Final Report

TPF-5(241)

Western States Rural Transportation Consortium

By

Sean Campbell
Senior Transportation Engineer, Electrical (Specialist)
Chief, ITS Special Projects Branch
Office of Traffic Operations Research
Division of Research, Innovation, and System Information
California Department of Transportation

Leann A.F. Koon
Research Associate II
Western Transportation Institute
Montana State University

Douglas Galarus
Assistant Professor, Computer Science Department
Montana Technological Institute

A report prepared for the
Washington State Department of Transportation

March 1, 2023

DISCLAIMER

The contents of this report reflect the view of the authors, who are responsible for the facts and the accuracy of the data herein. The contents do not necessarily reflect the official views or policies of the State of Washington, the Washington State Department of Transportation, the California Department of Transportation, Montana State University, or Montana Technological University. This report does not constitute a standard, specification, or regulation.

Alternative accessible formats of this document will be provided upon request. Persons with disabilities who need an alternative accessible format of this information, or who require some other reasonable accommodation to participate, should contact Neil Hetherington, Visual Communications Manager, Western Transportation Institute, Montana State University, PO Box 174250, Bozeman, MT 59717-4250, telephone number 406-994-3566, e-mail: hetherington@montana.edu.

EXECUTIVE SUMMARY

The Western States Rural Transportation Consortium (WSRTC) TPF-5(241), comprised of California, Oregon, Washington, Nevada, and Utah, has been established to facilitate and enhance safe, seamless travel throughout the Western United States. The Consortium seeks to promote innovative partnerships, technologies, and educational opportunities to meet these objectives. Additionally, the Consortium seeks to provide a collaborative mechanism to leverage research activities in a coordinated manner to respond to rural transportation issues among western states related to technology, operations, and safety. Consequently, activities of the Consortium are focused on technology transfer/education (Western States Rural Transportation Technology Implementers Forum) and incubator projects (small scale research projects intended to serve as a "proof of concept" for larger subsequent efforts) centered on the Consortium pillars of technology, operations, and safety.

ACKNOWLEDGEMENTS

The Western States Rural Transportation Consortium would like to thank and recognize the members of this Transportation Pooled Fund for their support and guidance:

Washington State Department of Transportation

- Doug Brodin – Research Manager, Research and Library Services
- Fheejay Painter – Business Manager, Research and Library Services
- Mara Kim – Fiscal Manager, Research and Library Services
- Ron Vessey – State ITS Operations Engineer, Retired
- Ted Bailey – Cooperative Automated Transportation Program Manager
- Tony Leingang – Acting State ITS Operations Engineer/Incident Management and Operations Administrator

Oregon Department of Transportation

- Galen McGill – System Operations & Intelligent Transportation Systems Manager
- Doug Spencer – Standards Engineer, Intelligent Transportation Systems

California Department of Transportation

- Sean Campbell, PE – Chief, ITS Special Projects Branch, DRISI
- Jeremiah Pearce, PE – Chief, Office of ITS Engineering and Support, District 2
- Ian Turnbull, PE – Chief, Office of ITS Engineering and Support, District 2, Retired

Nevada Department of Transportation

- Seth Daniels – Assistant Division Chief, Traffic Operations
- Jim Whalen, IT Manager
- Denise Inda, Assistant Chief Operations Engineer, Retired
- Rod Schilling, Assistant Chief Traffic Operations

Utah Department of Transportation

- Tyler Laing – ITS Program Manager, Traffic Management Division

Western Transportation Institute, Montana State University

- Leann Koon – Research Associate II, Systems Engineering, Development and Integration Program
- David Veneziano – Research Scientist
- Chris Strong – Research Scientist

Montana Technological University

- Doug Galarus - Assistant Professor, Department of Computer Science

The Consortium would also like to thank the participants and presenters who attended the 16 Western States Rural Transportation Technology Implementers Forums to date. The efforts made by the presenters at the Forum has made this event very successful and useful to the participants.

TABLE OF CONTENTS

LIST OF FIGURES

1. BRIEF HISTORY OF THE WSRTC

The WSRTC is a continuation and broadening of the original California Oregon Advanced Transportation System (COATS) project. COATS began in 1998 as a collaborative effort among the California Department of Transportation (Caltrans), the Oregon Department of Transportation (ODOT) and the Montana State University, Bozeman's Western Transportation Institute (WTI) to investigate the use of Intelligent Transportation Systems (ITS) in rural areas. The intent of the COATS project was to facilitate the use of ITS to enhance safety, improve the movement of people, goods, and services, and subsequently promote the economic development of the bi-state region and begin deployment of those solutions.

During the third phase of the COATS project, the Western States Rural Transportation Technology Implementers Forum (WSF) was initiated. The Forum provided a venue for presentations and frank discussions on how technology projects were implemented in the field. It also provided insight not only for the need to collaborate on rural ITS technology transfer, but also operations and safety research. Through attendance at the Forum, representatives from the Washington and Nevada Departments of Transportation expressed interest in becoming affiliated with the COATS partnership to foster greater research, technology transfer, and collaboration. Similarly, Utah DOT joined the Consortium in 2018. The following is a synopsis of the evolution of the Consortium since inception:

- June 2009 - Informal discussions occur during the Western States Forum regarding Consortium establishment and expansion of the COATS project and region.
- August 2009 - Formal discussions between COATS members for expansion and consortium development result in agreement to pursue development of the WSRTC.
- August-October 2009 - Development of a Consortium charter and mission/vision/goals documents is undertaken.
- November 2009 - Formal discussion between all potential consortium members (California, Oregon, Washington, Nevada) regarding the charter and mission/vision/goals documents, intended roles and responsibilities, etc. occurs. Based on these discussions, all parties agree to move forward in formalizing the Consortium.
- February 2010 - Follow-up discussions on changes to Consortium charter and mission/vision/goals documents occur. Additionally, Year 1 incubator projects are discussed, with selections made of technology, operations, and safety projects for which initial Scopes of Work will be developed.
- April 2010 - Scopes of Work completed for first group of incubator projects.
- June 2018 – Utah Department of Transportation formally joins the WSRTC.

