added to the Material Producer List or Prequalified Product List at the time of construction. To provide flexibility, the CAT Organization should educate and reinforce the use of Special Accounts for use in PS&E.

GOAL: Educating and reinforcing the use of Special Accounts will provide flexibility in design and bidding. This flexibility will create efficiencies and potentially save TxDOT time and resources.

EXPECTED OUTCOME: Educated staff and consultants on the use of Special Accounts to aid in project design and construction.

S35.I1: SUPPORT EFFECTIVE AND FLEXIBLE CAT PROCUREMENT PRACTICES

DESCRIPTION: As technology and devices continue to influence transportation, it will be vital to remain agile with the ability to adapt to new concepts, systems, and installations. To get ahead of this changing landscape, TxDOT should review critical paths and barriers to the successful integration of the CAT Program. One area that could prove to act as a barrier to CAT integration are product and professional services procurement. TxDOT should review current procurement practices and identify any barriers to CAT Program Integration and provide recommendations for improvement, if required.

EXPECTED BENEFITS: Reviewing procurement policies and procedures will help the CAT Organization identify potential barriers to CAT integration and allow for recommended actions. Resolving or eliminating barriers to CAT integration will allow for the successful procurement of professional services, bidding, and goods.

INITIATIVE DETAILS:

Timeline to Initiate:

Near Term (2-4 years)

Lead Stakeholder(s):

CAT Organization

Support Stakeholder(s):

PEPS, PRO, and TRF

RECOMMENDED PROJECT(S)/ACTION(S)

S35.I1.P1: CAT "Connect" Brief: Technology Procurement Best Practices

PROJECT: This brief should review the procurement practices of other State DOTs regarding innovation and provide recommendation for best practices. TxDOT or a Consultant should complete a thorough state-of-the-practice review of other state DOT procurement practices with a focus on innovation. Additionally, authors may wish to conduct a survey or one-on-one discussions with other state DOTs to learn of ways these agencies are handling innovative systems and procurement. The summary brief would include lessons learned and recommended best practices for TxDOT's consideration.

GOAL: Establish recommended Best Practices for flexible procurement to aid CAT Program integration. These best practices, if implemented, have the potential to save TxDOT time and resources.

EXPECTED OUTCOME: Technical Memorandum (5-15 pages) and CAT "Connect" Brief (1-2) summary document.

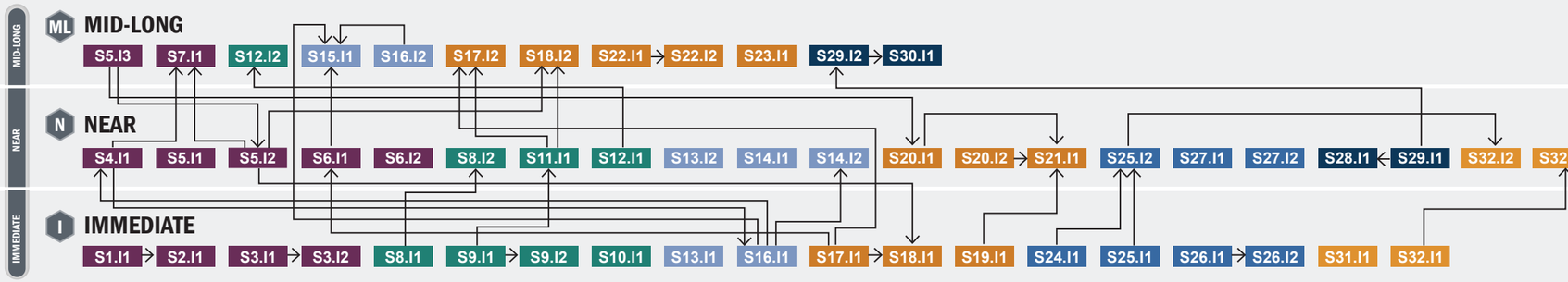
S35.I1.P2: CAT "Connect" Brief: Review of TxDOT Procurement Practices

PROJECT: This brief would review and document current TxDOT professional services, bidding, and goods procurement practices and complete a comparative analysis to the Best Practices recommended in CAT "Connect" Brief: Technology Procurement Best Practices. The analysis would result in the identification of procurement practices that could aid the CAT Program and practices that could act as barriers to CAT integration. The brief will produce recommendations for changes to provide for more agile TxDOT procurement practices to support CAT Program integration.

GOAL: Provide recommendations (for consideration) that could improve procurement practice and aid integration of the CAT Program. Resolving or eliminating barriers will allow for the successful procurement of needed services and products.

EXPECTED OUTCOME: CAT "Connect" Brief (1-2 page) document.

CAT Program Roadmap



IMMEDIATE TERM INITIATIVES

S1.I1 Establish a CAT Organization
ADM - FIN, HRD, STR, TPD, TPP, & TRF
- S1.I1.P1 CAT "Connect" Brief: The TxDOT CAT Organization & Staffing Needs
- S1.I1.P2 CAT Organization Annual Report
- S1.I1.A1 Expand Current CAV Work Group to a Form Joint CAV-CAT Work Group
- S1.I1.A2 Instate the CAT Program
- S1.I1.P3 CAT Organization Policy Manual

S2.I1 Establish Open Channels of Communication and Information Exchange
CAT Organization - CAV Work Group, CMD, Districts, STR, TPP, & TRF
- S2.I1.P1 CAT "Connect" Brief TxDOT Emerging Technology Planning Matrix
- S2.I1.P2 CAT "Connect" Brief: Emerging Technology Initiatives Summary Sheet
- S2.I1.A1 Appoint a Technical Work Group
- S2.I1.A2 Organize Emerging Technology Initiatives Meeting Series
- S2.I1.A3 Report: Prioritized Updates to Emerging Transportation Technology Plan

S3.I1 Identify CAT Security and Privacy Issues
CAT Organization - CMD, GCD, ITD, & TRF
- S3.I1.P1 CAT "Connect" Brief: CAT Security and Privacy Concerns
- S3.I1.P2 Security Credential Management Systems Vendor RFI
- S3.I1.P3 CAT "Connect" Brief: TxDOT's Security Baseline and Benchmark Study

S3.I2 Develop and Adopt a Robust Security and Privacy Policy Framework
ITD - CAT Organization, CMD, Districts, GCD, TRF, & TRV
- S3.I2.A1 Prepare and Adopt CAT Data Security and Privacy Policy Framework

S8.I1 Identify and Make an Inventory of CAT Infrastructure
CAT Organization - CST, Districts, ITD, MNT, ROW, TPP & TRF
- S8.I1.P1 CAT "Connect" Brief: What is CAT Infrastructure
- S8.I1.P2 Statewide CAT Infrastructure Inventory

S9.I1 Investigate and Document Utilizing Public Private Partnerships for CAT Implementation
CAT Organization - FIN, ALD, PFD, & STR
- S9.I1.P1 CAT "Connect" Brief: CAT-Public-Private-Partnership (CPPP) Barriers and Opportunities
- S9.I1.A1 Create Private Public Partnership Subcommittee within the Texas CAV Task Force

S9.I2 Facilitate Public Private Partnerships
ALD - CAT Organization, CSD, Districts, PFD, FIN, PRO, STR, & TRF
- S9.I2.P1 CAT "Connect" Brief: Encouraging CAT Public-Private-Partnership
- S9.I2.A1 Develop Public-Private-Partnership Application Mechanism/Portal

