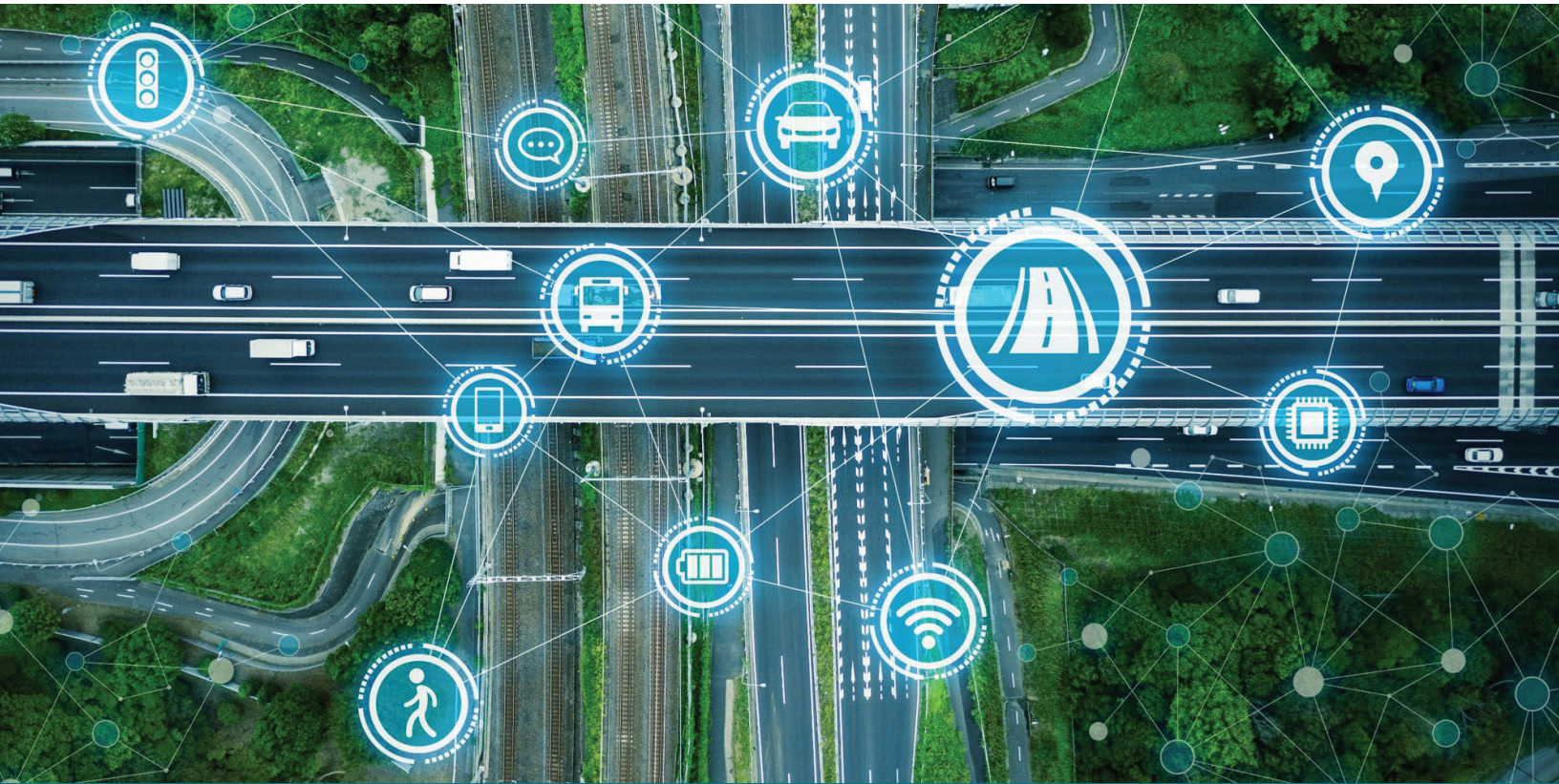


Oregon Connected Vehicle Ecosystem

VOLUME 1: TECHNICAL APPLICATION



ATCMTD NOFO #693JJ321NF00005

Cover Page



Project Name	Connected Vehicle Ecosystem – Mobility and Safety Applications
Eligible Entity Applying to Receive Federal Funding	Oregon Department of Transportation (ODOT)
Total Project Cost (from all sources)	\$4,000,000
ATCMTD Request	\$2,000,000
Are matching funds restricted to a specific project component? If so, which one?	No
State(s) in which the project is located?	Oregon
Is the project currently programmed in the: • Transportation Improvement Program • Statewide Transportation Improvement Program • MPO Long Range Transportation Plan • State Long Range Transportation Plan	Yes, programmed in the: • ODOT Statewide Transportation Improvement Program • ODOT Statewide ITS Architecture and Operational Concept • ODOT Road Usage Charge Program
Technologies Proposed to be Deployed	Cloud-based Connected Vehicle Ecosystem (CVE) leveraging moving vehicle and public agency data to create a data-sharing hub that delivers safety and mobility applications over the network and via road side units (RSUs) using C-V2X

Will the project use connected vehicle technologies? If so, which technologies will be used - for instance, will the project use:

- C-V2X/5.9 GHz spectrum?
- Cellular/4G/5G communications?
- Another connectivity technology? (please specify - e.g., “Wi-Fi,” “Bluetooth,” “RFID,” etc.)

If the connectivity technology has yet to be determined, please specify “TBD”

Yes - C-V2X (5.9 GHz) and Cellular 4G/5G

Will the project use automated driving system technologies?

No

Is the project located in a rural area?

A rural area is an area not in a Census-designated urbanized area (a Census-designated urban area 50,000 residents or more)

Yes, statewide

Is the project located in a qualified opportunity zone designated pursuant to 26 U.S.C. § 1400Z-1?

Yes, statewide

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1. Technical Criteria Table (Specified in Section E.1)

SELECTION CRITERIA	RELEVANCE
TECHNICAL MERIT	
Alignment with program requirements and DOT goals, including safety, innovation, and opportunity	HIGH – The CVE with safety and mobility applications improves safety, mobility, sustainability, economic vitality, and air quality. This program brings proven, state-of-the-art technology to remove a barrier to realizing a connected vehicle future - enabling two-way information flow between both V2X equipped cars and Internet-connected cars and infrastructure owner operators.
Readiness of proposed technology, likelihood of success	HIGH – Up front planning and development of the initial platform for Road Usage Charging is supported under a \$10 million project that is currently underway. This project enhances the system with Connected Vehicle (CV) safety and mobility applications. Project addresses equity and climate change. See section 2.10 for further detail.
Scalability or portability of the proposed technology deployment to other jurisdictions	HIGH – The proposed CVE with mobility and safety applications has significant scalability is planned to be a statewide system, and it could be scaled for the entire country. This project adds safety and mobility applications to a Road Usage Charging CV ecosystem project. The system collects and delivers transportation data from moving vehicles and field infrastructure using open data standards, the cellular network, the Internet, and V2I using the 5.9GHz frequency band.
Commitment to evaluate the effectiveness (i.e cost benefit) of activities proposed	HIGH – ODOT is committed to evaluating the proposed solutions and has established performance metrics for this purpose. Several existing data collection and dissemination systems will be used, including the ODOT TripCheck Data API, ODOT Real Time™, and the Regional Integrated Transportation Information System (RITIS).
STAFFING	
Program/project management to oversee deployment	HIGH – ODOT’s Program Managers will ensure deployment of safety and mobility elements. This project leverages the planning and management structure already in place to deliver the connected vehicle ecosystem to support Road Usage Charging.
Expertise and qualifications of key personnel for technology deployment	HIGH – Key personnel have been selected for their technical knowledge with advanced transportation and connected vehicle technologies. They are statewide experts and are involved in national committees, research partnerships with universities, and development of innovative vendor solutions leveraging open data standards.
COST	
Cost reasonableness, match, stewardship	HIGH – The project requires \$2 million in federal funding, which will be paired with \$2 million in non-federal matching funds. The requested funds do not exceed the maximum, and the match from ODOT meets the requirement. Through our commitment to long-term operations and maintenance funding, ODOT will sustain the value of USDOT’s investment. Further, ODOT has demonstrated success in administering federal grants including recent experience with ATCMTD and TIGER grants for technology projects.
Funding availability	HIGH – The project builds on a current \$10 million investment to plan and build the foundation for the ecosystem specifically focused on road usage charging, and another \$2 million investment from ITS to build safety and mobility applications. This represents a strong return on investment for FHWA with respect to this portable and scalable set of projects, even before the significant regional and national benefits are quantified.

2. Project Narrative

2.1 PROJECT SUMMARY

The purpose of this project is for Oregon Department of Transportation (ODOT) to develop and implement a Connected Vehicle Ecosystem (CVE) that will support Intelligent Transportation System (ITS) safety and mobility applications and Road Usage Charging (RUC). The intention of this project is to reduce crashes and improve mobility with a high return on investment (ROI). This grant request leverages the RUC project investment to add safety and mobility applications to the CVE.

2.2 PROPOSED PROJECT

The future of transportation is increasingly data-driven and depends on reliable, and standardized information about roadway conditions. Connected Vehicles (CVs) are rapidly becoming more common. In fact, in 2019, there were approximately 49 million Internet-connected cars on U.S. roadways. In some states, Internet-connected cars represent up to 20 percent of traffic.

A December 2018 report,¹ estimates that the connected car penetration could reach more than 70 percent by 2023. Working directly with leading automobile original equipment manufacturers (OEMs), ODOT is currently developing a technology-agnostic connected vehicle ecosystem to support road usage charging.

THE OREGON CONNECTED VEHICLE ECOSYSTEM SAFETY AND MOBILITY APPLICATIONS SERVES AS A NATIONAL MODEL FOR CONNECTED VEHICLE ECOSYSTEMS. THE PROJECT LEVERAGES THE HARD WORK AND VALUE OF V2X DEVELOPMENT AND APPLIES THE APPLICATIONS TO INTERNET-CONNECTED CAR DATA INSIGHTS.