2. WSRTC MISSION, VISION AND GOALS

2.1. Mission

The WSRTC shall promote innovative partnerships, technologies, and educational opportunities to facilitate and enhance safe, seamless rural travel throughout the Western United States.

2.2. Vision

Provide a framework to leverage research and promote collaboration in solving rural transportation issues.

2.3. Goals

- To leverage research resources related to rural issues concerning technology, operations, and safety.
- Provide technology solutions in the form of technology transfer to rural areas and training on a regular basis.
- Recycle and reuse existing research, applying its results to rural issues.
- Development of a rural western states integrated corridor management system to improve seamless, coordinated, and safe transportation to the public.

3. WSRTC PROJECTS

3.1. Operations Research - Automated Safety Warning System Controller

The Automated Safety Warning System Controller (Controller) device is a roadside system that monitors road and weather conditions and updates driver warning systems accordingly. The Controller system informs drivers through changeable message signs or flashing beacons.

California has several automated warning systems on the state highways; however, all the systems to date are unique implementations using one-of-a-kind software for system control with the controller being a custom device only used with that project's physical and electrical layout. Currently there is no standardized automated warning system controller which controls standardized field elements in a system environment. The WTI project team has worked with Caltrans to design and build an automated warning system controller that can be easily configured to acquire sensor data from Roadside Weather Information Systems (RWIS), detection loops, Remote Traffic Microwave Sensors (RTMS), and video detection systems. The controller includes hardware and software interfaces for remote management and data acquisition. In addition, the controller includes extensive programming/scripting capability, allowing for programmed logic implementing the best practice algorithms for condition analysis and identification and corresponding warning signal/message actuation.

The Controller System moves decision making intelligence to the roadside. This is critical in a rural environment where communications are often unreliable. The ASWSC has been designed for flexibility and extensibility, allowing for the integration and control of a variety of roadside devices. As such, it could potentially be used as a standardized component with widespread applicability. The standardized use of such a device would likely result in decreased maintenance costs, improved reliability, and greater flexibility in implementation when compared with "one-of-a-kind" deployments. Other benefits include:

- A controller that can interface with various field sensors/elements and safety warning systems in a uniform manner will enhance operations and avoid a multitude of unique systems.
- An automated controller for safety warning systems can improve traveler safety with more timely and relevant warning messages.
- Using commercial off the shelf equipment makes the automated controller an economical solution.
- The ability to remotely access the controller will reduce the cost of service for warning systems.
- TMC operators and field engineers will have the ability to adjust decision thresholds in response to changing weather, road, and incident conditions. This improves effectiveness and efficiency and in turn improves traveler safety.

The ASWSC was selected as a finalist for Best New Innovative Practice at the 2014 National Rural ITS Conference.

More information can be found here regarding the Advanced Safety Warning System Controller:

- http://westernstates.org/Projects/Controller/Default.html

3.2. Operations Research - One Stop Shop for Traveler Information (OSS)

Real-time traveler information is a valuable tool in protecting and enhancing both traveler safety and mobility, especially in rural areas. From a safety perspective, it is important for rural travelers to know before a trip about potential challenges including snow, ice, high winds, fires and other hazards. These same challenges may degrade mobility, as may challenges such as vehicle crashes and work zones. While such information may currently be available through a variety of sources, there is inconsistency in the types and quality of information available. In addition, information is generally scattered over numerous web-based (and sometimes non-web-based) sources, meaning travelers must spend significant amounts of time assembling this information prior to a trip. As a result of the effort involved with gathering this information, many rural travelers do not seek out all the information they need, if they seek any at all. This may result in increased delays and can potentially degrade safety.

The One-Stop-Shop currently provides traveler information for 11 states including Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington and Wyoming. This research serves as a proof of concept for route-based traveler information provided in one location. While this scale of implementation will yield some direct benefits for the selected states, it is believed that the principal value of this research is in demonstrating the feasibility and attractiveness of a One-Stop-Shop for real-time, route-specific traveler information for rural areas. The proof of concept is designed in a scalable fashion so that the system may be expanded to other routes and states. Ultimately, the One-Stop-Shop could become an umbrella traveler information web site that can be used as a primary point of reference for longer distance trips, improving safety and mobility for all highway system users across the United States.

At the 2014 ITS World Congress in Detroit, Michigan, the One-Stop-Shop was announced as the winner of ITS America's Best of ITS Award for Best New Innovative Practice — Research Design and Innovation. ITS America presents these awards to "the most prominent and innovative transportation technology leaders in the Americas" whose projects exemplify innovation and demonstrate specific and measurable outcomes.

More information can be found here regarding the One Stop Shop for Traveler Information:

- http://westernstates.org/Projects/OSS/Default.html
- https://oss.weathershare.org/

3.3. Operations Research – WeatherShare

WeatherShare, a Caltrans (California Department of Transportation) funded project, aims to streamline and integrate essential road weather information from Caltrans Road Weather Information System (RWIS) sites. This data is combined with weather data from other sources, such as MADIS and MesoWest, as well as with National Weather Service forecasts, into one unified source. This information is displayed on an interactive map as well as detailed tabular

and graph displays, allowing maintenance personnel and incident responders to visualize road conditions quickly and easily for an entire region or a specific location. The system will allow Caltrans personnel to make a more informed and efficient assessment of current road weather conditions in the region for a variety of purposes, including incident management and highway maintenance.