S10.I1 Monitor the Availability of CAT Grants
CAT Organization - CSD, ENV, FIN, GOV, & TPP
- S10.I1.P1 CAT "Connect" Brief: Synthesis of Available Grant Funding for CAT
- S10.I1.A1 Establish a Periodic TxDOT District Innovation Call

S13.I1 Advance CAT Program at Internal Conferences
CAT Organization - CMD, Districts, ENV, MNT, STR, TPP, & TRF
- S13.I1.P1 CAT "Connect" Brief: Synthesis of Current CAT Related Events
- S13.I1.A1 Prepare CAT Informational Materials

S16.I1 Develop CAT Communication and Outreach Plan
CAT Organization - CAV Work Group, CMD, GOV & TRV
- S16.I2.P1 CAT "Connect" Brief: CAT Brand Guide and Materials
- S16.I2.P2 CAT "Connect" Brief: CAT Social Media Strategy Document
- S16.I2.A1 Create a Statewide Slogan for CAT Initiatives
- S16.I2.A2 Develop CAT Informational Resources for Legislators, TxDOT Staff, and Partner Agencies
- S16.I2.A3 Develop TxDOT CAT Webpage

S17.I1 Pilot CAT Technologies across Texas
CAT Organization - Districts, FIN, GCD, ITD, PRO, RTI, TPP, & TRF
- S17.I2.P1 CAT "Connect" Brief: CV Pilot Selection Methodology
- S17.I2.P2 Automated Vehicle Pilots

S18.I1 Upgrade TxDOT Signals
TRF - CAT Organization, Districts, ITD, MTD, & TPP
- S18.I1.P1 Traffic Signal Standards Updates
- S18.I1.P2 I2V System Standardization
- S18.I1.P3 Detection Systems Testing & Deployment
- S18.I1.A1 Standardize I2V and Advanced Detection Systems Deployment at Signals

S19.I1 Establish Priority Corridor Network Connectivity
ITD - CAT Organization, CST, DES, ROW, STR, TPP, & TRF
- S19.I1.P1 CAT Connect Brief: Corridor Connectivity Prioritization Methodology
- S19.I1.P2 Priority Corridor Communication Implementation

S24.I1 Identify and Prioritize CAT Data Use Cases
CAT Organization - Districts, ITD, MNT, MTD, RTI, SSD, TPP, & TRF
- S24.I2.P1 CAT "Connect" Brief: How Can TxDOT Utilize CAT Data?
- S24.I2.A1 CAT Data Use Case Workshop

S25.I1 Understand and Prepare for the Challenges of CAT Data
CAT Organization - ITD, SSD, & TRF
- S25.I2.P1 CAT "Connect" Brief – What are the Challenges of CAT Data?
- S25.I2.P2 CAT "Connect" Brief – A Guide to Being CAT Data Ready

S26.I1 Be "At the Table" for CAT Data Standards Development
CAT Organization - ITD, TPP, & TRF
- S26.I1.A1 TxDOT Participation in Multiple National/ International Forums
- S26.I1.P1 CAT "Connect" Brief What are the Minimum CAT Data Standards and Needs for TxDOT?

S26.I2 Harmonize CAT Data Standards for Texas
ITD - CAT Organization, CMD, Districts, TPP, TRF, & TRV
- S26.I2.P1 CAT "Connect" Brief: Can TxDOT Keep up with CAT Data?
- S26.I2.A1 Adopt Statewide Data Standards and Protocols

S31.I1 Explore CAT Opportunities to Enhance TxDOT Maintenance & Operations
CAT Organization - Districts, MNT, RTI, STR, & TRF
- S3.I1.A1 Maintenance & Operations CAT Opportunities Workshop
- S31.I1.P1 CAT "Connect" Brief: Maintenance & Operations CAT Opportunities
- S31.I1.P2 Deploy Maintenance & Operations CAT Project

S32.I1 Study CAT Influence on TSMO Practices
CAT Organization - Districts, TRF
- S32.I1.P1 CAT "Connect" Brief: TSMO Opportunities with CAT

NEAR TERM INITIATIVES

S4.I1 Identify and Remove Legislative Barriers
GOV - CAT Organization, Districts, GCD, STR, & TRF
- S4.I1.P1 CAT "Connect" Brief: Legal Concerns with CAT Implementation
- S4.I1.A1 Engage General Counsel for Support

S5.I1 Update TxDOT Planning Processes that Influence
TPP - CAT Organization, Districts, FIN & STR
- S5.I1.P1 CAT "Connect" Brief: Accommodating CAT in TxDOT's Planning Processes

S5.I2 Develop Statewide Design Standards and Deployment Framework
CAT Organization - DES, Districts, MTD, RTI, & TRF
- S5.I2.P1 CAT "Connect" Brief: CAT Impact on Standard Operations
- S5.I2.P2 CAT Implementation Playbook and Deployment Framework
- S5.I2.P3 Statewide CAT Standards

S6.I1 Coordinate standard CAT Requirements with OEMs
CAT Organization - CMD, DES, ITD, MTD, RTI & TRF
- S6.I1.A1 Deploy Infrastructure Standards Feedback Portal

S6.I2 Ensure Existing Manuals and Standards Incorporate CAT
CAT Organization - BRG, CMD, CST, DES, Districts, ITD, MNT, MTD, ROW, & TRF
- S6.I2.P1 CAT "Connect" Brief: Evaluation of CAT Impact on Manuals and Standards
- S6.I2.A1 Report: CAT Updates to TxDOT Manuals and Standards

S8.I2 Include CAT in Future Asset Management Practices
CAT Organization, MNT - CST, Districts, ITD, ROW, TPP, & TRF
- S8.I2.P1 CAT "Connect" Brief: CAT and TxDOT Asset Management Practices
- S8.I2.A1 Update Asset Management Planning Documents

S11.I1 Plan for Funding CAT Activities
ADM - CAT Organization, Districts, FIN, & TPP
- S11.I1.P1 CAT "Connect" Brief: How Can TxDOT Fund Innovation?
- S11.I1.P2 Develop Internal CAT Funding Plan/ Framework
- S11.I1.A1 Hold Internal CAT Funding Workshop with TxDOT and Division Leadership

S12.I1 Investigate and Document Potential Revenue Impacts Due to CAT
CAT Organization - FIN, GOV, RTI, STR, & TPP
- S12.I1.P1 CAT "Connect" Brief: The Intersection of CAT, Electric Vehicles, and Mobility-as-a-Service
- S12.I1.P2 CAT "Connect" Brief: Will CAT Impact Revenue?
- S12.I1.P3 Analysis of Revenue Impacts of CAT (RTI - Formal Research)

S13.I2 Expand and Establish Leadership at External Conferences
CAT Organization - CAV Work Group, CMD, RTI, & STR
- S13.I2.A1 Continue and Expand Mobility Summit Conference
- S13.I2.A2 Assemble a List of Conferences to Showcase TxDOT's CAT Initiatives

S14.I1 Establish CAT Challenge
CAT Organization - CAV Work Group, CMD, CSD, Districts, MTD, PRO, RTI, & TRF
- S14.I1.A1 Organize CAT Data Challenge

S14.I2 Build CAT Consortium
CAT Organization - CAV Work Group, CMD, GCD, GOV, ITD, RTI, & TRF
- S14.I2.A1 Organize CAT Consortium
- S14.I2.P1 CAT "Connect" Brief: CAT Research Topics
- S14.I2.P2 CAT "Connect" Brief: Peer Agency Lessons Learned on Deploying CAT Technologies