The CVE under development enables information sharing to and from vehicles on the highway system. The CVE Safety and Mobility Applications expands the platform to include two-way gathering and sharing data from the following sources:

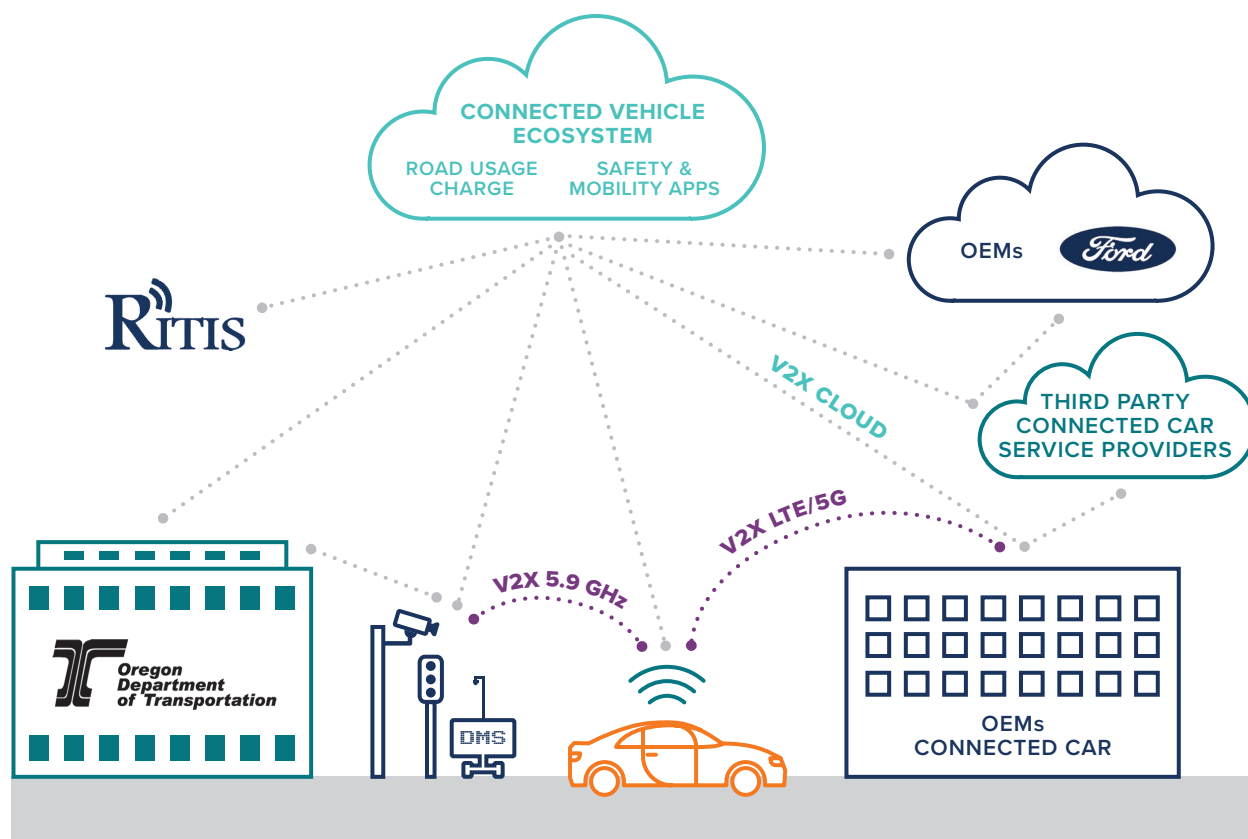
- Internet connected vehicles utilizing the cellular network
- Vehicles equipped with 5.9 GHz radios
- ODOT central software systems (e.g. central signal system, active traffic management system, RealTime™, etc.)
- The Tri-County Metropolitan Transportation District of Oregon's (TriMet) Next Generation Central Transit Signal Priority System, providing transit location, on-time performance, and transit priority calls

¹ Connected Car Report 2019, Statista Digital Market Outlook, Released December 2018.

Combining data from moving CVs, infrastructure, and other data sources creates a powerful ecosystem that enables a connected highway future. Based on the benefits demonstrated in other federally connected vehicle pilot deployment projects, public agencies will be able to gather data and insights on the transportation system to improve planning, management and operations, and significantly reduce crashes, improve travel times, and lower transportation related greenhouse gas emissions. People will enjoy a more reliable and safe transportation experience. Freight providers will experience more predictability and cost savings.

The CVE platform, illustrated in Figure 1, will support multimodal data sharing using open data standards that will enable CV safety and mobility applications that are shared over the Internet and via roadside units with connected cars. This approach leverages C-V2X as a short range communication, the LTE network, and Internet connectivity for a comprehensive connected vehicle aggregation and delivery system. ODOT will build upon its partnership with the University of Maryland to utilize the RITIS system as the data visualization and analysis tool for the data processed through the CVE.

FIGURE 1. CONNECTED VEHICLE ECOSYSTEM



² Oregon DOT's Road Usage Charge Program, <https://www.myorego.org/>

This is an opportune time to build and deploy the CVE Safety and Mobility Applications. ODOT recently received a \$10 million grant from the Surface Transportation System Funding Alternatives Program to conduct the initial planning, design, and implementation of the CVE with a focus on (RUC).² The work being completed for the RUC applications

can be leveraged for the safety and mobility applications by using the same platform, thereby reducing costs associated with deploying these multiple applications separately. This has potential benefits for all states because the CVE will be data agnostic and use standards enabling it to collect and disseminate data from any vehicle.

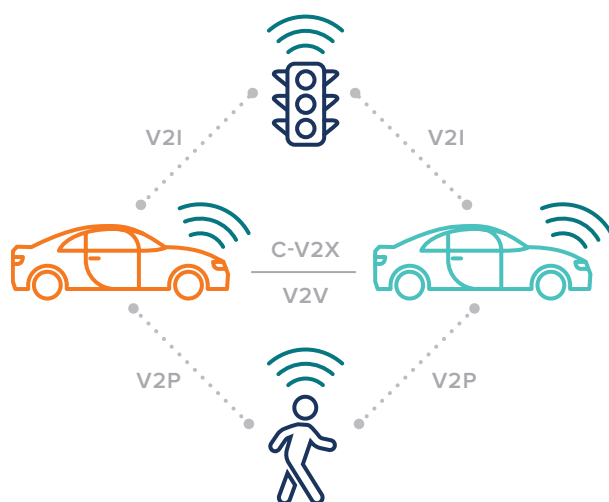
IMPORTANT FEATURES OF THE OREGON CONNECTED VEHICLE ECOSYSTEM

Supports Roadside and Network-Based Communications

The Oregon CVE supports two-way communications using C-V2X at the roadside on the 5.9GHz frequency band (V2X), and network-based communications over the cellular network and Internet. Figure 2 illustrates how the roadside and network-based communications work.

FIGURE 2. ROADSIDE AND NETWORK-BASED CONNECTED VEHICLE ECOSYSTEM COMMUNICATIONS

V2X VEHICLE-TO-EVERYTHING



DIRECT COMMUNICATIONS

- USES C-V2X
- OPERATES IN THE ITS BAND (5.9 GHz)

V2N VEHICLE-TO-NETWORK



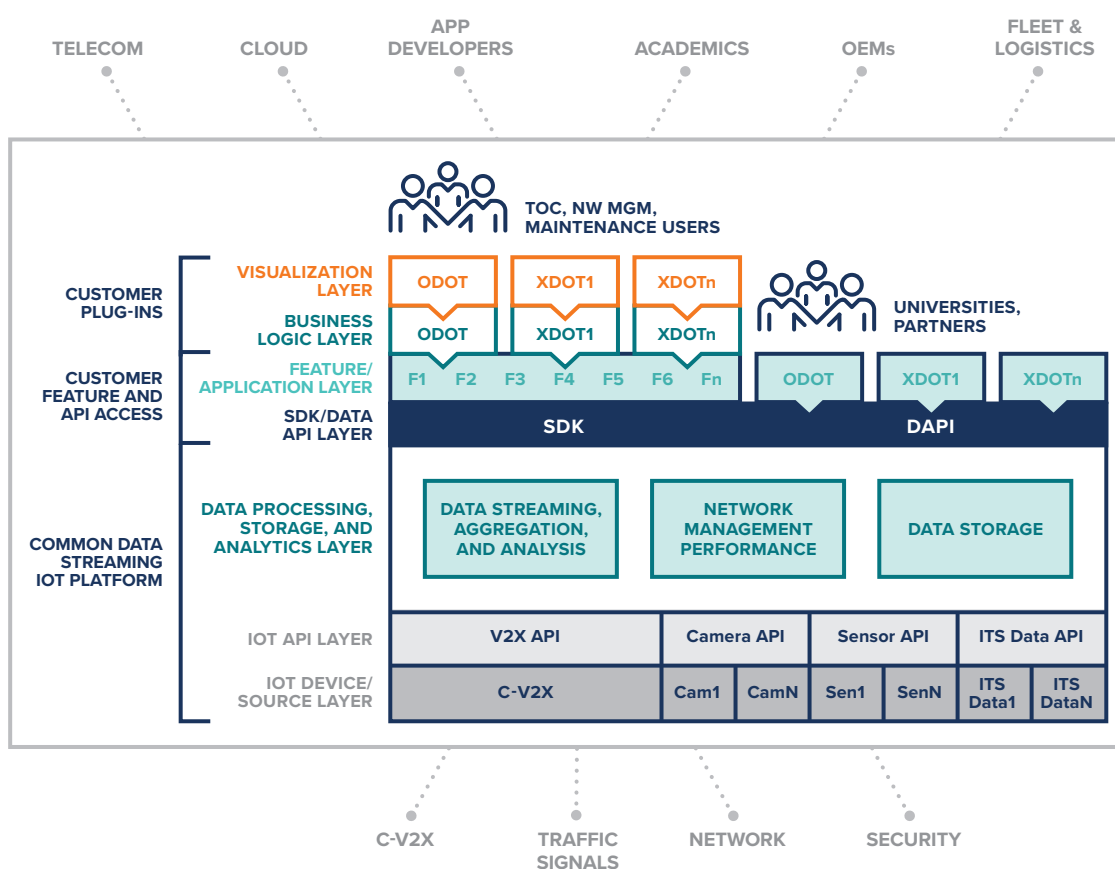
NETWORK COMMUNICATIONS

- LTE/5G FOR V2N
- OPERATES IN LICENSED CELLULAR SPECTRUM AND OVER THE INTERNET

Data From Many Sources

The Oregon CVE integrates data from both public and private sources, secures and anonymizes sensitive data, and makes anonymized data available to third-party users through real-time and historic application programming interfaces (APIs). The ecosystem and management platform will also utilize visual analytic tools, and other methods to support applications development, research, planning, and operations. Figure 3 illustrates the systems architecture.