The WeatherShare prototype system was developed with an emphasis on ease of use and usability. In its first phase, a proof-of-concept was developed showcasing the system's applicability to incident management, highway maintenance and emergency medical services in Northern California. By the completion of the second phase, WeatherShare provided data covering the entire state of California and utilized Google Maps for displaying spatially accurate data.

Currently in its maintenance phase, the project is focused on transitioning WeatherShare to become the central repository for Caltrans RWIS data and weather information. Mission-critical roadway data, such as surface temperature and condition (dry, wet, icy, etc.), are sourced from over 150 Road Weather Information Stations (RWIS). Additional weather data is retrieved from approximately 2,000 third-party weather stations. Caltrans maintenance and operations personnel will have access to real-time and historical weather information that will help them better manage roadways, apply treatments, and handle weather-related incidents. This platform of weather observations and forecasts with near real-time road sensor data will allow Caltrans crews to make the best-possible decisions both for maintenance operations and incident response.

WeatherShare features include:

- Repository for current and historical RWIS data.
- Leveraged resources (more than 2,000 weather stations in addition to 150 Caltrans RWIS stations).
- Integrated alert capability.
- Scalable, interactive elements for map, tabular and graph display.
- An easy-to-maintain, cost-effective product powered by an open-source platform.

More information can be found here regarding WeatherShare:

- http://westernstates.org/Projects/Weathershare/Default.html
- http://www.weathershare.org/

3.4. Technology Transfer – Western States Rural Transportation Technology Implementers Forum

What does it take to make Rural ITS work? It takes technical excellence across a variety of skill areas. It takes creativity. It also helps to learn from the experiences of others. The challenges in making Rural ITS work are significant. Therefore, it's important for ITS technology practitioners to be able to meet to share what they've learned and help advance the state-of-the-practice.

Starting in 2006, the Western States Rural Transportation Technology Implementers Forum has provided ITS implementers and engineers from the western states region with valuable opportunities for detailed dialogue about some innovative engineering and communications projects designed to support the rural transportation system. The Forum is valuable, not only for the detailed and knowledgeable presentations and demonstrations, but also for the times outside of sessions where participants can network with their peers from other districts and states.

The Western States Forum is an annual event where implementers of ITS technologies can share technical information on best practices and field deployment experiences with fellow professionals from across the Western United States. It is an engineering practitioner's conference with the goal of providing a forum for high-quality exchange of technical information that can help to support better ITS deployment in rural areas. It is a forum for dynamic discussion of practical and technical issues associated with rural ITS, to promote transferability of solutions and knowledge across the ITS community. Multiple, highly interactive technical presentations, ranging in length from 1 to 2 hours each, in-depth equipment demonstrations, and numerous opportunities for networking with peers, are all part of the agenda. The Western States Forum places high importance on the following:

- Technical Content
    - Presenters delve into how solutions were developed, focusing on applications that have been deployed in the field and are being used in live traffic situations. The longer presentation time ensures that this level of detail may be presented and understood.
- Discussion
    - Attendance is limited and extended time is allocated to facilitate and encourage detailed technical discussions.
- Transparency and trust.
    - Presenters discuss not only success stories, but also about failures and problems, so participants can learn about what does and doesn't work and why.
- Who should attend?
    - ITS technology practitioners at the state and local level
    - Field engineers and maintenance staff
    - Systems integration/networking engineers
    - Wireless/communications technicians

The Western States Forum is unique. Speakers are given an extended amount of time to really delve into the nuts and bolts of how a project works, whether it relates to equations, source code, component-level discussion, or lessons learned. Questions and discussion are encouraged

throughout and not just at the end of a presentation or demonstration. High quality technical content, discussion, transparency, and trust are the main goals of the Forum.

In June 2022, the Forum had its 17th annual event. To date, there have been:

- 121 technical presentations on a variety of transportation technology topics,
- 610 total participants at all the Forums,
- 273 individual participants,
- 13 states and 9 state DOTs represented,
- 12 universities participating, and
- 12 other organizations represented.

In 2012, the Western States Forum was honored to be selected as the National Rural ITS Conference Best of Rural ITS – Best New Innovative Product, Service or Application.

More information can be found here regarding the Western States Forum:

- http://westernstates.org/
- http://www.westernstates.org/Projects/WesternStatesForum/Default.html
- http://www.westernstatesforum.org/

4. SUMMARY AND NEXT STEPS

The Western States Rural Transportation Consortium (WSRTC) TPF-5(241) was established in 2009 to facilitate and enhance safe, seamless travel throughout the Western United States. The Consortium has promoted innovative partnerships, technologies, and educational opportunities to meet this objective.

The Consortium has focused on technology transfer/education via the Western States Rural Transportation Technology Implementers Forum. The Forum started in 2006, predating the Consortium, and subsequently became the principal annual event of the Consortium, held in conjunction with the annual steering committee meeting for the WSRTC. The Forum places importance on in depth technical content, detailed discussion, transparency and trust, and attendance by hands-on practitioners. The Forum held its 17th annual event in June 2022.

The Consortium has sponsored incubator projects (small scale research projects intended to serve as a "proof of concept" for larger subsequent efforts) centered on the Consortium pillars of technology, operations, and safety.

The WSRTC has conducted the following "Operations" research incubator projects:

- Automated Safety Warning System Controller (ASWSC)
- One Stop Shop for Traveler Information (OSS)
- WeatherShare

The Consortium initially included California, Oregon, Washington and Nevada. Utah joined the Consortium in 2018. The Consortium has leveraged and coordinated research activities in response to rural transportation issues involving technology, operations, and safety.