S20.I1 Investigate and Document Urban Versus Rural Needs
CAT Organization - Districts, ITD, STR, TPP, & TRF
- S20.I1.P1 CAT "Connect" Brief: District Communications Needs and Priorities Survey

S20.I2 Integrate Future Communications Build-Out in Construction Projects
ITD & TRF - CAT Organization, CST, DES, Districts, MTD, & TPP
- S20.I2.P1 Develop CAT Communications Checklist for Rural/Urban Construction Projects
- S20.I2.P2 Develop Typical Standard for Future Backhaul Conduit
- S20.I2.P3 Develop Typical Standard for Cellar Communications (5G & Small Cell)
- S20.I2.A1 Create Updated Engineering Design Process for Communications Checklist

S21.I1 Plan for Complete Network Connectivity
CAT Organization - CST, Districts, ITD, ROW, TPP, & TRF
- S21.I1.P1 District Network Gap Analysis
- S21.I1.P2 District Connectivity Master Plans
- S21.I1.P3 Statewide Network Construction and Integration
- S21.I1.A1 Private Communications Provider Working Group/Panel

S25.I2 Modernize Existing Data Management Strategies
CAT Organization - Districts, ITD, TPP, & TRF
- S25.I2.P1 Develop CAT Data Management Framework
- S25.I2.P2 CAT Data Management Systems Concept of Operations
- S26.I2.P3 CAT "Connect" Brief: CAT Data Integration with LoneStar
- S26.I2.A1 Procure CAT Data Management Systems

S27.I1 Create a CAT Clearinghouse
STR -CAT Organization, CMD, Districts, ITD, & TRF
- S27.I1.P1 CAT Project Portal
- S27.I1.P2 CAT Portal Outreach Materials
- S27.I1.P3 CAT "Connect" Minute E-mail

S27.I2 Connect CAT Data to a Centralized Data Lake
CAT Organization - Districts, ITD, STR, TPP, & TRF
- S27.I2.A1 Include CAT Data in TxDOT's Data Lake

S28.I1 Develop Design Toolkit for Vulnerable Road Users
CAT Organization - CIV, DES, Districts, PTN, RRD, & TRF
- S28.I1.P1 CAT "Connect" Brief: Accessible and Active CAT Design Toolkit

S29.I1 Study Multimodal CAT Applications
CAT Organization - AVN, Districts, MRD, PTN, RRD, RTI, & TPP
- S29.I1.P1 Multimodal CAT Whitepaper Series

S32.I2 Use Real-Time CAT Data for Improved Operations and Management
CAT Organization - Districts, ITD, TPP & TRF
- S32.I2.P1 CAT "Connect" Brief: Real-Time Monitoring and Traffic Data Collection
- S32.I2.A1 Real-Time CAT Data Dashboard

S32.I3 Integrate CAT into Regular Operations and Maintenance
CAT Organization - Districts, ITD, MNT, TPP, & TRF
- S32.I3.P1 Develop TSMO-CAT Integration Concept of Operations
- S32.I3.P2 Update TSMO Standard Operating Procedures to Incorporate CAT Applications

S33.I1 Synchronize CAT and Current Connected Work Zone Practices
CAT Organization - CST, Districts, MTD, RTI, & TRF
- S33.I1.P1 CAT "Connect" Brief: CAT and Connected Work Zones
- S33.I1.P2 Deploy and Evaluate CAT/Work Zone Applications
- S33.I1.A1 Update Connected Work Zone Guidance
- S33.I1.A2 Align Connected Work Zone Effort with CAT Strategic/Program Plans

S34.I1 Proactively Update Active Procurement Lists
CAT Organization - PRO, RTI, & TRF
- S34I1.A1 Create/Maintain a CAT Material Producer List and Prequalified Product List

S34.I2 Provide Flexible Bid Codes
CAT Organization - Districts, MTD, PRO, & TRF
- S34.I2.A1 Develop Comprehensive CAT Bid Codes
- S34.I2.A2 Educate and Reinforce use of Special Accounts for CAT Projects

S35.I1 Support Effective and Flexible CAT Procurement Practices
CAT Organization - PEPS, PRO, & TRF
- S35.I1.P1 CAT "Connect" Brief: Technology Procurement Best Practices
- S35.I1.P2 "Connect" Brief: Review of TxDOT's Technology Procurement Practices

MID-LONG TERM INITIATIVES

S5.I3 Assess and Develop Customized Strategies for Rural and Urban CAT Implementation
CAT Organization - Districts, STR, FIN & TRF
- S5.I3.P1 CAT "Connect" Brief: Planning for CAT – Rural Versus Urban Applications

S7.I1 Document Potential CAT Impacts on Border Crossings
CAT Organization - AVN, Districts, GCD, GOV, MRD, PTN, RTI, TPP, & TRF
- S7.I1.P1 CAT "Connect" Brief: CAT and Border Crossing Impacts
- S7.I1.P2 CAT "Connect" Brief: Border Crossing Guide for Automated Freight

S12.I2 Mitigate Potential Revenue Impacts
CAT Organization - FIN, GOV, STR, & TPP
- S12.I1.P1 Alternative Revenue Pilot Project
- S12.I1.P2 Develop Formal CAT Business (Revenue Mitigation) Plan

S15.I1 Form TxDOT CAT Academy
CAT Organization - CAV Work Group, HRD, ITD, RTI, & TRF
- S15.I1.P1 CAT "Connect" Brief: CAT Training Needs
- S15.I1.A1 Identify CAT Subject Matter Experts (SMEs) that Receives Specialized Training
- S15.I1.A2 Organize CAT Training Workshop with Certification

S16.I2 Host Recurring Internal and External CAT Forums
CAT Organization - CAV Work Group, CMD, GOV, & TRF
- S16.I2.A1 Organize CAT Perception Focus Groups
- S16.I2.A2 Conduct CAT Informational Webinars

S17.I2 Establish Innovation Corridor(s)
CAT Organization - Districts, ENV, STR, RTI, TPP, & TRF
- S17.I2.P1 CAT "Connect" Brief: Innovation Corridor Selection Methodology
- S17.I2.P2 Deploy Innovation Corridor Project(s)
- S17.I2.P3 Establish Innovation Area Design

S18.I2 Upgrade Traffic Management Systems
TRF - CAT Organization, Districts, ITD, & MTD
- S18.I2.P1 CAT Freeway Management Application Deployments

S22.I1 Evaluate Statewide Electric Vehicle Charging Needs
CAT Organization - ENV, RTI, & TPP
- S22.I1.P1 CAT "Connect" Brief: Electric Charging Future Needs Study

S22.I2 Facilitate Municipal EV Charging Partnerships
CAT Organization - Districts & TPD
- S22.I2.P1 Execute Charging Partnerships
- S22.I2.P2 Electric Vehicle Chargin Market Research

S23.I1 Research and Test CAV Fleet Scenarios
CAT Organization - FOD, RTI, TOD, TPP, TRF, & TRV
- S23.I2.P1 CAV Facility Study (Dedicated Lanes & Mixed Fleet)
- S23.I2.P2 Innovation Corridor CAT Lane Pilot

S29.I2 Explore Multimodal Partnership and Pilot Opportunities
CAT Organization - AVN, Districts, MRD, PTN, RRD, RTI, TPP, TRF, & TRV
- S29.I2.P1 Pilot Multimodal CV Priority System Application(s) Deployment

S30.I1 Develop Next Generation Mobility Hub Concepts
RTI - CAT Organization, Districts, PTN, & TPP
- S30.I1.P1 CAT "Connect" Brief: Next Generation Mobility Hub
- S30.I1.P2 Mobility Hub Feasibility and Needs Study

III CAT PROJECT EVALUATION FRAMEWORK

Available CAT Applications

The landscape of CAT technologies continuously evolves at a pace that can be difficult to keep up with. An analysis of currently known CAT applications was performed to offer a snapshot of available technology that may serve TxDOT to improve mobility and connectivity for Texans. The appendix includes a table of CAT applications that can help a variety of roadway users including travelers and system operators in private vehicles (cars and heavy vehicles; public vehicles (ambulance, fire truck, transit), and pedestrians.