FIGURE 3. SYSTEM ARCHITECTURE FOR THE CONNECTED VEHICLE ECOSYSTEM



BENEFITS TO THE DOT, AUTOMOBILE OEMS, AND ROADWAY USERS

TABLE 1. PERFORMANCE MEASURES

DOT & PARTNER AGENCIES	OEMs	ROADWAY USERS
• Rapid detection and response to incidents through on-board sensors (airbag deployments, rollover warnings, low visibility indicators, severe weather, etc.)	• Receive actionable data directly from state and local DOTs including things like: higher quality work zone and construction data, real-time signal data, better real-time traveler information and roadway conditions for routing guidance, and information during emergencies	• Better real-time traveler information via in-vehicle navigation systems
• Improved capabilities for planning and programming of construction projects due to higher quality data on mobility patterns and improved safety for construction workers during construction	• OEM technology currently exceeds capabilities of data sharing from agency infrastructure – this advancement helps activate the whole CV system	• Safety and mobility data will benefit all system users, including pedestrians, cyclists, and transit riders
• Lower cost of data collection	• More accessible data from multiple sources	• Reduced delays and congestion
• Enable new areas of data research and application development for decades to come	• The CVE is scalable and offers substantial savings over traditional CV technology. This means OEMs will more quickly realize the benefits of their investment to CV technology	• Better operated and maintained roadways

INNOVATIONS

The proposed CVE delivers several innovations that benefit CV deployments both in Oregon and nationally.

Direct from the Source: Other CV and RUC systems in the country rely on third-party devices that must be installed by users in their vehicles. This is costly to users and the DOT—adding risk and security issues. The Oregon solution sources data directly from OEMs, which increases the quality, timeliness, and quantity of the data, all while better protecting privacy and enabling faster implementation. With multiple OEMs involved, this application has the potential to activate a greater percentage of data from vehicles on the roadway than any other third-party data vendor.

Solution that Leverages the Network:

Other states are acquiring similar data through the deployment of Road Side Units (RSUs) in work zones, at signals, and in other locations. The RSU approach is valuable but the cost and maintenance for wide-scale deployment is a challenge. The Oregon solution uses RSUs in spot locations, but does not rely on RSUs only. It will collect data on all roads at all times for millions upon millions of vehicles with full adoption leveraging data from vehicles collected over the Internet, cellular network, or RSUs. This approach significantly reduces cost and provides for higher quality data collection that goes beyond the basic safety message. Additional data that could be collected or derived includes airbag deployments, traction control engagement, low visibility, hard braking, queue warning, road weather conditions, emissions data, trip origin and

destination, trip purpose, and more. All of this data can be leveraged by operators to better manage the roadways in real-time, while also providing planners the information they require to prioritize and plan construction projects, analyze trends in system performance, time signals, build higher quality models, and evaluate or predict development impacts.

Multi-OEM Collaboration: No other system in the country will support so many OEM partners and produce such a large data set. Even the best private sector data aggregators rarely have more than one or two OEMs providing data. The Oregon approach is innovative in that it will be the first of its kind to facilitate the coordinated sharing of data between OEMs to produce a collaborative data marketplace that supports all road users and generates the largest connected-vehicles data set the country has ever seen. Working with OEMs ensures that applicable safety requirements are being met in CVs.

Scalable: Other CV deployments in the country have been extremely costly to implement and maintain. The Oregon solution enables a highly-scalable data stream direct from OEMs that is extremely cost effective and scalable—while relying on minimal additional roadside infrastructure. This architecture also relies heavily on the existing cellular networks, which are already providing extensive coverage across the state and across the country.

FOCUS ON SAFETY AND MOBILITY APPLICATIONS

Leveraging the work done to build the CVE for RUC, this project will add safety and mobility applications. The following CV applications have been identified as high priority based on previous planning efforts.

- **Freeway Active Traffic Management:** Shares real-time variable speeds, queue warning, road weather conditions, and travel times, and informs the ATM system with vehicle dynamics, and weather conditions from vehicle sensors.
- **Rural Freeway Weather Incident:** Shares road condition, road status, and incident information in rural, mountainous areas and informs operations and incident response personnel of incident conditions from vehicle dynamics, and vehicle sensors.
- **Work Zone Data Exchange (WZDx):** Uses the active work zone data feed specification to share work zone information with connected vehicles and informs operators and construction managers with Internet-connected car data insights.

- **Traffic Signal Timing and Operations:** Shares real-time signal phase status and time to red or green using over-the-network and RSUs. ODOT uses Signal Phase and Timing (SPaT) and Map Management (MAP) applications provided by the MaxConnect API through the TripCheck Data API to share traffic signal lane geometry and current phase information.
- **Curve Speed Warning:** Shares curve warnings based on vehicle speed and road conditions.

While these applications are of most interest to ODOT, during the project development ODOT will continue to work with the selected CVE vendor and OEM partners to continue to identify, prioritize, and refine applications of mutual interest for development. The CVE vendor will be selected in 2022 as part of the RUC system project and will be on-board in advance of implementation of the safety and mobility applications.

2.3 GEOGRAPHIC AREA

The proposed system is an Oregon statewide system. The CVE is built to support a data exchange with all public agencies and transit agencies in Oregon and provides a model ecosystem that can be replicated across the country. For mobility and safety applications using RSUs, the project will

deploy on a 20-mile segment of US26, OR35, and US97 over Mt. Hood. The Mt. Hood corridor already has high-speed fiber optic communications, variable speeds, road weather sensors, and dynamic message signs. The CVE project will deploy RSUs to deliver the road and traffic condition information to vehicles equipped with On Board Units (OBUs).

FIGURE 4. PHOTOS OF THE MT. HOOD CONNECTED VEHICLE ECOSYSTEM



2.4 REAL-WORLD ISSUES AND CHALLENGES

The following is a discussion of real-world issues and challenges that will be addressed by the proposed technology deployment.

SEVERITY AND FREQUENCY OF CRASHES

Severe and fatal crashes are a significant issue on roadways throughout the country. Oregon experiences over 300 fatalities on average each year,³ but this is trending upward in 2018 with over 446 fatal crashes and over 27,000 injury crashes.⁴ The top driver actions contributing to these numbers are errors that connected vehicle technology is designed to address, such as following too closely, hitting a stopped or slower vehicle, running off the road, and exceeding safe speeds during poor weather. Successful connected vehicle implementation is expected to minimize the severity and frequency of incidents with the rapid detection responses and better real-time traveler information discussed in previous real-world challenges.

INCREASING CONGESTION AND MOBILITY, IMPACTS ON THE ENVIRONMENT

As populations continue to grow in the State of Oregon and in large metropolitan areas across the country, increasing congestion is a primary concern for many agencies. Connected vehicle technology and a data-sharing ecosystem would not likely solve all facets of the congestion problems, however, capabilities like improving incident response

times and interfacing with traffic signals to optimize corridor flow have the potential to significantly improve the capacity of existing roadways and reduce congestion. As just one result of reduction in congestion throughout the transportation network, fewer greenhouse gas emissions will be attributed to personal vehicle transportation and therefore mitigate the impacts of climate change.

MANAGING A MULTIMODAL SYSTEM

Several modes compete for capacity on today's transportation networks. A connected vehicle ecosystem has the potential to share information that would significantly benefit both transit and freight in its earliest applications. Both modes would benefit from the increased data sharing and congestion warning features of such a system, and the location based data and routing of both transit and freight would contribute to the overall picture of the transportation network for both the agency and public roadway users.

PARTNERSHIPS WITH OEMS AND THE FUTURE OF TRANSPORTATION

It is becoming increasingly important for car manufacturers and transportation network owners and operators to collaborate for a more connected future as vehicle technology advances. This project provides a unique opportunity for the two sectors to develop a tool that integrates new technologies for the benefit of roadway users and the efficiency of the system.

³ 2016 Oregon Transportation Safety Action Plan Executive Summary. https://www.oregon.gov/odot/Safety/Documents/TSAP2016_ExecSum.pdf

⁴ 2016 Oregon Transportation Safety Action Plan Executive Summary. https://www.oregon.gov/odot/Safety/Documents/TSAP2016_ExecSum.pdf

REAL-TIME DATA FLOW

ODOT is responsible for the management and operations of the highway network throughout the state. Improved availability of real time data enables more proactive and effective response to disruptions to system operations. Application ranges include items such as improved incident management, improved response to weather hazards, improved work zone management, enhanced information to support active traffic management software algorithms, and enhanced traveler information. With a connected vehicle ecosystem in place, real-time situational awareness can:

- Allow the DOT to effectively and safely manage congestion, especially during incidents
- Present roadway conditions, work zone information, incident information, and more to the traveling public before they reach a congested or unsafe segment of the system
- More rapidly detect incidents and respond to reduce traffic congestion and risk of secondary crashes.
- Improve real time software algorithms for applications such as active traffic management
- Fill data gaps that exist statewide, particularly in the more rural areas of the state

COST OF DATA COLLECTION

Transportation analyses and research today use performance-based and data-backed methods. Typically, that data is being collected through a variety of methods,

including permanent count stations, temporary count locations, signal detection information, and some collection of vehicle-probe data by third parties. Due to the high cost of the higher-resolution vehicle-probe data collected by third parties, agencies like ODOT are often forced to choose between quality data or their budget. A connected vehicle ecosystem with the data sharing capabilities available internally to the agency, gives ODOT the potential to access the quality of data needed for robust research and development applications.

RELIANCE ON ROADSIDE INFRASTRUCTURE FOR CV IMPLEMENTATION

Across the country, the majority of connected vehicle implementations have relied on significant roadside infrastructure. The roadside only approach is a challenge to fund, operate, and maintain due to the amount of equipment required. By complementing roadside infrastructure with in-vehicle systems and existing communications networks in a connected vehicle ecosystem, DOTs have the ability to implement connected vehicle technologies more rapidly. This method of implementation promotes a scalable solution that could be used throughout the country.