The FHWA has requested the lead state of the WSRTC pooled fund project, Washington State DOT, to close out the pooled fund associated with this effort. Washington State DOT will create a closeout funding spreadsheet, along with a closeout memo, and send to the member States. There remains approximately $12,000 left unencumbered in the account. These funds will be returned to the member states in accordance to rules established in the Transportation Pooled Fund Program.

The WSRTC steering committee expressed a desire to continue the WSRTC project into a new pooled fund. Washington State DOT created a new pooled fund solicitation 1564 in November of 2021. This solicitation was cleared in January 2022 and became an active pooled fund TPF-5(494). The term of the new pooled fund runs from 2022 through 2026. Minimum commitment level per year is $5,000, for a total of $20,000 over the course of the pooled fund. Washington State DOT has secured a 100% SP&R funding waiver and has created an acceptance letter.

5. APPENDIX A: WESTERN STATES FORUM PRESENTATIONS

5.1. 2006 Western State Forum

Date, Location: June 6 – 8, 2006; Mount Shasta, California

Technical Content

Fiber Optic Network/Topology Design on State Highways

Jose De Alba, Caltrans District 6

This presentation provided a design primer on fiber optic networks using the Fresno metropolitan area as a case study. The presentation discussed conduit layout, fiber optic system components, and network topologies.

Figure 1: Jose De Alba, Caltrans District 6

Microwave Communications for Rural ITS Applications

Ian Turnbull, Caltrans District 2

This presentation discussed the implementation of microwave for supporting ITS communications in District 2. It discussed why microwave was used for this application, how the microwave system was designed and developed, system frequency planning, path calculations, and reliability objectives.

Figure 2: Ian Turnbull, Caltrans District 2

The Redding Responder Project: Mobile Data Communication Challenges and Solutions in Remote Rural Areas

Doug Galarus, Western Transportation Institute

This presentation discussed a "proof-of-concept" mobile data communication system for use on any roadway, particularly in remote rural locations with little or no communication infrastructure. It provided a detailed summary of the analysis techniques, findings and their consequences, and resulting implementation decisions.

Figure 3: Doug Galarus, WTI

Caltrans District 9 Mountain Pass Signs

Phil Graham, Caltrans District 9

This presentation focused on a project to provide remote control of signs which indicated whether certain highway mountain passes were open or closed. It talked about system challenges, subsystem requirements, communications and power challenges, and lessons learned.

Figure 4: Phil Graham, Caltrans District 9

Web-Based ITS Field Element Control

Sean Campbell, Caltrans Division of Research and Innovation

This presentation talked about how to design a system to control a remotely located ITS field element using a web browser and carefully selected commercially available hardware components. The presentation covered the requirements and challenges associated with various system components, and issues regarding latency and integration.

Figure 5: Sean Campbell, Caltrans DRI

5.2. 2007 Western State Forum

Date, Location: June 20 – 22, 2007; Mount Shasta, California

Technical Content

Improving Traffic Data Collection Using Wireless Technology

Clint Gregory, Caltrans District 10

This presentation focused on an intelligent modem that allows systems to collect, process, and distribute data within a wireless network. The system integrates into the Caltrans Automated Warning System (CAWS) as a means to reduce highway incidents caused by high traffic volumes and severe weather conditions. The data from the system is also sent to the Freeway Performance Measurement System for use in real-time traffic decisions.

Figure 6: Clint Gregory, Caltrans District 10

Weather Warning Systems in Oregon and Region 5 Interstate Access Gates

Doug Spencer, Oregon Department of Transportation

The first presentation discussed flood, high wind, ice, and debris warning systems installed and operated by ODOT. The second presentation discussed the implementation of remotely operated gates on on-ramps on Interstate 84, which eliminated the need to dispatch ODOT personnel to implement and monitor road closures. Both presentations included discussions of systems architecture, equipment, engineering design and installation and maintenance issues.

Figure 7: Doug Spencer, Oregon DOT

Unlicensed Wireless Multipoint System in Sacramento Metro

Dean Campbell, Caltrans District 3

This presentation discussed the creation of a multi-point wireless link to provide telecommunications between four cameras along I-80 and downtown Sacramento. It compared the manufacturer's claims with actual experience, and reviewed lessons learned.

Figure 8: Dean Campbell, Caltrans District 3

Weigh-In-Motion NOT DONE ON A WIM!

Matt Hanson & Stanley Norikane, Caltrans

This presentation dealt with both technical and institutional issues related to Caltrans' high-speed weigh-in-motion (WIM) technology, which has been used at 135 locations in the state. It discussed installation, operation, and maintenance issues, as well as issues associated with data delivery.

Figure 9: Stanley Norikane (center) and Matt Hanson (seated right), Caltrans Traffic Operations/Weigh-In-Motion

5.3. 2008 Western State Forum

Date, Location: June 3 – 5, 2008; Mount Shasta, California

Technical Content

A Tale of Two RWISs

Ken Beals, Caltrans District 2

This presentation was a detailed look at RWIS sensors in Caltrans District 2, specifically how they measure surface and atmospheric conditions and what parameters are involved in these measurements. The presentation explained how to use the RWIS to control Extinguishable Message Signs (EMS) and more accurately inform the public of hazardous conditions.

Figure 10: Ken Beals, Caltrans District 2

WSDOT Field Tests of Wireless and Microwave Vehicle Detection Systems

Ted Bailey, Matt Neeley; Washington State Department of Transportation

This presentation began by describing two field test sites specifically used for testing ITS equipment. Field tests were conducted on three types of systems. Vehicle speed and count data were collected, and the results were shared along with discussion about the installation processes and lessons learned.