Details corresponding to the functionality of each application are provided in the table, including application type, communication message type required by the application, CV penetration required to adequately support the application, desired communication media, etc. The applications are also identified as near ready or future ready, based on their anticipated deployment time frame. Near ready applications are currently being tested or are already field deployed. Future deployment applications typically have a concept of operations developed but would require research, infrastructure investment, and potentially more time for technologies to develop before deployment is feasible. This information can be used by Districts and Divisions as a toolbox to implement deployment-ready applications based on factors that influence the application's successful functionality, such as communications infrastructure and data availability.

Evaluating Potential CAT Projects

This section outlines a process for prioritizing projects for available statewide and/or regional funding based on their expected performance. Note, this evaluation process is expected to change over time as CAT trends and performance data become available. In the short-term, while there is limited data on an array of potential CAT projects, TxDOT may execute this qualitative evaluation.

Evaluation criteria for CAT projects align with the CAT Program goals, along with other criteria that are focused on delivering high-value CAT projects. CAT evaluation criteria are as follows:

- **Safety:** The project improves safety for the traveling public and helps achieve TxDOT's Road to Zero goal for zero roadway fatalities by 2050
- **Reliability:** The project improves overall system dependability for both people and freight
- **Mobility:** The project improves mobility and accessibility for all road users
- **Agility:** The project supports the agency's proactive approach to CAT technology deployment
- **Vitality:** The project provides a direct or indirect economic benefit to the State of Texas

The following Evaluation Criteria Questionnaire provides general guidance to score potential CAT projects based on questions tied to each of the criteria above. The CAT Organization or districts

may evaluate and prioritize proposed CAT projects by completing the questionnaire and scoring each proposed project. A score of one to three and the nature of the project (technology or planning) should be assigned to the proposed projects for each criterion, to help provide an "apples to apples" comparison across projects.

CAT EVALUATION CRITERIA QUESTIONNAIRE

Criteria	Description	Technology / Planning	Score
SAFETY	Does this project implement safety countermeasures and directly reduce or have the potential to reduce fatal, incapacitating injury, and secondary crashes?	Technology/ Planning	3 – High crash reduction 2 – Medium crash reduction 1 – Low crash reduction
	Does this project safeguard data privacy or enhance cybersecurity through systematic data collection, storage, sharing, and analytics?	Technology/ Planning	3 – High data safety; 2 – Medium data safety 1 – Low data safety
RELIABILITY	Does this project improve transportation operational efficiency for people and freight through the deployment and expansion of regional ITS infrastructure?	Technology/ Planning	3 – High congestion reduction 2 – Medium congestion reduction 1 – Low congestion reduction
MOBILITY	Does this project enhance connectivity for all modes including pedestrians and bicyclists	Technology/ Planning	3 – Multimodal focused 2 – Auto and Truck focused 1 – Auto or Truck focused
AGILITY	Is this project/application deployment-ready?	Technology/ Planning	3 – Deployment ready 2 – Deployment near ready 1 – Future deployment ready
	Does the project/application comply with relevant state and federal safety laws?	Technology/ Planning	3 – Highly compliant 2 – Somewhat compliant 1 – Need a legislative change
	Will the proposed project be interoperable with the existing or planned CAT Projects?	Technology/ Planning	3 – Highly interoperable 2 – Somewhat interoperable 1 – Not interoperable
	Does this project expand internal workforce capabilities and collaboration?	Technology/ Planning	3 – High workforce development 2 – Medium workforce development 1 – Low workforce development
VITALITY	Does this project utilize innovative funding mechanisms or identify new revenue sources?	Technology/ Planning	3 – Innovative funding/revenue 2 – Traditional funding/revenue 1 – No funding/revenue identified
	Does this project offer cost-saving benefits with a high B/C and a good return on investment?	Technology/ Planning	3 – Highly B/C 2 – Medium B/C 1 – Low B/C
	Does this project accelerate the deployment and implementation of CAT technologies in Texas?	Technology/ Planning	3 – Very critical to the deployment 2 – Somewhat critical to the deployment 1 – Not critical to the deployment
		Total Score	

IV MEASURING PROGRAM PERFORMANCE

In order to measure CAT Program performance, a series of potential performance metrics are provided in the table below to assess TxDOT's progress in the execution of CAT goals. The proposed metrics are categorized by CAT Focus Area and closely align with the initiatives developed in this plan. It is recommended that TxDOT assess CAT Program performance on an annual basis. TxDOT leadership should identify annual targets for each performance metric to set reasonable expectations that can grow with time and CAT penetration growth. Routine goal setting and performance evaluation will allow TxDOT to:

- gauge its efficacy in achieving CAT Program initiatives and goals;
- understand and plan for future resource allocation; and,
- closely manage the pace and direction of CAT Program activities.

CAT PROGRAM PERFORMANCE METRICS

			Example		FY 2023 (tentative)	
	Focus Area	Qty.	Actual	Target	Actual	Target
POLICY	Staff	EA	5	5		
	Initiatives In Progress	EA	3	3		
	Work Group Meetings Held	EA	12	12		
	Documents Produced (Reports/Briefs)	EA	2	16		
	Standard Created and Updated	EA	-	2		
	Security Concerns Identified and Resolved	EA	-	3		
FISCAL RESPONSIBILITY	Unique CAT Infrastructure Assets identified	EA	425	1,256		
	CAT-PPP Established	EA	-	1		
	Federal Funds Awarded	$	$25,000	$300,000		
	Organization Budget	$	$125,000	$750,000		
	Funds Distributed through Organization	$	$635,245	$2,500,000		
COLLABORATION	Number of Conferences Attended	EA	2	8		
	Private and Academic Partnerships	EA	1	4		
	CAT Training Sessions & Webinars Held	EA	2	6		
	Unique CAT Informational Materials Available	EA	4	100		
	CAT Program Website Traffic	Views	10,000	35,000		
	CAT Connect Brief Downloads	EA	15	100		

			Example		FY 2023 (tentative)	
	Focus Area	Qty.	Actual	Target	Actual	Target
INFRASTRUCTURE READINESS	CAT Deployments Initiated	EA	1	5		
	CAT Deployments Evaluated	EA	1	2		
	Traffic Signals Upgraded	EA	251	125		
	Traffic Management Systems Upgraded	EA	1	5		
	Communication Gaps Identified	Miles	125	500		
	Communication Improvements	Miles	25	75		
	Electric Vehicle Charging Stations	EA	-	2		
	Electric Vehicle Charging Station Partnerships	EA	-	1		
	Dedicated Lane Miles for CAT	Miles	54	54		
SYSTEMS READINESS	Amount of CAT Data Received	TB	15	100		
	Amount of CAT Data Distributed	TB	5	25		
	Data Standards Established	EA	1	5		
	Data Portals Available (Internal)	EA	1	4		
	Data Portals Available (External)	EA	-	1		
MULTIMODAL	Standard/Policies Created for Accessibility & Activity	EA	1	4		
	Multimodal Deployments/Projects	EA	4	2		
	Number of Next Gen Mobility Hubs (Involvement)	EA	-	1		
MAINTENANCE & OPERATIONS	CAT Projects Initiated	EA	8	5		
	Successful CAT Project Deployments	EA	3	2		
	CAT Projects with Positive Benefit/Cost Ratios	EA	3	5		
	CAT Work Zones	EA	2	5		
	Travel Time Reliability Index	%	42	40		
	CAT Device Up-Time	%	90	85		
	Incident Management Clearance Times	Min	32	30		
PROCUREMENT	CAT Products on Qualified Lists	EA	5	15		
	CAT Bid Codes	EA	2	10		

