Texas Department of Transportation

PRESIDIO TEXAS

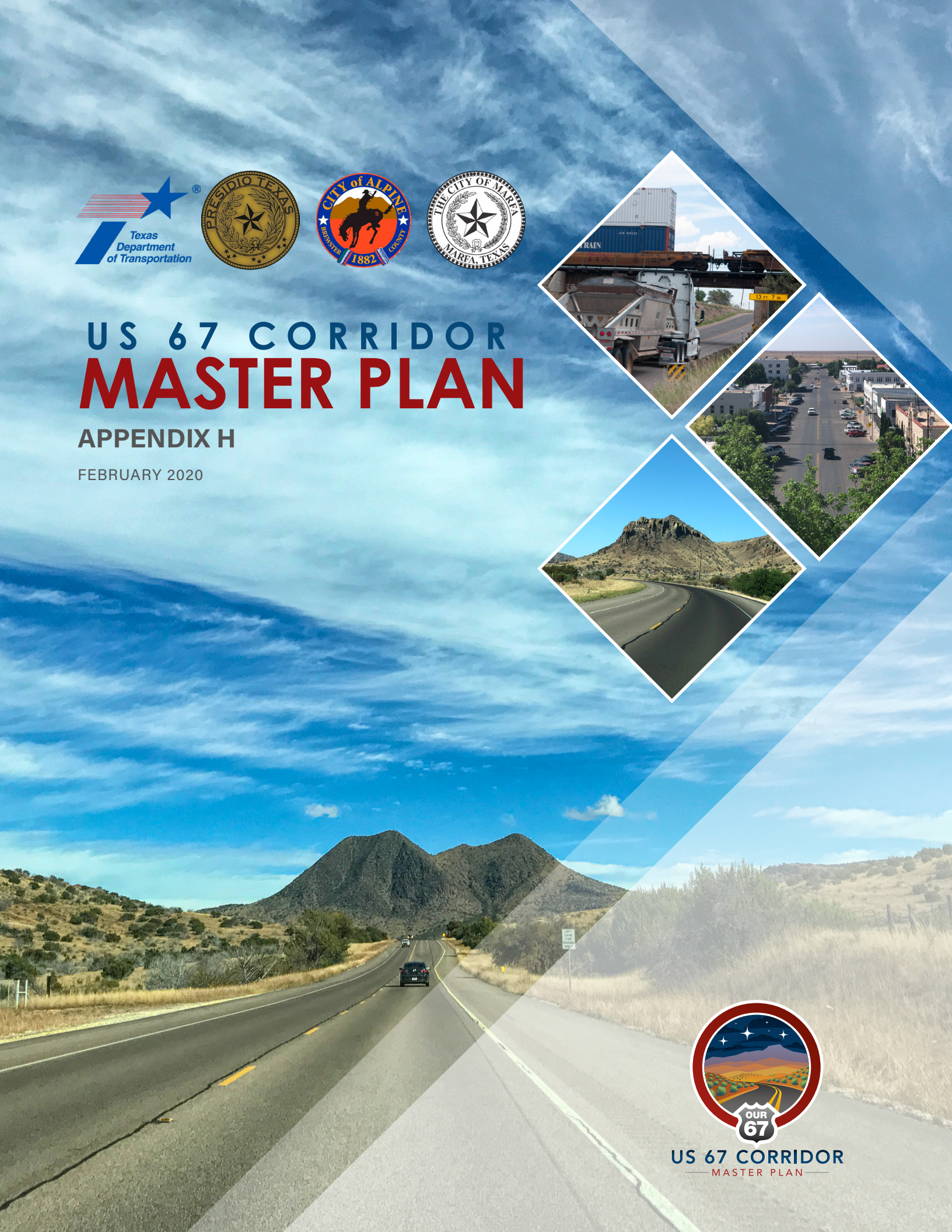
CITY of ALPINE BREWSTER COUNTY 1882

THE CITY OF MARFA MARFA, TEXAS

US 67 CORRIDOR MASTER PLAN

APPENDIX H

FEBRUARY 2020



OUR 67

US 67 CORRIDOR
MASTER PLAN

This page intentionally left blank.