Figure 11: Ted Bailey, WSDOT

Figure 12: Matt Neeley, WSDOT

TMC-TMS Communications: Overview and Demonstration

Doug Galarus, Western Transportation Institute

This presentation described the results of an evaluation of communication technologies for application to TMC-TMS communications. Wireless and wired technologies were evaluated for prospective use, and general pros and cons as well as site-specific analyses were presented. An emphasis was placed on promising wireless technologies. The live "parking lot demonstration" conducted the next day complemented this presentation.

Figure 13: Doug Galarus, WTI

ODOT Traveler Information Systems

Galen McGill, Oregon Department of Transportation

Oregon DOT has an extensive Advanced Traveler Information System (ATIS). This presentation reviewed the system first at a high level and then broke it down into subsystems to describe in detail the components, technologies, data "hand-offs" and image processing that make up the system as a whole. Experiences and lessons learned from 10 years of constructing, implementing, and maintaining ATIS technologies were shared.

Figure 14: Galen McGill, ODOT

5.4. 2009 Western State Forum

Date, Location: June 16 – 18, 2009; Mount Shasta, California

Technical Content

Ground System Design and its Role in ITS

Jeremiah Pearce, Caltrans District 2

Grounding systems are critically important to wireless communications systems. Caltrans District 2 recognized the need to develop a standardized approach for ground system design, implementation and construction for Intelligent Transportation Systems (ITS) field elements. Mr. Pearce explained how the varying ground conditions within Caltrans District 2 were accurately modeled for the purpose of defining a standardized ground system design methodology. Applicable study sites were Highway Advisory Radio (HAR) transmitters and mountain top communications sites.

Figure 15: Jeremiah Pearce, Caltrans District 2

Creation of an Ethernet/IP Backbone System for Wyoming's Department of Transportation

Paul J Anderson, Wyoming Department of Transportation

The design, deployment, and current and anticipated use of an Ethernet/IP backbone network that will bring long haul communications back to the WyDOT's headquarters in Cheyenne. Additionally, the creation of individual networks serving roadside ITS devices allowed WyDOT to adopt a standard approach to rural roadside communications.

Figure 16: Paul Anderson, Wyoming DOT

Automatic Traffic Data Collection Using Surveillance Video Cameras

Yegor Malinovskiy*, Yao-Jan Wu, Yinhai Wang*; STAR Lab, University of Washington

Matthew Neeley and Ted Bailey; Washington State Department of Transportation

*Presenters

Representatives from the STAR Lab at the University of Washington, with support from WSDOT, discussed the development and field testing of a Video-Based Vehicle Detection and Classification system. They showed a number of real video examples of the working system and described the test results under various challenging conditions, e.g., rain, fog, darkness, and camera vibrations.

Figure 17: Yinhai Wang, UW STAR Lab

Figure 18: Yegor Malinovskiy, student researcher, UW STAR Lab

Run-Away Truck Escape Ramp: A Trucker's Safety Net

Jose De Alba, Caltrans District 6

Along one of the nation's steepest and longest grades on an Interstate, Caltrans District 6's team led by Jose de Alba developed and implemented a fully automated truck escape ramp notification system. Using new and existing technology, the system detects a vehicle upon entry to the escape ramp, activates EMS's, records the incident on a CCTV, and alerts Traffic Management Center personnel. Forum participants viewed actual footage of the Run-Away Truck Escape Ramp in use.