V SUMMARY

Technological advancements in vehicle automation, electrification, and communication have the potential to change the transportation system fundamentally. TxDOT recognizes the opportunities and challenges associated with these technologies and envisions a Cooperative and Automated Transportation (CAT) system to connect people and goods in Texas safely and efficiently. A statewide CAT Strategic Plan has been developed to articulate TxDOT's vision and goals for CAT and to lay strategic foundations in various focus areas. This CAT Program Plan identifies actionable initiatives aligned with each strategy and focus area to break down incremental efforts that may be taken to achieve CAT strategies. Additionally, a roadmap depicting the timeline for launching proposed CAT initiatives is provided for implementation from immediate to long terms. In total, 56 initiatives have been developed for TxDOT's consideration. Top initiatives for immediate consideration in each focus area include:

- Policy: **Establish a CAT Organization** for clear and strong leadership (S1.I1)
- Fiscal Responsibility: **Plan for Funding CAT Activities** to work towards establishing a dedicated funding mechanism for transportation technology (S11. I1)
- Collaboration: **Develop CAT Communication and Outreach Plan** to develop understanding and support for CAT technologies (S16.I1)
- Infrastructure Readiness: Continue to **Pilot CAT Technologies** to prove the benefits of CAT application across Texas (S17.I1)
- Systems Readiness: **Understand and Prepare for the Challenges of CAT Data** to protect and prepare TxDOT for a data-driven transportation future (S25.I1)
- Maintenance & Operations: **Explore CAT Opportunities to Enhance TxDOT Maintenance & Operations** to align CAT efforts with TxDOT's most pressing operational needs (S31.I1)

The initiatives in this Program Plan aim to guide TxDOT in taking a holistic approach to the planning and implementation of CAT across the State of Texas. Additionally, it provides a project evaluation framework for comparing potential CAT efforts, as well as quantifiable performance metrics to measure and monitor the achievement of initiatives and the overall CAT Program.

This Program Plan shall be incorporated into and coordinated with other TxDOT planning and programming efforts such as 2050 Statewide Long-Range Transportation Plan update, Road to Zero Program, Network Communication Plan, etc. In addition, as technology evolves at a rapid pace, TxDOT shall evaluate all possible scenarios for the future and maintain this Program Plan as a living document.

APPENDIX

LIST OF ACRONYMS

AERIS	Applications for the Environment: Real-Time Information Synthesis
AV	Automated Vehicle
BEM	Basic Environmental Message
BIM	Basic Information Message
BMM	Basic Mobility Message
BSM	Basic Safety Message
BWM	Basic Weather Message
C2C	Center to Center Communication
CAT	Cooperative Automated Transportation
CAV	Connected Automated Vehicle
CV	Connected Vehicle
DSRC	Dedicated Short Range Communication
ETTP	Emerging Transportation Technology Plan
EV	Electric Vehicle
FHWA	Federal Highway Administration
FNTOP	Freight Network Technology and Operations Plan
GPS	Global Positioning System
ITS	Intelligent Transportation Systems
LRTP	Long-Range Transportation Plan
MUTCD	Manual on Uniform Traffic Control Devices
OEM	Original Equipment Manufacturer
PSM	Personal Safety Message
RSU	Roadside Unit
RTP	Regional Transportation Plan 2040
SME	Subject Matter Expert
SPaT	Signal Phase and Timing
SRM	Signal Request Message
SSM	Signal Status Message
STIP	Statewide Transportation Improvement Program
SWZ	Smart Work Zones
TIM	Traveler Information Message
TSMO	Transportation Systems Management and Operations
TTP	Texas Transportation Plan 2050
TxDOT	Texas Department of Transportation
USDOT	United States Department of Transportation
UTP	Unified Transportation Program
V2I	Vehicle to Infrastructure Communications
V2V	Vehicle to Vehicle Communication
V2X	Vehicle to Everything/Many Communication