Memorandum

To: *Rebecca Reyes, TxDOT Project Manager*
Christopher Weber, TxDOT Alpine Area Engineer

From: *CDM Smith*

Date: *February 2020*

Subject: *US 67 Corridor Master Plan Intelligent Transportation Systems (ITS) Connected and Autonomous Vehicles Technical Memorandum*

1.0 Introduction

The purpose of this memorandum is to provide a general overview of the requirements and limitations of Connected Vehicles (CVs) and Autonomous Vehicles (AVs) in rural corridors like the US 67 study corridor and to provide recommendations in support of future CV and AV deployments.

Considerable discussion is ongoing among public agencies on how to best prepare for the future of CVs and AVs. Connected vehicle technology will enable vehicles to "talk" to each other and the infrastructure, sharing important safety and mobility information. Autonomous vehicles use technology to eliminate the need for a human driver. Many of these discussions are focused on urban arterials or expressways; however, one of the three major federal CV Pilot projects[1] is for a rural interstate in Wyoming. The Wyoming CV Pilot is primarily freight focused but does address the unique needs and constraints of long rural corridors. Applications addressing maydays and weather are relevant to US 67.

1.1 The Emerging Technologies Future

Emerging technologies encompass a wide range of new applications to the transportation industry. Through programs such as CV and AV, agencies, companies, and residents may realize benefits in safety and efficiency. With a fleet of CV travelers along the US 67 study corridor, agencies would have the ability to know real-time conditions of traffic, weather, incidents, and pavement conditions. This would allow them to better manage their resources and respond to incidents and issues. This data can also be used in planning and programming – identifying those projects that best address the needs of the corridor. Companies will have a better idea of their fleet of vehicles and will be able to manage them, both in real-time and in planning more efficient future routes. All residents will benefit from increased safety and traveler information, knowing where problem areas are to better plan trips and having a safer trip with better information and improved emergency response.

[1] USDOT Intelligent Transportation Systems Joint Program Office https://www.its.dot.gov/pilots/cv_pilot_apps.htm

To receive these benefits, a CV must "talk" to something – a network, an agency, another vehicle. In order to "talk", the CV needs an On-Board Unit (OBU) that is available from some original equipment manufacturers (OEMs) and aftermarket. While there is an ongoing debate on "how" CVs will be able to talk – either Dedicated Short Range Communications (DSRC) or 5G – at the moment this debate does not affect the recommendations of this report.

CV communications are referred to by many acronyms such as V2I (vehicle to infrastructure), V2V (vehicle to vehicle), and V2X (vehicle to everything). The V2V requires no infrastructure of transportation agencies but instead, it is the communication with other vehicles. V2I and V2X require power and communications infrastructure to transmit/receive information to/from an agency network. While a stand-alone solar power generator may provide enough power for the communications system, a dial-up cellular connection for the communication is not sufficient enough to relay the amount of data communicated between the radio-based Roadside Unit (RSU) back to the agency network. Whether using DSRC or 5G, the V2I communications should be more than sufficient. The communications back bone, however, will likely need to be fiber optic cable to provide sufficient bandwidth to transmit the large amounts of CV data. While trunk line fiber-optic cable may be available over most of the study corridor, it likely does not have frequent enough access points for the RSUs and associated equipment (e.g., cabinets, equipment, handholes) to provide for full coverage of a CV system. The addition of an extensive CV infrastructure for a lengthy rural corridor, such as US 67, will be costly.

Beyond the equipment required to establish the CV system, the RSUs need to be monitored by a Traffic Management Center (TMC) in order to receive the full benefit of the CV technology. TxDOT El Paso District has a TMC (TransVista) that could provide the required staff skills and expertise to work with the data and communications to and from the CV system. The required activity level of the monitoring can vary widely depending on the applications that might be tested on the corridor. Some require near real-time operations staff actions while others are more related to historic data gathering. The presence of a formal TMC and associated system should allow for the addition of CV applications and communications into the network relatively easily. The physical installation and creation of the communications network, along with allocating local agency staff to monitor the CV system, will be the larger issue.

1.2 Applications

Applications are the "programs" used by CV equipment to provide information or guidance to drivers. USDOT, working with industry partners, has already identified over three dozen potential CV applications. Many of these are currently being tested in the three USDOT-sponsored Pilot Studies.