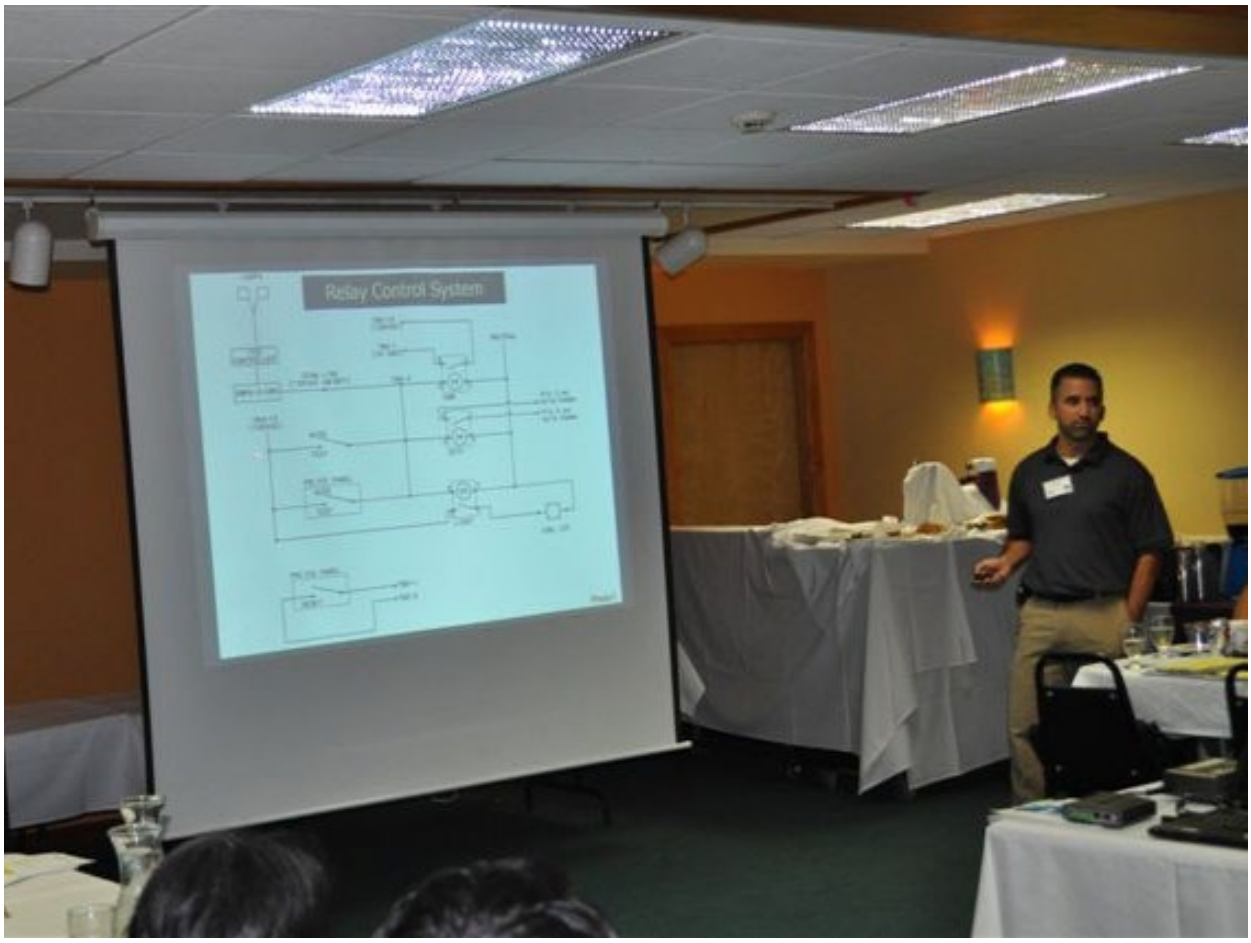

Figure 19: Jose DeAlba, Caltrans District 6

Idaho Traffic Management System (ITMS)

Mark Blackshaw, Idaho Transportation Department

Idaho's Traffic Management System (TMS) software accesses 32 Variable Message Signs (VMS) located throughout the state. ITD is facing difficult challenges with communications, especially with signs located in rural areas with challenging terrain. Mr. Blackshaw demonstrated how ITD's TMS operates, how it communicates with ITS field elements, and what it takes to connect a VMS, HAR, or RWIS to a central software system.

Figure 20: Mark Blackshaw, Idaho Transportation Department

Simple Network Contact Closure

Dean Campbell, Caltrans District 3

Caltrans District 3 built a simple electro-mechanical relay with a built-in web server to control field elements such as Extinguishable Message Signs, especially those in remote locations. For the presentation, he illustrated the actual layout of the system, including the Web Relay page, monitoring relay, status light and GPRS modem, and then demonstrated the webpage and exercised the relay.

Figure 21: Dean Campbell, Caltrans District 3

Hand-Held Diagnostics Terminal

Michael Edwards, Ryan Huffman; Caltrans Division of Research & Innovation

Discussion of the need, approach, technical design, field testing results, conclusions, and development pitfalls for their ruggedized hand-held diagnostics terminal. The terminal is designed as a weather resistant alternative to a laptop computer for controlling and troubleshooting ITS field devices. The team developed specialized software for managing the terminal's modules which interact with particular ITS devices such as CCTV's, vehicle detectors, and CMS's.

Figure 22: Michael Edwards (right), Caltrans DRI

Figure 23: Ryan Huffman, Caltrans DRI

Caltrans WeatherShare System: A Look at Design, Development, and Usability

Shaowei Wang, Dan Richter; Western Transportation Institute

The WeatherShare system aims to improve weather incident recognition and response by providing streamlined access to surface weather data from multiple sources. The research team discussed the steps taken, decisions made, and the tools and techniques used in developing the WeatherShare system, as well as some of the problems encountered along the way, from the perspectives of both technical development and usability. The WeatherShare system is currently live and the team demonstrated many of the available features.

Figure 24: Shaowei Wang, WTI

Figure 25: Dan Richter, WTI

5.5. 2010 Western State Forum

Date, Location: June 15 – 17, 2010; Yreka, California

Technical Content

Passive Repeater Applications for Rural ITS Communications Systems "The Prequel"

Ian Turnbull, Caltrans District 2

Passive Repeaters for Rural ITS Communications Systems

Ken Beals, Caltrans District 2

Passive repeater system and how it can fit into a Rural ITS communications strategy. This presentation provided a detailed look at the physics behind passive repeater applications, how to identify potential passive repeater sites, how to engineer the associated microwave path and the physical installation and orientation of the reflecting structure.

Figure 26: Ian Turnbull, Caltrans District 2

Figure 27: Ken Beals, Caltrans District 2

A ShakeCast User's Observations on the Benefits of Situational Awareness of Seismic Risk Management

Loren Turner, Caltrans Division of Research & Innovation

The Caltrans ShakeCast system developed for prioritizing bridge inspections after an earthquake. Following a major earthquake, one of Caltrans' most critical tasks is to assess the condition of all potentially impacted bridges and roadway corridors in the state highway system. In the past, bridge inspection teams were significantly challenged with establishing priorities because they lacked precise information about where the worst shaking and the greatest damage had occurred. To address this, Caltrans partnered with the United States Geological Survey (USGS) to develop a Caltrans version of the USGS ShakeCast system, a post-event analysis tool. Mr. Turner explained and demonstrated the web-based Caltrans ShakeCast application, showing how the tool automatically retrieves measured earthquake shaking data, analyzes it against individual bridge performance characteristics, and generates inspection prioritization emails and other web-based products for emergency responders within minutes of an event.

Figure 28: Loren Turner, Caltrans Division of Research, Innovation, and System Information

Automated Safety Warning Controller (ASWC) Phase I - Proof of Concept

Kelvin Bateman, Dan Richter; Western Transportation Institute

Under contract with Caltrans, the Western Transportation Institute has established a proof of concept for an Automated Safety Warning Controller that interfaces with roadside devices such as sensors and signs. The controller allows for automated data collection and application of best practice algorithms to analyze sensor data and to actuate related warning messages to travelers. It is designed as a standardized system, versatile enough to be used at any location and with any number and type of field element data sources. This presentation summarized the system concept, requirements, testing and development lab set-up, system design, development, testing, evaluation, and next steps for the project and device.