LIST OF CAT APPLICATIONS

Application	Application Type	Application Setting		Message Type Exchanged									Required Penetration	Anticipated Application Deployment Time Frame	Communication Media Desired	USDOT Initiatives	Physical (P), Digital (D), Vehicle (V) Axis	Strategies
	V2I, V2V, C2C	Freeway App	Arterial App	SPaT/Map	SSM/SRM	TIM	BIM	BSM-I	BSM-II	PSM	BMM	BWM	BEM						
Connected Eco-Driving	V2I/V2V	✓	✓	✓	X	✓	✓	✓	✓	X	✓	✓	✓	High	Future	DSRC/C-V2X	AERIS	PDV	S18 S24
Dynamic Eco-Routing (light vehicle, transit, freight)	V2I	✓	✓	✓	X	✓	✓	✓	✓	X	✓	✓	✓	High	Future	C-V2X	AERIS	PDV	S18 S32
Eco-Approach and Departure at Signalized Intersections	V2I	X	✓	✓	X	✓	✓	✓	✓	✓	✓	✓	✓	High	Future	DSRC/C-V2X	AERIS	PDV	S18 S32
Eco-Cooperative Adaptive Cruise Control	V2I/V2V	✓	X	X	X	✓	✓	✓	✓	X	✓	✓	✓	High	Future	DSRC/C-V2X	AERIS	PDV	S18 S32
Eco-Freight Signal Priority	V2I/C2C	X	✓	✓	✓	✓	✓	✓	✓	✓	X	✓	✓	High	Future	DSRC/C-V2X/ Backbone	AERIS	PDV	S18 S32
Eco-Integrated Corridor Management Decision Support System	C2C	✓	✓	X	X	✓	X	X	X	X	X	✓	✓	High	Future	Backbone	AERIS	PDV	S18 S31 S32
Eco-Lanes Management	V2I	✓	X	X	X	✓	✓	✓	✓	X	✓	✓	✓	High	Future	DSRC/C-V2X	AERIS	PDV	S18 S24
Eco-Multimodal Real-Time Traveler Information	V2I/C2C	✓	✓	X	X	✓	✓	✓	✓	X	✓	✓	✓	High	Future	DSRC/C-V2X/ Backbone	AERIS	PDV	S17 S18 S24 S31 S32 S33
Eco-Ramp Metering (Next Generation Ramp Metering (RAMP))	V2I	✓	X	✓	X	✓	✓	✓	✓	X	✓	✓	✓	High	Future	DSRC/C-V2X	AERIS	PDV	S17 S18 S24 S31 S32 S33
Eco-Smart Parking	V2I/C2C	X	✓	X	X	✓	X	✓	✓	X	✓	✓	✓	High	Future	DSRC/C-V2X/ Backbone	AERIS	PDV	S17 S18
Eco-Speed Harmonization	V2I	✓	X	X	X	✓	✓	✓	✓	X	✓	✓	✓	High	Future	DSRC/C-V2X	AERIS	PDV	S18 S24 S31
Eco-Traffic Signal Timing	V2I	X	✓	✓	X	✓	✓	✓	✓	✓	✓	✓	✓	High	Future	DSRC/C-V2X	AERIS	PDV	S18 S24 S29 S31 S32
Eco-Transit Signal Priority	V2I/C2C	X	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	High	Future	DSRC/C-V2X/ Backbone	AERIS	PDV	S18 S29 S32
Electric Charging Stations Management (AFV Charging/Fueling Information Eco-Smart Parking)	V2I/C2C	X	✓	X	X	✓	✓	✓	✓	X	✓	✓	✓	High	Future	DSRC/C-V2X/ Backbone	AERIS	PDV	S22 S24
Low Emissions Zone Management	V2I	✓	✓	X	X	✓	✓	✓	✓	X	✓	✓	✓	High	Future	DSRC/C-V2X	AERIS	PDV	S18 S24
Wireless Inductive/Resonance Charging	V2I	✓	✓	X	X	X	✓	✓	✓	X	✓	✓	✓	High	Future	DSRC/C-V2X	Environ-mental	PDV	S22
Roadside Lighting	V2I	✓	✓	X	X	X	✓	✓	✓	X	X	X	X	High	Future	DSRC/C-V2X	Environ-mental	PDV	S17 S24
Enhanced Maintenance Decision Support System (Enhanced MDSS)	V2I	✓	✓	X	X	✓	✓	✓	✓	X	✓	✓	✓	Low	Near	DSRC/C-V2X	Road Weather	PDV	S18 S24 S31
Road Weather Information and Routing Support for Emergency Responders	V2I/C2C	✓	✓	X	X	✓	X	✓	✓	X	✓	✓	X	Low	Near	DSRC/C-V2X/ Backbone	Road Weather	PDV	S17 S25 S31
Road Weather Information for Freight Carriers	V2I/C2C	✓	✓	X	X	✓	X	✓	✓	X	✓	✓	X	Low	Near	C-V2X/Backbone	Road Weather	PDV	S18 S24 S29 S31
Road Weather Information for Maintenance and Fleet Management Systems	V2I	✓	✓	X	X	✓	X	✓	✓	X	✓	✓	X	Low	Near	DSRC/C-V2X	Road Weather	PDV	S18 S24 S31
Road Weather Motorist Alert and Warning (MAW)	V2I/C2C	✓	✓	X	X	✓	X	✓	✓	X	✓	✓	X	Low	Near	DSRC/C-V2X/ Backbone	Road Weather, DMA-EnabledATIS	PDV	S18 S24 S32
Weather Data Translator (VDT)	V2I	✓	✓	X	X	X	X	✓	✓	X	✓	✓	X	Low	Near	C-V2X	Road Weather	PDV	S18 S24 S32
Variable Speed Limits for Weather-Responsive Traffic Management (WxTINFO)	V2I	✓	X	X	X	✓	X	✓	✓	X	✓	✓	X	Medium	Future	DSRC/C-V2X	Road Weather	PDV	S17 S25 S32
Border Management Systems	C2C/V2I	X	✓	X	X	✓	✓	✓	✓	X	✓	X	X	High	Future	DSRC/C-V2X/ Backbone	Border	PDV	S7 S24 S29
Container Security	V2I/ V2V/C2C	X	✓	X	X	X	X	✓	✓	X	✓	X	X	High	Future	DSRC/C-V2X/ Backbone	CVFO	PDV	S17 S29

Application	Application Type	Application Setting		Message Type Exchanged															
	V2I, V2V, C2C	Freeway App	Arterial App	SPaT/Map	SSM/SRM	TIM	BIM	BSM-I	BSM-II	PSM	BMM	BWM	BEM	Required Penetration	Anticipated Application Deployment Time Frame	Communication Media Desired	USDOT Initiatives	Physical (P), Digital (D), Vehicle (V) Axis	Strategies
Container/Chassis Operating Data	V2I	✗	✓	✗	✗	✗	✗	✓	✓	✗	✓	✗	✗	High	Future	DSRC/C-V2X	CVFO	PDV	S17 S24 S29
Electronic Work Diaries	V2I	✗	✓	✗	✗	✗	✗	✓	✓	✗	✓	✗	✗	High	Future	C-V2X	CVFO	PDV	S24 S29
Intelligent Access Program	V2I/C2C	✗	✓	✗	✗	✗	✗	✓	✓	✗	✓	✗	✗	High	Future	C-V2X/Backbone	CVFO	PDV	S24 S29
Intelligent Access Program - Mass Monitoring	V2I/C2C	✗	✓	✗	✗	✗	✗	✓	✓	✗	✓	✗	✗	High	Future	C-V2X/Backbone	CVFO	PDV	S24 S29
Intelligent Speed Compliance	V2I/C2C	✓	✓	✗	✗	✗	✗	✓	✗	✗	✓	✗	✗	High	Future	C-V2X/Backbone	CVFO	PDV	S24 S29
Smart Roadside Initiative (Wireless Inspection)	V2I/C2C	✓	✗	✗	✗	✗	✗	✓	✓	✗	✓	✗	✗	High	Future	DSRC/C-V2X/ Backbone	CVFO, Smart Roadside	PDV	S24 S29
Electronic Toll Collection	V2I	✓	✗	✗	✗	✓	✗	✓	✓	✗	✓	✗	✗	High	Future	DSRC/C-V2X	E-Payment	PDV	S18 S24 S29
Road Use Charging (Congestion Pricing)	V2I	✓	✓	✗	✗	✓	✗	✓	✓	✗	✓	✗	✗	High	Future	DSRC/C-V2X	E-Payment	PDV	S12 S17 S25 S31
Freight Drayage Optimization	V2I/C2C	✗	✓	✗	✗	✓	✗	✓	✓	✗	✓	✗	✗	High	Future	DSRC/C-V2X/ Backbone	CVFO, DMA-FRATIS	PDV	S24 S29
Freight-Specific Dynamic Travel Planning	V2I/C2C	✓	✓	✗	✗	✓	✗	✓	✓	✗	✓	✗	✗	High	Future	C-V2X/Backnone	CVFO – DMA-FRATIS	PDV	S24 S29
Performance Monitoring and Planning	V2I/C2C	✓	✓	✗	✗	✗	✗	✓	✓	✗	✓	✗	✗	High	Future	C-V2X/Backbone		PDV	S24 S32
Advanced Automatic Crash Notification Relay (AACN)	V2I/V2V	✓	✓	✗	✗	✓	✗	✓	✓	✗	✓	✗	✗	Medium	Future	DSRC/C-V2X	DMA-RESCUME	PDV	S17 S24 S31
Emergency Communications and Evacuation (EVAC)	C2C	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	Low	Future	Backbone	DMA-RESCUME	PDV	S18 S24 S31
Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (RESP-STG)	C2C/ V2I/V2V	✓	✓	✓	✗	✓	✓	✓	✓	✗	✓	✗	✗	Low	Future	Backbone/DSRC/ C-V2X	DMA-RESCUME	PDV	S17 S31
Incident Scene Work Zone Alerts for Drivers and Workers (INC-ZONE)	C2C/ V2I/V2V	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✗	✗	Low	Near	DSRC/C-V2X/ Bacbone	DMA-RESCUME	PDV	S17 S24 S31
Cooperative Adaptive Cruise Control (CACC)	V2I/V2V	✓	✗	✗	✗	✓	✓	✓	✓	✓	✓	✗	✗	Low	Near	DSRC/C-V2X	DMA-INFLO	PDV	S17 S24 S31
Queue Warning (Q-WARN)	V2I/ V2V/C2C	✓	✗	✗	✗	✓	✓	✓	✓	✗	✓	✗	✗	High	Future	DSRC/C-V2X/ Backbone	DMA-INFLO	PDV	S17 S24 S31
Speed Harmonization (SPD-HARM)	V2I	✓	✗	✗	✗	✓	✓	✓	✓	✗	✓	✗	✗	High	Future	DSRC/C-V2X	DMA-INFLO	PDV	S18 S25 S31
Vehicle Data for Traffic Operations	V2I/C2C	✓	✓	✗	✗	✓	✓	✓	✓	✗	✓	✗	✗	High	Future	DSRC/C-V2X/ Backbone	Agency Data	PDV	S18 S25 S26 S31 S32
Emergency Vehicle Preemption (PREEMPT)	V2I	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	Low	Near	DSRC/C-V2X	DMA-MMITSS	PDV	S18 S25 S32
Freight Signal Priority	V2I/C2C	✗	✓	✓	✓	✗	✓	✓	✓	✓	✓	✗	✗	Low	Near	DSRC/C-V2X/ Backnone	DMA-MMITSS	PDV	S18 S29 S32
Intelligent Traffic Signal System (I-SIG)	V2I/C2C	✗	✓	✓	✗	✓	✓	✓	✓	✓	✓	✗	✗	High	Future	DSRC/C-V2X/ Backbone	DMA-MMITSS	PDV	S18 S25 S29 S32 S33
Pedestrian Mobility	V2I/V2P	✗	✓	✓	✗	✓	✓	✗	✗	✓	✗	✗	✗	Low	Near	DSRC/C-V2X	DMA-MMITSS	PDV	S17 S28
Transit Signal Priority	V2I/C2C	✗	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✗	Low	Near	DSRC/C-V2X/ Backbone	DMA-MMITSS	PDV	S18 S29 S32
Dynamic Ridesharing (D-RIDE)	V2I/C2C	✗	✓	✗	✗	✓	✗	✓	✓	✗	✓	✗	✗	High	Future	C-V2X/Backbone	DMA-IDTO	PDV	S14 S18 S29
Dynamic Transit Operations (T-DISP)	V2I/C2C	✗	✓	✗	✗	✓	✗	✓	✓	✗	✓	✗	✗	High	Future	C-V2X	DMA-IDTO	PDV	S17 S24 S28
Integrated Multi-Modal Electronic Payment	V2I	✗	✓	✗	✗	✓	✗	✗	✗	✗	✓	✗	✗	High	Future	C-V2X	Transit	PDV	S24 S29
Intermittent Bus Lanes	V2I/ V2V/C2C	✗	✓	✗	✗	✓	✓	✓	✓	✗	✓	✗	✗	High	Future	DSRC/C-V2X/ Backbone	Transit	PDV	S18 S29
Route ID for the Visually Impaired	V2I	✗	✓	✗	✗	✓	✓	✗	✗	✓	✓	✗	✗	High	Future	DSRC/C-V2X	Transit	PDV	S17 S28
Smart Park and Ride System	V2I/C2C	✗	✓	✗	✗	✓	✓	✓	✓	✗	✓	✗	✗	High	Future	DSRC/C-V2X/ Backbone	DMA-EnableATIS	PDV	S24 S29