Table 4 (pg. 22) indicates where the proposed project aligns with the grant's key focus areas. As shown, the project aligns with the majority of focus areas either directly through its implementation and expected benefits, or through its link to the Road Usage Charging (RUC) Program. The project's alignment with goals of the initiative are discussed in more detail under section 2.13.

2.5 TRANSPORTATION SYSTEMS AND SERVICES INCLUDED IN THE PROJECT

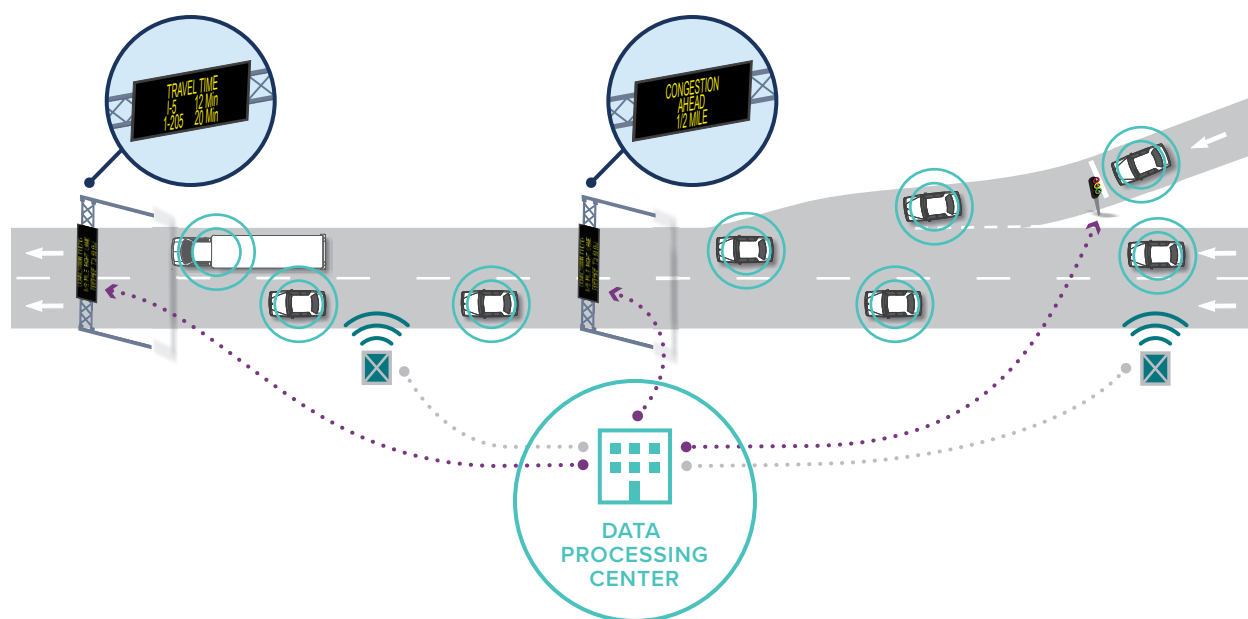
In 2016, ODOT developed a Connected Vehicle Roadmap as part of the update of the state's ITS Architecture at the time. That initiative identified the Connected Vehicle applications that ODOT considered highest priority from an agency perspective. This project picks up where that work left off, to set the foundation to begin implementing the various applications that both ODOT and its private sector partners find to be of highest value.

Leveraging the work done to build the CVE for RUC, this project will add safety and mobility applications. The proposed safety and mobility applications will use the CVE to collect and communicate information to and from vehicles on the highway system and display safety and mobility information to drivers.

Several use cases will be supported by the deployment. These use cases will combine and distribute data from moving vehicles and the infrastructure both over-the-network and via RSUs. The five priority use cases include:

- **Freeway Active Traffic Management:** Shares real-time variable speeds, queue warning, road weather conditions, and travel times, and informs the ATM system with vehicle dynamics, and weather conditions from vehicle sensors (shown in Figure 5).
- **Rural Freeway Weather Incident:** Shares road condition, road status, and incident information in rural, mountainous areas and informs operations and incident response personnel of incident conditions from vehicle dynamics, and from vehicle sensors.

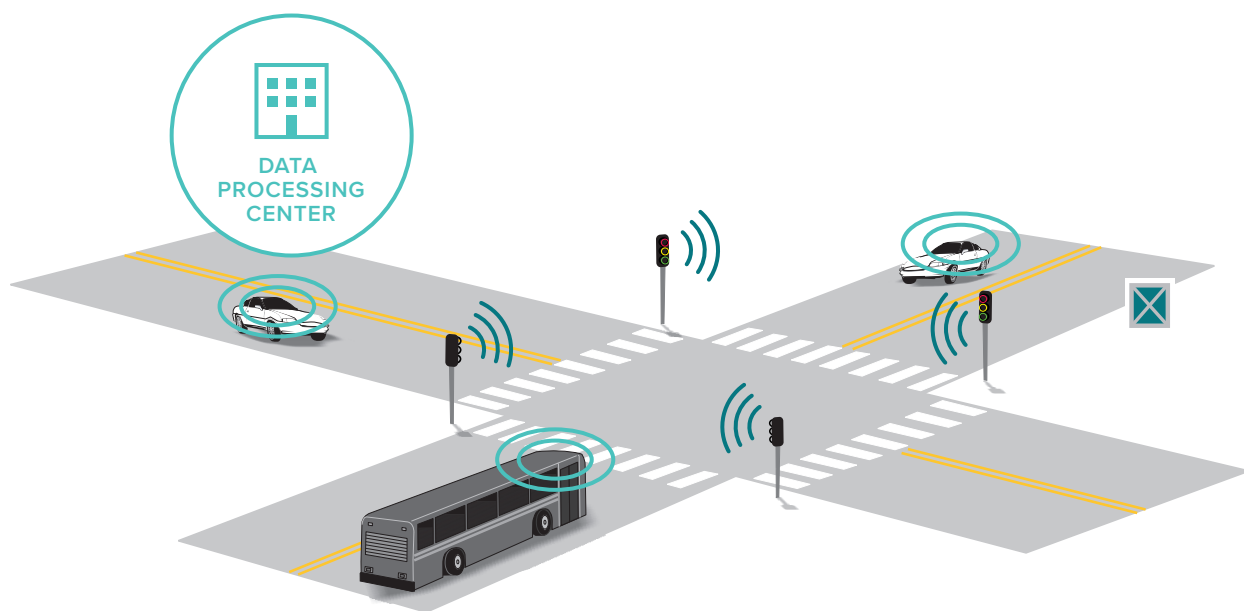
FIGURE 5. EXAMPLE FREEWAY ACTIVE TRAFFIC MANAGEMENT



- **Work Zone Data Exchange (WZDx):** Uses the active work zone data feed specification to share work zone information with connected vehicles and informs operators and construction managers with Internet-connected car data insights.
- **Traffic Signal Timing and Operations:** Shares real-time signal phase status and time to red or green using over-the-network and RSUs. ODOT uses Signal Phase and Timing (SPaT) and Map Management (MAP) applications provided by the MaxConnect API through the TripCheck Data API to share traffic signal lane geometry and current phase information (shown in Figure 6).
- **Curve Speed Warning:** Shares curve warnings based on vehicle speed and road conditions.

These safety and mobility applications benefit public agencies and travelers.

FIGURE 6. EXAMPLE TRAFFIC SIGNAL TIMING AND OPERATIONS DISTRIBUTION



2.6 DEPLOYMENT PLAN INCLUDING ONGOING OPERATIONS

The proposed Oregon Connected Vehicle Ecosystem will build on the work done nationally with V2X deployments, partner with the automotive industry, and leverage both the current project to build the CVE for RUC and the existing transportation systems already deployed in Oregon. ODOT has a long history of successful ITS and TSMO deployments and has created a robust staffing and organizational structure to ensure effective operations and maintenance of its investments.

Relation to RUC CVE Project. This project leverages and builds on the existing \$10 million ODOT project to plan and build the CVE for RUC. Therefore, the project management and leadership structure for deployment, operations and maintenance are already in place.

ODOT CVE Leadership Team. The ODOT CVE Leadership Team will oversee the RUC and CV project teams and is responsible for setting the vision, collaborating with industry partners, primary decision-making, consultant/vendor selection, and oversight on project progress. This team was established for the RUC CVE project and they will fold in the CV safety and mobility application responsibilities.

Consultants and Vendors. ODOT intends to use consultant support for planning, systems engineering, development of specifications and procurement documents, and program management. Vendors will be procured to build the CVE platform and supply the RSUs and OBUs.

Operations and Maintenance. The CVE system will be vendor-developed and operated, but ODOT will operate and maintain the connections of ODOT systems to the CV ecosystem. Data analysis and visualizations will be provided through the RITIS system that will be operated and maintained through ODOT's existing agreement with the University of Maryland. ODOT has a complete team including ITS technical analysts, system managers, IT support, developers, ITS field technicians, and project management support that maintains the existing ITS assets and systems. This experienced team will guide the development of the CVE and its connection to other systems, and they will provide the day-to-day operations and maintenance functions, and oversee development of future system enhancements.

ODOT HAS PROVEN EXPERIENCE IMPLEMENTING AND OPERATING COMPLEX SYSTEMS. WITH A GRANT FROM THE FHWA IN 2012, ODOT DEVELOPED A STATEWIDE ATM SYSTEM THAT WON AN ITS AMERICA "BEST OF ITS" AWARD AND HAS SUPPORTED A SCALED IMPLEMENTATION OF ATM TO MORE THAN TEN RURAL AND URBAN CORRIDORS.

The ODOT team has proven expertise and qualifications to successfully manage and sustain the deployed systems through their full life cycle, well beyond the period of performance.

ODOT demonstrates its commitment to long-term operations and maintenance through dedicated funding. ODOT has spent over \$8 million on Transportation Operation Center (TOC) operations and over \$6 million on ITS maintenance over the past two years. Continued operations and maintenance funding is anticipated in the next biennium to ensure long-term program success beyond the period of performance.

2.7 OBSTACLES TO DEPLOYMENT

As with any new technology, challenges are expected. With any cutting-edge technology, some institutional, collaboration, and technological challenges are expected, and ODOT has a plan to address each one.