Figure 29: Kelvin Bateman, WTI

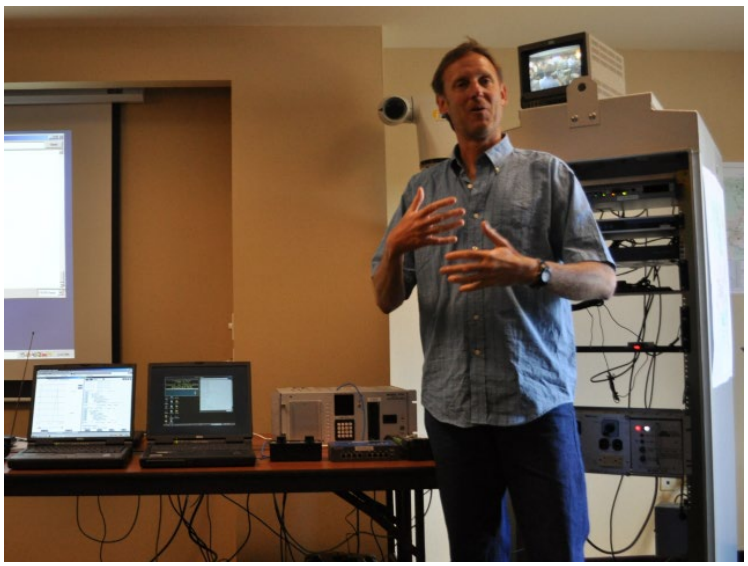

Figure 30: Dan Richter, WTI

Support and Asset Inventory Management of ITS Devices

Jason Shaddix, Oregon Department of Transportation

ODOT's Jason Shaddix demonstrated their support and asset inventory management system for ITS devices and systems. The system coordinates troubleshooting processes between many unrelated support groups, helps to manage and distribute the work, documents the inventory and systems interdependencies, and schedules and tracks preventative maintenance. Mr. Shaddix showed how the system handles work requests and then the reporting mechanism for increased workloads. He explained costs and benefits associated with the system and its implementation, lessons learned, and the different aspects of support and inventory management and how those fit with ODOT's organizational practices.

Figure 31: Jason Shaddix, Oregon DOT

Mobile Inspection System

Mike Pannone, Laura Edwards; Alaska Department of Transportation & Public Facilities

Alaska DOT developed a mobile inspection station (MIS) to increase inspection capability of the seven fixed weigh stations that are currently covering Alaska's 14,000-mile road system. The MIS consists of all components necessary to allow inspectors to perform roadside inspections of commercial vehicles, enforce size and weight regulations, and utilize e-screening to check commercial motor vehicle safety records, all in previously unpatrolled areas and for an extended period of time. The Alaska CVE team discussed the technical challenges related to MIS configuration, technical capabilities, non-technical challenges faced after deployment, data analysis and MIS effectiveness, solutions and lessons learned.

Figure 32: Mike Pannone, Alaska Department of Transportation & Public Facilities

Figure 33: Laura Edwards, Alaska Department of Transportation & Public Facilities

Field Experiments with Bluetooth Sensors

Yinhai Wang, Yegor Malinovskiy*, Yao-Jan Wu and Un-Kun Lee; University of Washington

*Speaker

This presentation described experiments conducted by the University of Washington that compared travel times determined using a Bluetooth MAC address-based sensor developed in house to travel time data collected by commonly used, standard automatic license plate recognition devices. Mr. Malinovskiy discussed the effectiveness of using different types of antennae, how the experiments were set up and conducted, limitations, and the design and building of the device itself. To discuss rural challenges and applicability, two experiments were conducted near Yreka during the Forum (Anderson Grade, Walters Road) and the results were presented to the group. The devices were set up and collected data during the demonstration.

Figure 34: Yegor Malinovskiy, student researcher, UW STAR Lab

5.6. 2011 Western State Forum

Date, Location: June 14 – 16, 2011; Yreka, California

Technical Content

Wireless Communications for Rural ITS

Tim McDowell, Washington State Department of Transportation (WSDOT)

The Washington State Department of Transportation identified more efficient and cost-effective ways to collect data from rural areas of the state in order to develop a new communications system. This involved evaluating successes and failures of previous projects, and determining the data type, capacity needs, and data speeds needed in rural areas. To be efficient, the new system needed to leverage existing resources used by WSDOT's voice system. Mr. McDowell gave a detailed review of WSDOT's wireless data communication systems for rural ITS, including lessons learned from previous projects, and engineering, tools, and technology used to implement the current system. Currently, WSDOT uses high speed (above 500 Kbps) and medium speed wireless communications to control over 125 rural ITS devices statewide.

Figure 35: Tim McDowell, Washington State DOT

Photovoltaic Power Systems for Rural ITS

Mark Aragon, Jon Dickinson; Nevada Department of Transportation (NDOT)

The Nevada DOT has deployed ITS devices at several remote locations throughout the state where municipal power sources are either unavailable or cost prohibitive. Photovoltaic technology has successfully provided a reliable and cost-effective method of generating electrical power for rural RWIS, CCTV, flashing beacons, and flow detection installations. Mr. Aragon and Mr. Dickinson discussed how Nevada DOT has implemented solar systems to power rural ITS elements, including design methods and calculations, system lifecycle costs, and lessons learned. The duo set-up a basic mock-up of a complete photovoltaic power system typical of those used in rural ITS applications.