Application	Application Type	Application Setting		Message Type Exchanged										Required Penetration	Anticipated Application Deployment Time Frame	Communication Media Desired	USDOT Initiatives	Physical (P), Digital (D), Vehicle (V) Axis	Strategies
	V2I, V2V, C2C	Freeway App	Arterial App	SPaT/Map	SSM/SRM	TIM	BIM	BSM-I	BSM-II	PSM	BMM	BWM	BEM						
Transit Connection Protection (T-CONNECT)	V2I/C2C	✗	✓	✗	✗	✓	✗	✓	✓	✗	✓	✗	✗	High	Future	C-V2X/Backbone	DMA-IDTO	PDV	S17 S24 S29
Transit Stop Request	V2P	✗	✓	✗	✗	✓	✗	✓	✓	✗	✓	✗	✗	High	Future	DSRC/C-V2X	Transit	PDV	S17 S24 S29
Advanced Traveler Information Systems	C2C/V2I	✓	✓	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	High	Future	Backbone/DSRC/ C-V2X	DMA -EnableATIS	PDV	S17 S31 S33
Traveler Information- Smart Parking	V2I/C2C	✗	✓	✗	✗	✓	✓	✓	✓	✗	✓	✗	✗	Low	Near	DSRC/C-V2X/ Backnone	DMA-EnableATIS	PDV	S17 S24 S25
Transit Pedestrian Indication	V2P	✗	✓	✗	✗	✗	✗	✗	✗	✓	✓	✗	✗	High	Future	C-V2X	Transit	PDV	S17 S24 S28 S29
Transit Vehicle at Station/Stop Warnings	V2I	✗	✓	✗	✗	✗	✓	✓	✓	✗	✓	✗	✗	High	Future	DSRC/C-V2X	Transit	PDV	S17 S24 S29
Vehicle Turning Right in Front of a Transit Vehicle	V2V	✗	✓	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	High	Future	DSRC/C-V2X	Transit	PDV	S17
Curve Speed Warning	V2I	✓	✗	✗	✗	✓	✓	✓	✓	✗	✓	✗	✗	Low	Near	DSRC/C-V2X		PDV	S17
In-Vehicle Signage	V2I	✓	✓	✓	✗	✓	✓	✗	✗	✗	✓	✗	✗	High	Future	DSRC/C-V2X		PDV	S17 S32
Oversize Vehicle Warning	V2I/C2C	✓	✓	✓	✗	✓	✓	✗	✗	✗	✗	✗	✗	High	Future	DSRC/C-V2X/ Backbone		PDV	S17 S32
Pedestrian in Signalized Crosswalk Warning	V2I	✗	✓	✓	✗	✓	✓	✓	✓	✓	✓	✗	✗	low	Near	DSRC/C-V2X		PDV	S17 S24 S28
Railroad Crossing Violation Warning	V2I	✗	✓	✓	✗	✓	✓	✓	✓	✗	✓	✗	✗	Low	Near	DSRC/C-V2X		PDV	S17 S29
Red Light Violation Warning	V2I	✗	✓	✓	✗	✓	✓	✓	✓	✗	✓	✗	✗	Medium	Near	DSRC/C-V2X		PDV	S17
Reduced Speed Zone Warning / Lane Closure	V2I	✓	✗	✗	✗	✓	✓	✓	✓	✗	✓	✗	✗	Medium	Near	DSRC/C-V2X		PDV	S17 S31
Restricted Lane Warnings	V2I	✓	✗	✗	✗	✓	✓	✓	✓	✗	✓	✗	✗	Low	Future	DSRC/C-V2X		PDV	S17 S31
Spot Weather Impact Warning	V2I/C2C	✓	✓	✗	✗	✓	✗	✓	✓	✗	✓	✓	✗	Low	Near	DSRC/C-V2X/ Backbone		PDV	S17 S32
Stop Sign Gap Assist	V2I	✗	✓	✗	✗	✓	✓	✓	✓	✗	✓	✗	✗	High	Future	DSRC/C-V2X		PDV	S17
Stop Sign Violation Warning	V2I	✗	✓	✗	✗	✓	✓	✓	✓	✗	✓	✗	✗	Low	Near	DSRC/C-V2X		PDV	S17
Warnings about Hazards in a Work Zone	V2I	✓	✗	✗	✗	✓	✓	✓	✓	✗	✓	✗	✗	Low	Near	DSRC/C-V2X		PDV	S17
Warnings about Upcoming Work Zone	V2I	✓	✗	✗	✗	✓	✓	✓	✓	✗	✓	✗	✗	Low	Near	DSRC/C-V2X		PDV	S17
Blind Spot Warning + Lane Change Warning (BSW/LCW)	V2V	✓	✓	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	Low	Near	DSRC/C-V2X		PDV	
Control Loss Warning	V2V	✓	✓	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	Low	Near	DSRC/C-V2X		PDV	
Do Not Pass Warning (DNPW)	V2V	✓	✓	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	Low	Near	DSRC/C-V2X		PDV	
Emergency Electronic Brake Light (EEBL)	V2V	✓	✓	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	Low	Near	DSRC/C-V2X		PDV	
Emergency Vehicle Alert	V2V	✓	✓	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	Low	Near	DSRC/C-V2X		PDV	
Forward Collision Warning (FCW)	V2V	✓	✓	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	Low	Near	DSRC/C-V2X		PDV	
Intersection Movement Assist (IMA) (Left Turn Assist (LTA))	V2V	✗	✓	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	Low	Near	DSRC/C-V2X		PDV	
Motorcycle Approaching Indication	V2V	✓	✓	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	Low	Near	DSRC/C-V2X		PDV	
Pre-crash Actions	Eco-Lanes Mngt.	✓	✓	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	Low	Near	DSRC/C-V2X		PDV	
Situational Awareness	V2V	✓	✓	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	Low	Near	DSRC/C-V2X		PDV	
Slow Vehicle Warning	V2V	✓	✓	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	Low	Near	DSRC/C-V2X		PDV	
Stationary Vehicle Warning	V2V	✓	✓	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	Low	Near	DSRC/C-V2X		PDV	