Applications that would be most relevant to the US 67 corridor include those related to weather conditions and incident/mayday calls. Traveler information is another including travel times and information relative to road work or other incidents on the corridor. Most of these needs are identified in the US 67 study corridor ITS plan and are being addressed by more traditional methods for the near term.

Significant market penetration of CV may take years, even with deployments by fleets. A recent study[2] indicated that a small-scale deployment in the greater Chicago area that did not include outfitting a fleet of vehicles (similar to the federal CV Pilots) is currently resulting in less than two identified CV a day in a section with an AADT approaching 200,000. The market penetration necessary for the US 67 corridor to benefit from CV will take more time. Meanwhile, developers will continue to develop potential applications in the near term. While the particular use and benefit of these applications remains to be determined, beginning to look at what infrastructure will be required to support these future applications is prudent.

It should also be noted that a few new cars and currently available smartphone apps already have some of the safety-related features included. For example, weather warnings can be received by a variety of available weather applications. And some navigation systems are able to provide warnings to drivers approaching horizontal curves at an excessive speed. These are not typically directly linked to automated car braking yet. But these functions are available commercially within the automotive industry and currently do not require any infrastructure changes on the agency side.

1.3 V2I

Many of the potential CV applications that would apply in the US 67 study corridor are safety-related. When considering potential RSU locations, the high number of curves along the corridor alone would require near full coverage of the corridor with RSUs. Other applications may be appropriate for a few isolated locations including smart truck parking and spot weather impact warning applications. The locations along US 67 that would benefit from these isolated applications may all have power and fiber from other ITS and operational systems that are planned for the corridor. Future CV equipment can utilize these power and fiber connections where available to reduce costs of installation. Those applications that are in the communities will have ready access to power and fiber.

The Wyoming CV Pilot has an RSU spacing of 6-7 miles.[3] This spacing may be sufficient for CV to provide weather-related information in a relevant timeframe. Considering the presence of communities and length of the US 67 study corridor, approximately 30 RSUs (assuming a 7-mile spacing and a few RSUs within the communities) would need to be deployed to accommodate initial weather and safety-related applications.

Safety-related information applications, such as those involving crashes or disabled vehicles, are less well served with RSUs placed every 6 to 7 miles, as RSUs would likely have to be in range of the incident location to recognize if there is an issue. Applications providing safety-related information include Queue Warning (Q-WARN), Incident Scene Pre-Arrival Staging Guidance for Emergency Responders (RESP-STG), and Incident Scene Work Zone Alerts for Drivers and Workers (INC-ZONE). Many of the urban applications are more relevant with signalized intersections and may not apply to the US 67 study corridor. In order to provide full corridor coverage for all safety applications, the spacing of RSUs may be required to be as dense as one every mile with continuous fiber available for

[2] ITS Midwest 2019 Annual Meeting presentation on the Illinois Tollway CV Pilot http://itsmidwest.org
[3] https://www.its.dot.gov/pilots/pdf/CVP_SitePM_webinar_Wyoming.pdf

access and backhaul. Achieving this density could require several hundred RSUs along the corridor including the necessary power and communications required to operate them.