- Partnering with private sector organizations such as OEMs given different motivations and needs.
- Delivering the information into vehicles without OBUs. The ODOT CVE is designed to leverage existing in-vehicle systems for delivering the information.
- Developing data privacy and security plans.
- Compatibility with multiple existing systems. ODOT has a long history promoting and leveraging standards.

ODOT's successful history with regional partnerships in transportation technology and leadership in systems engineering and ITS standards are key aspects of overcoming coordination and technological challenges. Multiple existing factors set a foundation for success:

- An active project to develop the CV ecosystem focused on RUC with \$10 million in funds including work with OEMs to develop the concept.

- A long, successful history promoting and using ITS standards and in developing and delivering effective software projects. This includes addressing data privacy and security for ITS applications. ODOT has project staff experience with implementing IT security technologies.
- Existing support from OEM partners and a plan to leverage the advanced work done for the RUC applications, which also plan to use in-vehicle systems.
- Success implementing an Active Traffic Management project using TIGER funds that resulted in safety and mobility benefits and received an ITS America "Best of ITS" award.

No legislative or regulatory challenges are expected for this deployment.

The legislative environment in Oregon is supportive of new technology, particularly with House Bill 4063, signed by Governor Kate Brown on April 10, 2018, naming ODOT the state's lead agency on automated vehicle (AV) policy (as recommended by NHTSA), and supporting the RUC concept. The solutions proposed for the Oregon Connected Vehicle Ecosystem will improve safety and mobility for all roadway users and support RUC and AV advancements.

2.8 QUANTIFIABLE SYSTEM PERFORMANCE IMPROVEMENTS

The proposed ecosystem enables ODOT to **optimize system efficiency** and **reduce traffic-related congestion** immediately. **Reducing traffic-related crashes, costs** and **improving access to transportation services** will be informed by the deployment of both this project and more widespread adoption of CVs.

By investing in an innovative data sharing ecosystem now, ODOT will set the stage for the several quantifiable safety, mobility, and environmental benefits in the future that result from a transportation system full of connected vehicles.

This project is the first step in showing how rapid connected vehicle deployment will impact safety and mobility in the future. As with any new technology, we expect an adoption rate that starts small with early adopters. Understanding that achieving a broad base of connected vehicles interacting with the CVE will take time, the initial deployment must assess the value delivered to a small percentage of vehicles on the roadway. Quantifying the system performance improvements will center on the following approach:

- **Qualitative Assessment** – The project team will dissect the lived experiences of roadway users and how they interpret the data that is made available to them through the data sharing ecosystem.
- **Quantitative Assessment** – Using moving vehicle data from the ecosystem and other third-party sources, the project team will evaluate differences in queuing, congestion, hard braking, and travel times.
- **Return on Investment (ROI)** – The proposed ecosystem sets the foundation for rapid CV deployment in Oregon and across the country. The project team will assess the ROI considering factors such as integration with RUC, adoption rate, ease of adding new CV applications, opportunity to incentivize travelers using the system, and cost savings.

have the potential to be measured with widespread implementation of the connected vehicle ecosystem proposed in this project.

By leveraging in-vehicle systems with the proposed ecosystem, this project will easily. With this direction, the investment of this project will inform widespread deployment practices and tools to ensure the highest ROI for the data sharing ecosystem for both roadway users and operators. In this way, traditional quantitative performance improvements such as congestion relief, travel time reliability, and reductions in fuel consumption can be achieved quickly and efficiently.

2.9 QUANTIFIABLE SAFETY, MOBILITY, AND ENVIRONMENTAL BENEFITS

In addition to the qualitative assessments that would occur during this project for the first set of road users with ecosystem service technology in their vehicles, investments in this project would ensure high ROI for funding agencies and have the potential to produce significant safety and mobility benefits in the future.

The safety, mobility, and environmental benefits of a connected vehicle enabled transportation system are expected to significantly enhance the transportation experience. Connected vehicles are expected to reduce crashes, reduce travel times (through signal priority, intelligent traffic signal systems, and work zone applications), and in turn reduce overall fuel consumption and emissions. ODOT's existing coordination with the Regional Integrated Transportation Information System (RITIS) will enable the

agency to measure the safety, mobility, and environmental benefits that emerge from a connected vehicle ecosystem. RITIS features analysis tools and reporting that can quantify these benefits. Table 2 provides several examples of the capabilities of RITIS that facilitate the ability to consume and

publish data to measure the expected benefits of connected vehicles. The model that this project is proposing would be easily scalable to all vehicles after successful implementation and lessons learned from this project.

TABLE 2. SAFETY, MOBILITY, AND ENVIRONMENTAL BENEFITS EXPECTED TO BE QUANTIFIED WITH FULL DEPLOYMENT OF THE PROPOSED ECOSYSTEM

OVERALL BENEFIT	QUANTIFIABLE BENEFIT	SAFETY	MOBILITY	ENVIRONMENTAL
Detect and respond to incidents more quickly	Incident clearance times before and after	●	●	●
Better traveler information to motorists	The amount of data being shared with third parties; estimate how many users are seeing the information	●	●	●
Reduce delays from incidents	User delay cost measures before and after	●	●	●
Increased situational awareness for operators and operations	Number and type of incidents detected	●	●	
Ability to share data with OEMs	Crashes within work zones	●	●	
Cost savings for the state	Investment in data collection prior to deployment compared to ease of data accessibility from vehicles	●	●	●
Improvement in operator's ability to do their job	Survey on quality of information, amount of information, job satisfaction, and more	●		

2.10 VISION, GOALS, AND OBJECTIVES FOR THE DEPLOYMENT

The vision for the deployment of the connected vehicle ecosystem is to **improve safety and mobility benefits for travelers**. This project will do so by deploying technologies that are **(1) feasible** for systemwide deployment by using open systems and eliminating the need to rely on roadside devices and their ongoing maintenance and operating costs, and deploy technology that is **(2) scalable** to the entire fleet of vehicles using the transportation system by leveraging in-vehicle systems. The objectives of the technology deployment are to:

- Discover how best to structure the data platform so that it is usable by transportation system operators and users
- Evaluate the ecosystem's impact on system performance
- Set the foundation for rapid CV deployment in Oregon and throughout the country
- Support implementation of Oregon's Greenhouse Gas Emissions Reduction goals.

The vision, goals, and objectives of this project directly align with the State of Oregon's goals of excellence and integrity. The proposed ecosystem will leverage the national investment made in CV applications and short-range communication technologies, and add another layer of communications using the Internet and cellular network. By coordinating with in-vehicle systems, roadway users will experience direct benefit of the investments made with successful implementation

of this project in their everyday travel that will be better informed, safer, more reliable, and better for the environment. The nature of the project also aligns directly with the goals of the Oregon Transportation Plan and the Statewide Intelligent Transportation Systems Vision and Goals in Oregon, as shown in Table 3 (pg. 19).

This project also implements strategies identified in the Oregon Statewide Transportation Strategy: A 2050 Vision for Greenhouse Gas Emissions Reductions. Optimizing the transportation system through operations and technology is Strategy 3 identified in the plan. Eco-driving applications and V2X communications are specific elements identified to implement this strategy. While the applications implemented through the CVE are dependent on alignment with interest from OEM's ODOT intends to pursue eco-driving applications through the CVE.

Finally, ODOT has identified Equity as a priority in the agency's Strategic Action Plan. This project supports that goal by providing economic opportunity. The proposed system architecture shown in Figure 3 (pg.5), includes the concept of an open, data API, that will provide nonexclusive data access. In this way, the project will reduce barriers for small, minority owned businesses that may not have the resources to develop this type of data platform. Providing open data access will allow innovation from more sources and will spur additional development that will benefit the transportation system. While this system will have broad application, it will be especially beneficial to urban areas, which not only experience the most congestion but also have large low-income and BIPoC populations. Reducing congestion will improve air quality, transit reliability, and access to key services for these under-served communities.

TABLE 3. GOALS OF THE TRANSPORTATION PLAN AND THEIR PROJECT ALIGNMENT

GOALS OF THE OREGON TRANSPORTATION PLAN	PROJECT ALIGNMENT
 Accessibility and Mobility	Full implementation will directly address mobility
 Management of the System	Constant two-way data sharing will help ODOT operate and manage the system in real time
 Economic Vitality	In addition to the economic benefits from congestion reduction, this project's work with the RUC program will make funding Oregon's transportation network feasible for the future
 Sustainability	Reducing congestion limits the greenhouse gases emitted while idling
 Safety and Security	Full implementation will directly reduce crashes and reduce incident response times
 Funding the Transportation System	This project's connection to the RUC program will directly address funding the transportation system for the future
 Coordination, Communication, and Cooperation	The nature of this project is to increase the amount of coordination, communication, and cooperation that occurs between roadway users, roadway operators, and third parties that affect the transportation system.

2.11 PLAN TO LEVERAGE AND OPTIMIZE EXISTING TECHNOLOGY INVESTMENTS

ODOT will leverage a significant investment in technologies built using standards and open data over the past 25 years.

- **RealTime™:** ODOT's active transportation management software, used for active traffic, active demand, queue warning, and road weather responsive systems. The RealTime platform was designed and built to be used for any urban or rural highway in the state, which has resulted in rapid deployment of ATDM strategies.
- **TripCheck:** ODOT's shared traveler information platform for dynamic routing and road weather information dissemination.
- **TripCheck Data API (Application Programming Interface):** ODOT's shared portal for distributing active traffic, active demand, road weather, and connected vehicle data to private industry and media.
- **Road Usage Charge Connected Vehicle Ecosystem:** This proposed project builds on the current \$10 million project to plan and build a CVE for road usage charging.
- **Regional Integrated Transportation System (RITIS):** ODOT's investment in the RITIS data archiving and analytics system will be used to store anonymized data for planning and analysis.
- **Advanced Transportation Controllers (ATCs):** Single statewide ATC type (capable of integrating RSUs and sharing CV data) allows consistency across the state. The local software produces MAP as part of the standard workflow and includes SPAT CV application.
- **Pikalert:** ODOT has an active project to implement the Pikalert system from the National Center for Atmospheric Research. It will merge ODOT's Road

Weather Information System (RWIS) data with road specific weather forecasts.