	Application Type	Application Setting		Message Type Exchanged															
Application	V2I, V2V, C2C	Freeway App	Arterial App	SPaT/Map	SSM/SRM	TIM	BIM	BSM-I	BSM-II	PSM	BMM	BWM	BEM	Required Penetration	Anticipated Application Deployment Time Frame	Communication Media Desired	USDOT Initiatives	Physical (P), Digital (D), Vehicle (V) Axis	Strategies
Tailgating Advisory	V2V	✓	✓	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	Low	Near	DSRC/C-V2X		PDV	
Vehicle Emergency Response	V2V	✓	✓	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	Low	Near	DSRC/C-V2X		PDV	
Connected Vehicle Map Management	V2I/C2C	✓	✓	✓	✗	✗	✓	✓	✗	✗	✓	✗	✗	Low	Near	DSRC/C-V2X/ Backnone		PDV	S24 S29
Core Authorization	C2C/V2I	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	Low	Near	DSRC/C-V2X/ Backbone		PDV	S24 S29
Data Distribution	C2C/V2I	✓	✓	✗	✗	✓	✓	✓	✓	✗	✓	✗	✗	Low	Near	DSRC/C-V2X/ Backnbone		PDV	
Infrastructure Management	C2C/V2I	✓	✓	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	Low	Near	DSRC/C-V2X/ Backnone		PDV	
Location and Time	C2C/V2I	✓	✓	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	Low	Near	DSRC/C-V2X/ Backnone		PDV	
Object Registration and Discovery	C2C/V2I	✓	✓	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	Low	Near	DSRC/C-V2X/ Backnone		PDV	
Privacy Protection	V2I	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	Low	Near	DSRC/C-V2X		PDV	
System Monitoring	V2I/C2C	✓	✓	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	Low	Near	DSRC/C-V2X/ Backbone		PDV	
Security and Credentials Management	V2I	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	Low	Near	DSRC/C-V2X		PDV	
Probe-based Pavement Maintenance	V2I	✓	✓	✗	✗	✗	✗	✓	✓	✗	✓	✓	✓	Low	Near	DSRC/C-V2X		PDV	S24 S29
Probe-enabled Traffic Monitoring	V2I	✓	✓	✗	✗	✗	✗	✓	✓	✗	✓	✗	✗	Low	Near	DSRC/C-V2X		PDV	S17 S25 S27
Vehicle Classification-based Traffic Studies	V2I	✓	✓	✗	✗	✗	✗	✓	✓	✗	✓	✗	✗	High	Future	DSRC/C-V2X		PDV	S24 S29
CV-Enabled Performance Measures	V2I	✓	✓	✗	✗	✗	✗	✓	✓	✗	✓	✓	✓	High	Future	DSRC/C-V2X		PDV	S24
CV-enabled Turning Movement & Intersection Analysis	V2I	✗	✓	✓	✗	✗	✗	✓	✓	✗	✓	✗	✗	High	Future	DSRC/C-V2X		PDV	S24
CV-enabled Origin-Destination Studies	V2I	✓	✓	✗	✗	✗	✗	✓	✓	✗	✓	✗	✗	High	Future	DSRC/C-V2X		PDV	S24
Work Zone Traveler Information	V2I/V2V	✓	✓	✗	✗	✗	✓	✓	✓	✗	✓	✓	✓	Low	Near	DSRC/C-V2X		PDV	S17 S24 S31 S32
Exit Ramp Deceleration Warning	V2I	✓	✗	✗	✗	✓	✓	✓	✓	✗	✓	✗	✗	Low	Near	DSRC/C-V2X	TxDOT CAT	PDV	S17
SPaT Map Display	V2I	✗	✓	✓	✗	✓	✓	✗	✗	✗	✓	✗	✗	Low	Near	DSRC/C-V2X	TxDOT CAT	PDV	S17 S24
Wrong Way Entry (WWE)	V2I	✓	✗	✗	✗	✓	✓	✓	✓	✗	✓	✗	✗	Low	Near	DSRC/C-V2X	TxDOT CAT	PDV	S17 S24
Speed Limit Warning	V2I	✗	✓	✓	✗	✓	✓	✓	✓	✗	✓	✗	✗	Low	Near	DSRC/C-V2X	TxDOT CAT	PDV	S17
Integrated Modeling for Road Weather Condirion Prediction	C2C	✓	✓	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	Low	Future	Backbone	TxDOT CAT	PDV	S17 S24 S32

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AMELIA HAYES	Federal Highway Administration
ANDREW MAO	Houston District
BARBARA RUSSELL	Traffic Safety Division
BRENT EASTMAN	Information Technology Division
CAROLINE MAYS	Transportation Planning and Programming Division
CASEY WELLS	Transportation Planning and Programming Division
DARRAN ANDERSON	Administration
GEORGE VILLARREAL	Traffic Safety Division
JIANMING MA	Traffic Safety Division
JAMES KUHR	Strategic Planning Division
JOSPEH HUNT	Traffic Safety Division
JOHN GIANOTTI	San Antonio District
MICHAEL CHAMBERLAIN	Transportation Planning and Programming Division
SHERRY PIFER	Transportation Planning and Programming Division
STEPHEN RATKE	Federal Highway Administration
YVETTE FLORES	Strategic Planning Division
ZEKE REYNA	Strategic Planning Division

INTERNAL CONTRIBUTING STAKEHOLDERS

Aviation Division
Communications Division
Government Affairs Division
Maritime Division
Information Technology Division
Public Transportation Division
Research and Technology Implementation Division
Strategic Planning Division
Transportation Planning and Programming Division
Traffic Safety Division
Austin District
Bryan District
Dallas District
Houston District
San Antonio District