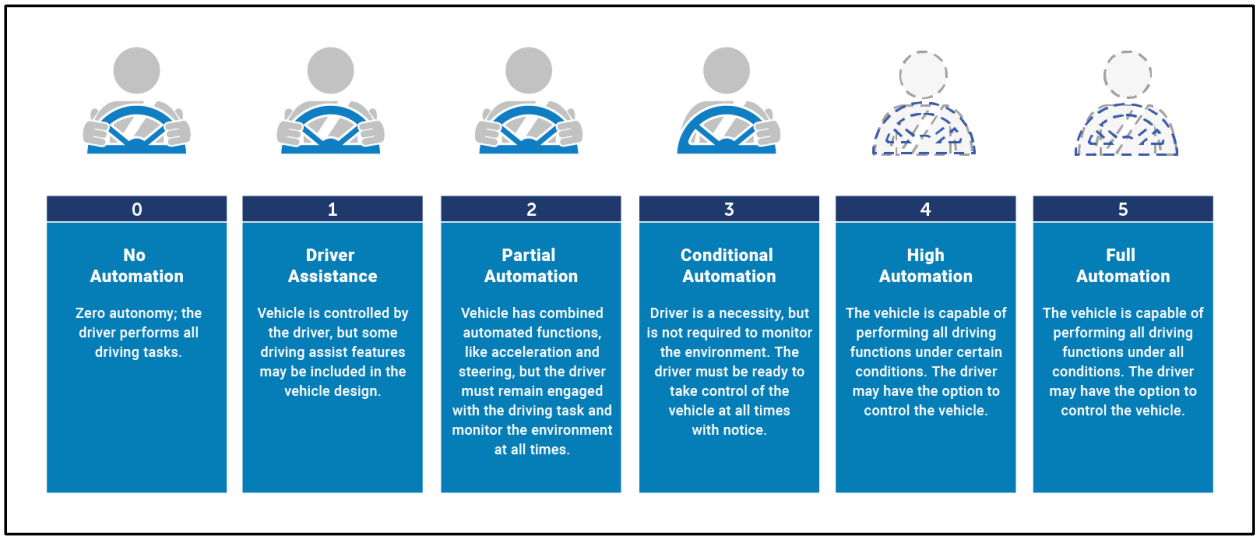
1.4 V2V

V2V applications do not require any infrastructure but do require that multiple CVs be within range of each other. The primary V2V applications are directly related to safety, including Emergency Electronic Brake Lights (EEBL) and Forward Collision Warning (FCW). Beyond the direct safety applications, the vision for CV is to communicate other conditions including events and roadway hazards directly to other vehicles traveling the same route. For example, if a CV has noted icy conditions, the CV will communicate information about the icy conditions to any CV vehicle passed en route. This is either accomplished through the information contained within the standard basic safety messages or through a vehicle-specific application. In both cases, no agency involvement is required to ensure this connection is completed.

In urban areas, applications such as Intersection Movement Assist (IMA) and Left Turn Assist (LTA) can exist with no new direct agency requirements at the intersections. The infrastructure is already present to add RSUs if desired. Again, if the CV can communicate problems, a TMC is needed to collect, disseminate, and communicate the information provided to a wider audience.

1.5 Autonomous and Automated Vehicles

AVs are meant to operate on roadways without any new requirements from the operating agency. That is, existing signage and pavement markings are assumed to be standard and adequately maintained but no new features or systems need to be installed for the AV to navigate the network. Society of Automotive Engineers (SAE) has identified five levels of automation ranging from cruise control at the lowest end to no driver required for a complete trip at the high end (see **Figure 1**). Newer automated vehicles have many of the safety features of an AV but still require a human being to operate (drive). An AV does not require specific new electronic infrastructure to operate. In addition to maintaining pavement and pavement markings in good condition, potential future applications could be considered including embedding additional information into sign sheeting that is visible to the AV but not to the human occupants or embedded pavement sensors/stripping that can provide an automated guide. Currently, there are no standards for these types of applications, but as the market for these vehicles matures, and standards are accepted, public agencies should accommodate the implementation.



Source: National Highway Traffic Safety Administration (NHTSA)
Figure 1: Society of Automotive Engineers (SAE) Automation Levels

1.6 Infrastructure

It has been noted that fiber optic cable exists along a large portion of the US 67 study corridor, but it is privately held with few access points. One of the proposals for ITS projects is to create several "total stations" across the rural portions of the study corridor. These points will require power and communications and should have sufficient space to accommodate RSUs and associated equipment. As individual RSUs are currently available for less than $1,500, including RSUs at these locations is of marginal cost. The communities along the US 67 study corridor would already have power and communications and could support one or more RSUs at almost any ITS device location. In the communities, any new cabinets should be oversized to allow for future deployments. Therefore, limited RSU deployments can be accomplished in the near future utilizing an infrastructure created to support other ITS projects.

If a smart corridor concept is developed for US 67 study corridor that requires more widespread deployment of RSUs, an Internet of Things (IoT) based TMC and supporting infrastructure may need to be implemented. An IoT based TMC would take advantage of both the connectivity provided between all field devices as well as any distributed field intelligence from IoT devices. While IoT and big data present a path-breaking opportunity in smart traffic management and solutions, they also have some limitations. Primarily, high-tech solutions need high-speed data transfer techniques. If for any reason, this connectivity is hampered or compromised, the operations along the entire corridor are jeopardized. Additionally, cybersecurity will need to be assessed to prevent malicious activity.