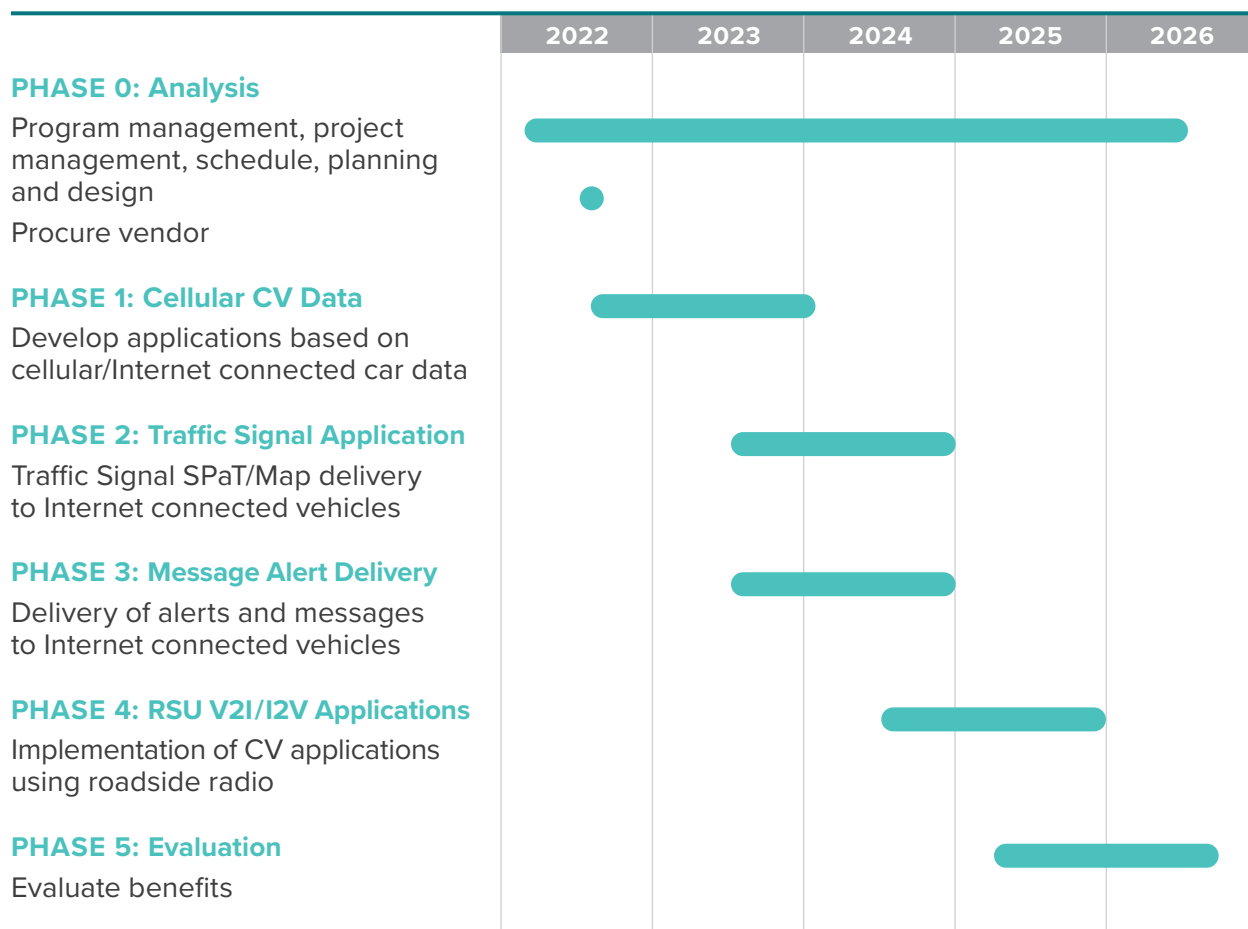
Pikalert was built to accept CV data when it is available.

- **Dynamic Message Signs (DMS):** All DMS in the state use National Transportation Communications for ITS Protocol (NTCIP) and sign messages that are shared through the TripCheck Data API. To speed posting priority messages for travelers, ODOT's Response Plan System automatically selects signs and recommends messages based on incident and event locations. Message Queue Manager software application coordinates message activation from ODOT's various software systems and activates the highest priority message for that sign. Adding RSUs quickly enables data sharing with CVs at the roadside.
- **Next Generation Transit Signal Priority (TSP):** The Tri-County Metropolitan Transportation District of Oregon (TriMet) is currently developing a centralized application for TSP from center-to-center. TriMet's TSP system will consume data from the CVE and use that data for decision-making related to transit priority requests.
- **Additional Supporting ODOT Systems:** Many existing systems support CV application deployment.
 - Adaptive Ramp Metering
 - Curve Speed and Weather Warning Systems
 - Statewide Communications Backbone

AUTOMOBILE OEMs

The project will also build on technology investments from original equipment manufacturers (OEMs) that provide the on-board vehicle technology and are open to sharing and consuming data from the CVE.

2.12 SCHEDULE



2.13 SUPPORT OR LEVERAGING ITS PROGRAM DOT INITIATIVES

The connected vehicle ecosystem with proposed safety and mobility enhancements supports the USDOT ITS Joint Program Office (JPO) Strategic Research areas that lead collaborative and innovative research, development, and implementation of ITS to improve the safety and mobility of people and goods, as shown in Table 4. The outcomes of the proposed project and its specific advancement of V2I communications for mobility and safety applications play a

key role in supporting and leveraging development and research priorities for the future of transportation innovation.

SUPPORTED ITS JPO STRATEGIC RESEARCH AREAS

- ✓ EMERGING AND ENABLING TECHNOLOGIES
- ✓ DATA ACCESS AND EXCHANGES
- ✓ AUTOMATION
- ✓ ACCELERATING ITS DEPLOYMENT

2.14 IMPLEMENTATION OF USDOT GOALS AND OBJECTIVES

TABLE 4. ALIGNMENT WITH TECHNOLOGIES, GOALS, FOCUS AREAS, AND OBJECTIVES

NOFO GOALS, FOCUS AREAS, AND OBJECTIVES	ACHIEVED
TECHNOLOGIES (SECTION A.3, PAGE 7-8)	
Advanced traveler information systems	●
Advanced transportation management technologies	●
Infrastructure maintenance, monitoring, and condition assessment	●
Advanced public transportation systems	●
Transportation system performance data collection, analysis, and dissemination systems	●
Advanced safety systems including V2V, V2I, and AV	●
Integration of ITS with the Smart Grid and other charging systems	
Electronic pricing and payment systems	
Advanced mobility and access (i.e., dynamic ridesharing)	
GOALS (SECTION A.4, PAGE 9-10)	
Reduced costs and improved return on investments	●
Environmental benefits that alleviate congestion	●
Measurement and improvement of operations	●
Reduction in traffic crashes and an increase in safety	●
Collection, dissemination, and use of real-time information	●
Monitoring transportation assets to ensure a state of good repair	●
Economic benefits by movement of goods, people, and services	●
Accelerated deployment of V2V, V2I, and AV	●
Integration of advanced technologies into TSMO	●

NOFO GOALS, FOCUS AREAS, AND OBJECTIVES	ACHIEVED
Evaluation of advanced technologies	●
Reproducibility of knowledge transfer	●
FOCUS AREAS (SECTION A.4, PAGE 10-12)	
Climate Change and Environmental Justice Impacts	●
Racial Equity and Barriers to Opportunity	●
Integration of intelligent transportation systems with the SMart Grid and other energy distribution and charging systems	
Advanced public transportation systems	●
Freight (or Port) Community Systems	
R.O.U.T.E.S.	●
Complete Trip	
KEY DEPARTMENTAL OBJECTIVES (SECTION A.5, PAGE 12-15)	
Supporting economic vitality at the national and regional level	●
Leveraging federal funding to attract investment	●
Innovative approaches to improve safety and expedite delivery	●
Achieving specific, measurable outcomes	●

3. Management Structure

The following is a description of the proposed management structure that will oversee the implementation of the project and provide administration of the agreement.

3.1 APPLICANT ENTERING AGREEMENT

ODOT will be responsible for the agreement with FHWA and the overall project delivery. ODOT personnel will manage the program including development of the Request for Proposal (RFP) for acquisition, development, installation, and testing of all project components. ODOT is accustomed to delivering transportation infrastructure, IT, and ITS projects and will use its established and proven process for systems engineering, design, procurement, software management, and delivery phases of program projects.

The proposed ecosystem will build on the development of ODOT's Road Usage Charging (RUC) Program that recently received funding from the Surface Transportation System Funding Alternatives Program Grant. The project teams will work closely with one another and will be managed by the same leadership team as shown in Section 3.4.

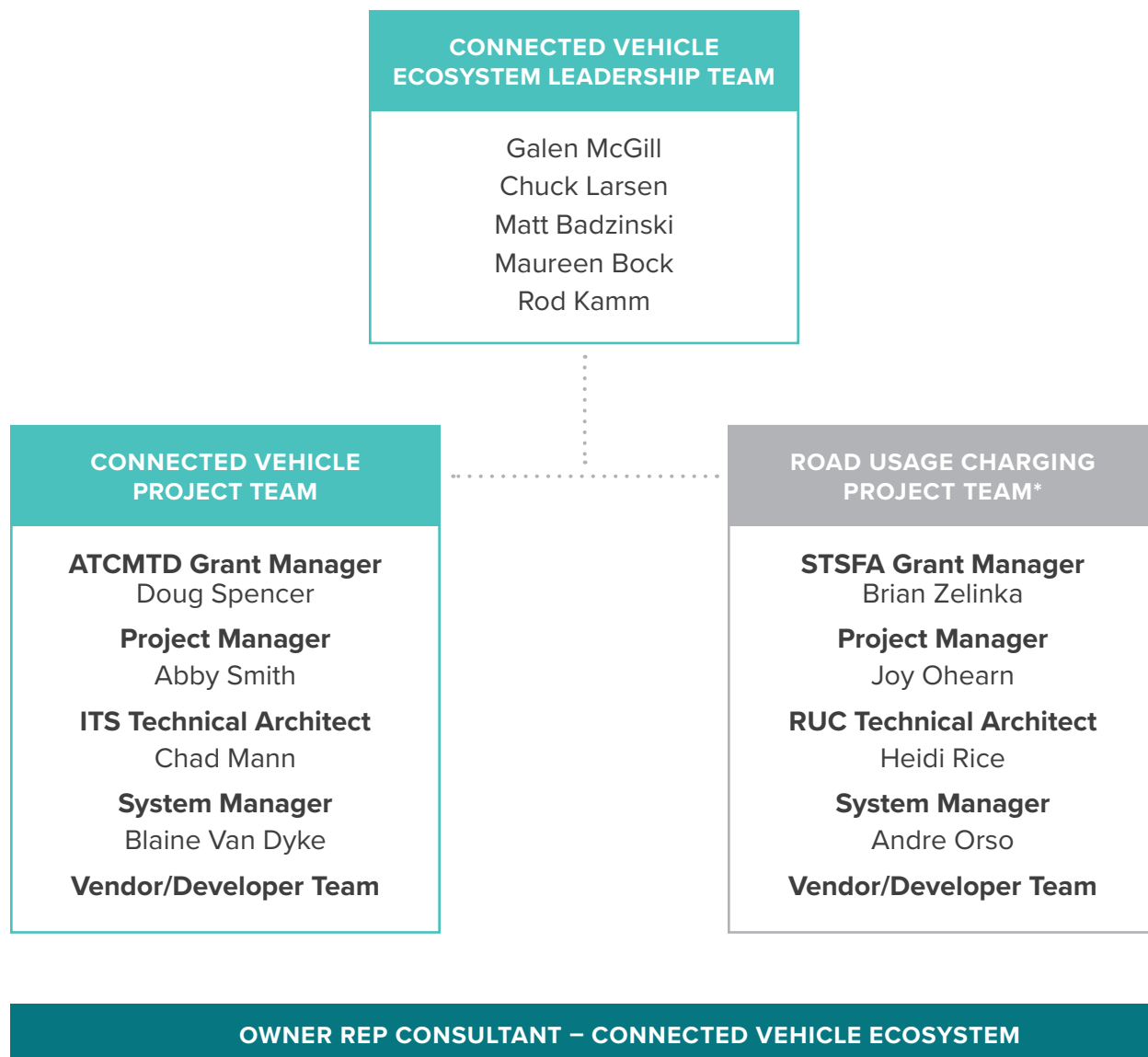
3.2 PUBLIC AND PRIVATE PARTNERSHIP OPPORTUNITIES

Implementation of this program will require partnerships with OEMs to ensure in-vehicle systems are compatible with the ecosystem. ODOT is already working to develop the RFP to select the vendor for the CVE through its innovative partnership program. We expect to have a vendor selected to begin work by mid-2022. This project leverages that contract and vendor relationship. Several OEMs have expressed interest and support of ODOT's proposal to expand the connected vehicle ecosystem to include safety and mobility considerations. A letter of support obtained from Ford Motor Company is provided in Volume 2.

3.3 PROPOSED SUB-RECIPIENTS

ODOT will be the sole agency responsible for this grant. Collected data and the ecosystem platform will be accessible by all partner agencies and third parties. One of the primary agencies that is expected to significantly benefit from the ecosystem is TriMet, whose letter of support for this project is included in Volume 2. No formal sub-recipients will be specified in this project.

3.4 PROJECT TEAM



**FUNDED THROUGH A SEPARATE BUDGET*

3.5 MULTIJURISDICTIONAL PARTNERSHIPS

No official multijurisdictional partnerships will be made for this project, though several jurisdictions in Oregon and across the country are expected to benefit from its

completion. TriMet is a non-financial partner collaborating to ensure their Next Generation Central Transit Signal Priority System will provide and consume data from the ecosystem.

4. Staffing Description

The following sections identify the key personnel who will be involved in implementation and deployment of the proposed projects, including their respective roles and responsibilities.

ODOT will work with a consultant to support planning, systems engineering, program management, design, and implementation, and ODOT will work with a vendor to build the platform and applications for the Connected Vehicle Ecosystem (CVE). The planning effort for the entire ecosystem will be completed through the separately funded RUC project, and the effort using this ATCMTD program will focus on implementation of safety and mobility applications.

4.1 KEY PERSONNEL

ODOT is enlisting a very experienced project team to manage and deliver this project. As the project described in this proposal is part of a broader CVE project aimed at implementing a road usage charging system at scale, we've proposed a leadership team to provide oversight for the broader initiative and to coordinate the work of the respective project teams with the selected CVE vendor. The leadership team is comprised of the following members:

- **Maureen Bock**, *ODOT Chief Innovation Officer*. Maureen is the manager for the ODOT Office of Innovative Funding and is a national leader in the area of Road Usage Charging.
- **Chuck Larsen**, *Highway IT Project Delivery Manager*. Chuck is responsible

for software delivery projects for the Office of Innovation and will be the IT manager responsible for delivery of the RUC portion of the CVE project.

- **Galen McGill**, *System Operations & ITS Manager*. Galen is responsible for delivery of ODOT's Operations Program and is a national leader in the area of transportation system management and operations.
- **Matt Badzinski**, *Maintenance & Operations IT Project Delivery Manager*. Matt is responsible for software delivery related to ITS applications and will be the IT Manager responsible for the delivery of the safety and mobility portion of the CVE project.

The Appendix to this application includes resumes for the key staff responsible for delivery of the project described in this proposal. This team is exceptionally well qualified to deliver this project, and a description of their roles on the project team is as follows:

- **Doug Spencer**, *ODOT ITS Standards Engineer*. Doug will coordinate delivery of the grant funded project with FHWA. This will include coordinating quarterly reporting and other communication with FHWA. Doug is serving in a similar role for the 2018 ATCMTD grant received by ODOT. He will also contribute to the project as a technical subject matter expert contributing his extensive experience related to ITS standards and systems. Their anticipated level of involvement is 20%.

- **Abby Smith**, *ITS IT Program Coordinator*. Abby will manage the project and coordinate delivery of the various software projects needed within the scope of this proposal. Their anticipated level of involvement is 80%.
- **Chad Mann**, *ITS Architect*. Chad's role in the ITS Program is in providing analysis and planning for system architecture across all of our ITS systems and projects. Chad will lead the system architecture design and integration with ODOT systems. Their anticipated level of involvement is 25%.
- **Blaine Van Dyke**, *Connected Vehicle Engineer*. Blaine's role will be the system manager, which is the business lead for ongoing operation of the system. Blaine serves in a similar role for other systems including ODOT's Active Traffic Management System, Road & Weather Information System, Travel Time System, Traffic Signal Connected Vehicle System, and Traffic Sensor Data Acquisition System. Blaine will serve as a subject matter expert related to integration of CV data with other ODOT systems and to connected vehicle technology. Their anticipated level of involvement is 40%.

4.2 PRIMARY POINT OF CONTACT

The primary point of contact for this grant proposal is Galen McGill, ODOT's System Operations & ITS Manager, reachable at (503) 508-1881 or galen.e.mcgill@odot.state.or.us.

APPENDIX

► Resumes



YEARS WITH OREGON DEPARTMENT OF TRANSPORTATION

33 years

EDUCATION

- BS, Electrical Engineering, Oregon State University
- MBA, Willamette University Atkinson Graduate School of Management
- Operations Academy Senior Management Program

PROFESSIONAL LICENSES

- Professional Engineer: OR

ACTIVITIES & AWARDS

- 2017: ODOT Lifetime Career Achievement Award
- 2016-present: US Representative, PIARC/World Road Association Road Network Operations & ITS Technical Committee
- 2015: Oregon DOT Mary Olson Leadership Award
- 2014-Present: AASHTO CTSO, Research Technical Working Group Chair

Galen McGill, P.E. System Operations and ITS Manager

PROJECT ROLE: CV Ecosystem Leadership Team

I'm passionate about utilizing innovation and technology to improve the operation of Oregon's transportation system, so I'm excited about the opportunity that this Connected Vehicle Ecosystem project presents to transform our approach to operating the system and to prepare Oregon for the future.

RELEVANT ACCOMPLISHMENTS

- Proficiency managing all aspects of a DOT Operations Program
- 30+ years of experience successfully delivering technology projects
- Awareness of industry trends and strong leadership skills developed through extensive involvement in state, national, and international initiatives

PROFESSIONAL EXPERIENCE

OREGON DEPARTMENT OF TRANSPORTATION, SYSTEM OPERATIONS & ITS MANAGER, SALEM, OREGON, 1998-PRESENT

- Statewide responsibility for delivery of the agency's Transportation System Management and Operations (TSMO) program including:
 - TSMO planning
 - Project delivery
 - Software systems
 - Maintenance and life cycle management of ITS assets
 - Transportation Operation Centers
 - Traffic Incident Management Program
 - Traveler Information
 - Performance metrics and data management
- Participate as a member of various agency leadership teams including Maintenance and Operations Leadership Team, Traffic Operations and Standards Team, Technical Standards Team, Connected and Automated Vehicle Steering Team, Data Warehouse Steering Team
- Contributor to multiple FHWA, TRB, and AASHTO project teams



Galen McGill, P.E. System Operations and ITS Manager

ACTIVITIES & AWARDS, CONTINUED

- 2001-Present: AASHTO Committee on Transportation System Operations
- 2015-Present: National Operations Center of Excellence Technical Advisory Committee
- 2018-2019: Oregon Task Force on Automated Vehicles
- 2018 – present: Society of Automotive Engineers Infrastructure Needs Related to Automated Driving Task Force
- 2019 – present: Oregon Broadband Advisory Council
- 2019 – present: NCHRP 23-10 Evaluation and Synthesis of V2X Technologies panel member



YEARS WITH OREGON DEPARTMENT OF TRANSPORTATION

21 years

EDUCATION

- Master of Science in Electrical Engineering, Washington State University
- Bachelor of Science in Electrical Engineering, Washington State University

PROFESSIONAL LICENSES

- Professional Engineer in the State of Oregon, Control Systems Engineer, License No. 66891PE
- Professional Engineer in the State of Washington, Control Systems Engineer, License No. 37466

Doug Spencer, P.E. ITS Standards Engineer

PROJECT ROLE: ATCMTD Grant Manager

As the ITS Standards Engineer, I ensure the agency is compliant with a variety of national ITS standards as required by federal rule. I also helped develop agency specific engineering design and construction standards as they relate to Intelligent Transportation Systems and traffic operations projects.