In general, there are no immediate infrastructure needs for the US 67 study corridor related to preparing for CV and AV, i.e., there are no needs to start deploying RSUs. Over the long-term, high-

speed high bandwidth communications and access to power will be necessary – likely for a wide variety of purposes and reasons. This could include the electrification of the vehicle fleet, increased demand for rural WiMAX, increased deployment of environmental sensors. If not specifically for ITS or CV, it is likely in the best interests of TxDOT to start planning for this need. This may include a mix of radio and fiber as well as alternative power sources. Whether through the deployment of TxDOT owned infrastructure, or agreements with private sector entities, this functionality is likely to be a key support element of the DOT of the future.

1.7 Future Interoperability

USDOT is working with the CV industry to try to make all equipment as interoperable as possible. A federal product certification program exists that certifies equipment by applying the latest CV standards – whether SAE, FHWA (Federal Highway Administration), or NHTSA (National Highway Traffic Safety Administration). The federal CV certification program, however, does not guarantee interoperability. In June of 2018, USDOT hosted an interoperability test at the Turner-Fairbank Highway Research Center where all current vendors demonstrated interoperability between their systems[4]. While interoperability was demonstrated during these tests, not all systems communicate with all other vendors in the various field deployments. Interoperability is possible, but not guaranteed.

CV equipment will evolve. Any RSUs deployed in the short term that are not for a dedicated purpose with a dedicated fleet will likely need to be replaced before market penetration supports more common applications. Considering the relatively low cost of the RSUs and the low number of units discussed, the evolution (replace or update) of deployed CV equipment over decades is feasible.

1.8 CV AV Action Items

As identified above, the costs for individual CV equipment are relatively minimal. This includes both the RSUs that would typically be deployed by public agencies and the OBUs that would be procured by public agencies, private entities, and individuals. The integration into TransVista should not be significant although the supporting infrastructure may be expensive. While the market penetration of CV equipment is currently negligible and many of the applications that directly address safety would require a significant amount of CV equipment to be deployed, it should be recognized that successful deployments will require ongoing coordination between the public and private sectors across a range of users and vendors.

No specific CV applications under TxDOT responsibility exist that are recommended for the US 67 study corridor. As the market develops and matures, future applications will be identified in subsequent plans. Before proceeding with any future CV or AV projects, a cost-benefit analysis is recommended to evaluate the overall benefit to the corridor traffic and safety operations. This approach would need to acknowledge the current uncertainty involved with technology

[4] USDOT https://highways.dot.gov/research

advancements and market adoption, especially concerning the ongoing Federal Communications Commission (FCC) recommendations relative to the 5.9 GHz band for V2V.

CV pilot studies to address specific purposes are encouraged as they are identified in the corridor. Pilot studies should take advantage of available infrastructure including ITS, power, and communications. These pilots should take advantage of federal deployment funds as much as possible. They should also be coordinated across TxDOT so as to take advantage of the lessons learned in other sites within Texas.

Two issues that require monitoring are data privacy and cybersecurity. Both of these issues are likely to be resolved on the national front before any significant deployment is expected on US 67. However, any deployment of CV must address these issues starting in the planning stage. Additionally, as the industry grows it is important to involve non-traditional partners starting in the planning process, such as phone carriers and representation from the equipment vendors.

The recommended action items to support future CV and AV deployments along US 67 study corridor are listed below:

- Maintain signs and pavement markings in good condition using consistent standards
- As ITS and traffic signal systems are deployed or upgraded in urban areas, additional space and capabilities should be designed into cabinets, power requirements, and communication requirements
- Any rural ITS project locations should be designed to include additional space and capabilities into cabinets, power requirements, and communication requirements
- Identify a single TMC point of contact to provide all interfaces
- Coordinate with TransVista to see what technology components need to be coordinated
- Stay informed about CV technology, in particular applications, privacy, and security requirements

These items should all be considered short-term. Longer term issues such as standards and mixed CV/AV and traditional traffic concerns should be monitored through the industry, but should not require any direct involvement relative to this corridor.

13 FT 7 IN
Texas Department of Transportation
PRESIDIO TEXAS
CITY of ALPINE
BREWSTER COUNTY
1882
THE CITY OF MARFA
MARFA TEXAS
OUR 67
US 67 CORRIDOR
MASTER PLAN