RELEVANT ACCOMPLISHMENTS

- Proficient managing all aspects of ITS, electrical, and control systems engineering projects
- 27+ years of experience managing engineering design, system integration, and construction projects
- Knowledgeable about ITS national initiatives through extensive involvement with ITS national standards and operational committees

PROFESSIONAL EXPERIENCE

- Responsible for the development of new NTCIP compliant traffic signal software contract for ODOT and local agencies in Oregon. Software included local traffic signal software, central traffic signal software, local and central Connected Vehicle software, and automated signal performance measures software. Worked within ODOT to make the new software the standard for signal operations statewide.
- Developed and negotiated new NTCIP compliant ramp metering software for the agency. Worked within the agency to upgrade the agency's ramp meter controllers to the ATC platform and utilize this new software statewide. Coordinated the integration of the roadside software with the agency's central ramp meter software vendor.
- Worked within ODOT and with a traffic signal vendor in the development of adaptive signal timing software for Lincoln City as a pilot project. This adaptive signal software runs locally on the ATC controller and utilizes the API to share the computing processes with the signal timing software. Peer to peer NTCIP communications are used to talk to each of the controllers throughout the corridor in real time. This project also used AASHTO/UDOT's ATSPM software.
- Developed and managed the project to build ODOT's RWIS controller and local firmware to run on the ATC platform, thus unifying the agency's roadside controller platform.



Doug Spencer, P.E. ITS Standards Engineer

ACTIVITIES & AWARDS

- National Transportation Communications for ITS Protocol, Joint Committee member, AASHTO
- Member Committee on Transportation System Operations, AASHTO
- 2016 Professional Achievement Award, Oregon Department of Transportation
- Who's Who in Science and Engineering, 1996/1997, Marquis Who's Who Publication Board

PROFESSIONAL EXPERIENCE, CONTINUED

- Developed and negotiated the Advanced Transportation Controller (ATC) and the Application Programming Interface contract for ODOT when the ITE ATC standards were still in draft status. Coordinated the API be provided to the ITE API working group for discussion as a reference implementation. ODOT was one of the first agencies in the country to use the ITE ATC controller.
- Developed and negotiated ODOT's TOC statewide video management software and hardware contract.
- Responsible for the agency's variable message sign usage, procurements, NTCIP communications, central DMS software, and installations.
- Developed and negotiated ODOT's ITS and Traffic network equipment contracts.
- Responsible for the review and approval of all ITS projects and the networking of all traffic signal projects statewide.

SONY DISC MANUFACTURING, ELECTRICAL ENGINEER, SPRINGFIELD, OREGON, 1997-2000

- Responsible for the electrical aspect of the mastering process for compact disc production of the facility.
- Developed capitol project estimates, process improvements, production automation, and training for maintenance and operators.
- Project manager for Sony's first Gigabit Ethernet networked signal feed system.
- Responsible for implementing an Atomic Force Microscope and Design of Experiments into the mastering process for production optimization.

FLUOR DANIEL NORTHWEST, CONTROL SYSTEMS ENGINEER, RICHLAND, WASHINGTON, 1993-1997

- Provided consultant services for the control systems of nuclear processing facilities for the Hanford reservation.
- Led discipline teams of engineers, designers, procurement staff, and construction workers.
- Provided network design and programming of programmable logic controllers (PLC's), distributed control systems (DCS's), and human machine interface (HMI) operator software.



YEARS WITH OREGON DEPARTMENT OF TRANSPORTATION

Three years

EDUCATION

Bachelor of Arts, Art History, and Psychology, Tulane University, New Orleans, LA

PROFESSIONAL LICENSES

- Certified Project Management Professional (PMP)

Abby Smith, PMP ITS Program Coordinator

PROJECT ROLE: Project Manager

I manage the ITS program's project portfolio to ensure projects are adequately resourced, funded and planned based on evolving priorities.

RELEVANT ACCOMPLISHMENTS

- Resolve resourcing issues for projects with competing priority within ODOT.
- Provide leadership to define, track, and manage project scope, deliverables, and implementation activities for the ITS project portfolio.
- Ensure all project deliverables achieve best practices and standards.
- Develop Request for Proposal (RFP) documents for the acquisition of software/software programming services and/or hardware.
- Lead large-scale and complex projects.
- Identify and mitigate the potential impact of planned system modifications on other applications.
- Monitor and evaluate the post-implementation performance of applications and coordinates implementation of system modifications if necessary.

PROFESSIONAL EXPERIENCE

ODOT, ITS PROJECT MANAGER, SALEM, OR 2018-2019

- Led System Analysts, Software Developers, and DBAs through project activities throughout the software development life cycle.
- Oversaw software architecture and design meetings; assisted technical leads in assembling presentations to communicate architecture with IT and business stakeholder groups.
- Collaborated with project team to identify tasks and activities to be performed and create work breakdown structure. Met with customers and stakeholders to evaluate, understand, document, and communicate customer needs.
- Developed resource, cost, and time estimates and created project plans.



Abby Smith, PMP ITS Program Coordinator

PROFESSIONAL EXPERIENCE, CONTINUED

CASTLE ROCK ASSOCIATES, SENIOR PROJECT MANAGER, PORTLAND, OR 2010-2017

- Managed ITS (Intelligent Transportation Systems) deployments for multiple government clients. ITS applications included ATMS components, public-facing traveler information websites, IVR phone systems, mobile applications, and numerous device (CCTV, DMS, RWIS) integrations.
- Responsible for oversight of approximately \$2.6m in annual project work.
- Worked directly with in-house Project Management, DevOps, and Executive teams to determine direction, approach, and best practices for new system designs and implementation schedules.
- Created detailed project management plans, including development of work breakdown structure (WBS) and resource management.
- Managed application development process from end-to-end, from whiteboarding through development, QA, and deployment/DevOps.
- Managed ITS (Intelligent Transportation Systems) deployments including ATMS components, traveler information websites, IVR phone systems, mobile applications, and device integrations.



YEARS WITH OREGON DEPARTMENT OF TRANSPORTATION

8 years

EDUCATION

BS, Computer Engineering,
Oregon State University

ACTIVITIES & AWARDS

- FHWA Work Zone Data Exchange Group
- Driving Force Award – Active Traffic Management project, 2014

Chad Mann

ITS Software Development Lead/Systems Architect

PROJECT ROLE: ITS Technical Architect

As the software systems architect for the ITS program, I help design integrations between applications that ensure the most interoperability and ensure business needs are met.

RELEVANT ACCOMPLISHMENTS

- Designed and Implemented integrated solution between a VMS Response Plan system and our own Event Management system.
- Designed secure data endpoint for SPaT data retrieval by external customers.
- Designed enhancements for Travel Time system which included retrieving and using data from WSDOT and Washington County.
- Implemented use of Azure API Management for an external data portal.

PROFESSIONAL EXPERIENCE

OREGON DEPARTMENT OF TRANSPORTATION, SOFTWARE SYSTEM ARCHITECT FOR ITS, SALEM, OREGON, 2015-PRESENT

- Responsible for software architecture as a whole across the ITS ecosystem of applications.
- Research new technologies and frameworks that will help improve the ITS system architecture.
- Develop enhancements and fixes for various ITS applications.

OREGON DEPARTMENT OF TRANSPORTATION, CLIENT/SERVER DEVELOPER, SALEM, OREGON, 2013-2015

- Performed quality control and assisted implementation of automated Traffic Systems such as Ramp Metering, Variable Speed, and Travel Time.
- Designed enhancements for the Active Traffic Management system.
- Developed small enhancements and fixes for various ITS applications.



Chad Mann

ITS Software Development Lead/Systems Architect

PROFESSIONAL EXPERIENCE, CONTINUED

MAGICBOX INC., SOFTWARE DEVELOPER,
CORVALLIS, OREGON, 2009-2013

- Worked on a team to develop new Web based Digital Signage content creation application.
- Helped sustain and develop main product line of digital signage solutions.
- Received and resolved escalated Technical Support issues.
- Contributed to marketing materials and attended trade shows.



YEARS WITH OREGON DEPARTMENT OF TRANSPORTATION

7 years

EDUCATION

- Bachelor of Science in Electrical and Computer Engineering from Oregon State University

PROFESSIONAL LICENSES

- Professional Engineer in the state of Oregon, Electrical Engineer, License No. 86005PE

Blaine Van Dyke, P.E. ITS Connected Vehicle Engineer

PROJECT ROLE: System Manager

As the statewide business system manager for the Centralized Connected Vehicle SPAT and MAP Data Sharing System, the Active Traffic Management (ATM) System, the Road and Weather Information Management System, the Travel Time System, and the Traffic Sensor Data Acquisition System I ensure these automated systems operate in accordance with stakeholder requirements and state law.

RELEVANT ACCOMPLISHMENTS

- Tested and coordinated deployment of ODOT's vehicle to infrastructure (V2I) roadside DSRC pilot and created a statewide Connected Vehicle Concept of Operations.
- Configured and tested the Centralized Connected Vehicle SPAT and MAP Data Sharing System.
- Designed and stamped plans, specifications, calculations, and estimates for ITS and Motor Carrier roadside systems including weather warning systems, congestion warning systems, curve warning systems, variable speed limit corridors, fiber optic infrastructure, and photovoltaic power systems.
- Provided construction support including reviewing contractor submittals, coordinated with utilities, site acceptance testing, system training, and assisted with commissioning devices.
- Developed, evaluated, and scored RFP's for fiber optic services, portable variable message signs, and AVL/telematics for snow plows.
- Researched and developed new hardware and software for ODOT's roadside Bluetooth travel time data collection units.
- Created, tested, and deployed Smart Work Zone trailers for construction monitoring and public notifications.
- Coordinated operation of the Fiber Optic Management System and troubleshoot fiber infrastructure related network issues with ITS Technicians.



Blaine Van Dyke, P.E. ITS Connected Vehicle Engineer

PROFESSIONAL EXPERIENCE

SUTRON CORPORATION, INTEGRATED SYSTEM DIVISION PROJECT MANAGER, STERLING, VIRGINIA, 2012-2014

- Integrated environmental monitoring systems comprised of telemetry, photovoltaic and AC power, data-logging, sensors, and cameras.
- Incorporated telemetry solutions including CDMA, GSM/GPRS, GOES, Iridium, Radios, and GPS.
- Created wiring diagrams, equipment mounting diagrams, station manuals, and project reports.
- Assembled bill of materials and ordered all of the parts required for the complete system.
- Tracked expenses and overall profit for each project.