Figure 36: Mark Aragon (center) and John Dickinson (right), Nevada DOT

Voice Communications in Rural Areas (Voting Scan)

Javier del Rio, John Schmidt; Caltrans Office of Radio Communications

Caltrans maintenance crews rely on a two-way radio system to communicate with each other and with their dispatch during normal operations as well as emergencies. Currently, maintenance crews in rural areas use an antiquated system that is inadequate for today's operational requirements. Caltrans has previously deployed 800 MHz two-way radio in urban areas, but because of the line of site requirement for signal propagation, the system was difficult to successfully deploy in rural and rugged terrain. To address this, Caltrans has designed, developed, and implemented a voting scan 800 MHz radio communications system that provides simplified operation and improved mobile radio coverage for maintenance crews. The Caltrans Headquarters team explained how the voting scan 800 MHz system works, why it was chosen for use in rural areas, and the design and challenges of current deployments of the system in northern California.

Figure 37: Javier del Rio (left) and John Schmidt (right), Caltrans

The IRIS Open Advanced Traffic Management System: Development, Deployment, Capabilities, and Maintenance

Michael Darter, Kin Sing Yen; AHMCT, University of California
John Castro, Caltrans District 10

Caltrans has teamed with the AHMCT Research Center at UC Davis to adopt and enhance the open-source Intelligent Roadway Information System (IRIS), an Advanced Traffic Management system. The IRIS system is a software tool that can provide TMC operators and traffic managers with a real-time view of highway conditions. The team explained the history behind Caltrans' adoption of IRIS and development done to enhance the system. The detailed presentation discussed development, functionality, configuration, testing, maintenance, associated costs, and scalability of the Caltrans IRIS system.

Figure 38: Michael Darter, AHMCT UC Davis

Redefining the Path to ITS Standards Training

Mac Lister; US DOT, RITA, ITS JPO

ITS Standards development has changed over the past few years requiring a need to update and improve previous ITS Standards training courses. Newly developed ITS Standards allow deployers to better ensure that they will implement a system that is compatible, interoperable, interchangeable, and conformant to ITS Standards. The ITS Standards Program and ITS Professional Capacity Building Program are undertaking a project to develop a new set of training materials to assist agencies in meeting project needs emphasizing the acquisition, implementation, and testing of ITS Standards. Mr. Lister gave a brief overview describing the project, initial development, and benefits of a re-designed ITS Standards training program.

Figure 39: Mac Lister, FHWA

The Power of Information

Keith Koeppen, Caltrans District 2

A key requirement of rural ITS deployments is to make roadway condition information, such as CCTV images, RWIS data and DMS messages, available to the public via the web for effective pre-trip planning. This usually requires two types of communication networks, a field element network and an administrative network. Often there is a need for a device that virtually "glues" a field network together with an administrative network. Engineers in Caltrans District 2 have developed an Information Relay to act as a "glue" device. Mr. Koeppen reviewed and demonstrated a system and single processor that has been designed and configured to both pull data from the field/local devices as well as push information to external sources, simplifying information exchange and eliminating unneeded devices and processes.

Figure 40: Keith Koeppen, Caltrans District 2

Avoiding the Remote Callout

Dean Campbell, Caltrans District 3
Sean Campbell, Caltrans Division of Research and Innovation

In the past, when a field element was no longer communicating with the TMC, the device would first be verified as unreachable and then a technician would be sent to the field to investigate. To potentially avoid the remote callout, a remote power controller could interrogate and reset the field element device. Dean Campbell and Sean Campbell explained and demonstrated a remote power controller with telephone and internet control functions that can reduce or eliminate the need for personnel callouts to rural ITS field elements.

Figure 41: Dean Campbell, Caltrans District 3

Antenna Characterization for Bluetooth-based Travel Time Data Collection

J. David Porter, David S. Kim*, Mario E. Magaña, Carlos Antar Gutierrez Arriaga,Panupat Poocharoen, Amirali Saeedi*, Sejoon Park; Oregon State University

*speakers

There are several factors that may affect the quantity and the quality of the travel time data collected with a Bluetooth-based system reading Media Access Control (MAC) addresses. A critical hardware factor is antenna type. Dr. David Kim and graduate student Amirali Saeedi explained the project objectives, testing procedures, and data analysis for a study comparing the effect of the characteristics of various antennas on travel time data collection using Bluetooth-based technology. Results and continuing research were shared and discussed.

Figure 42: David Kim, Oregon State University

MAC Address-based Delay Measurements at Rural "Gateways"

Yegor Malinovskiy*, Yinhai Wang*, Un-Kun Lee; University of Washington
Ted Bailey, Matt Neeley; Washington State Department of Transportation (WSDOT)

*speakers

The lack of extensive sensor, communication and power networks makes traffic data collection in rural areas a challenge. However, recent advances in Media Access Control (MAC) address based travel time collection technologies have allowed for travel time data to be collected in remote locations without significant investment. Rural "gateways" such as border crossings, passes, and weigh stations, and associated travel delay are of particular interest to the trucking industry as well as the general public. Graduate student Yegor Malinovskiy and Dr. Yinhai Wang presented their research project that is examining the use of Bluetooth technology to measure delays at rural "Gateways." The basics of Bluetooth technology and its accuracy were discussed along with up-and-coming technologies, truck performance measurements, and the results of the field experiments conducted to date.

Figure 43: Yegor Malinovskiy, University of Washington

5.7. 2012 Western State Forum

Date, Location: June 12 – 14, 2012; Yreka, California

Technical Content

Field Element Network Design for a Rural Transportation Management Center, Part One

Ian Turnbull, P.E.; Caltrans District 2

Field Element Network Design for a Rural Transportation Management Center, Part Two

Jeremiah Pearce, P.E.; Caltrans District 2

While most urban TMCs are focused on congestion relief and incident management, rural TMCs are dominated by weather, winter operations and non-recurring events such as wildfires. In the rural environment, extremes in climate, remote locations and a lack of communication services make gathering real-time field information challenging. Caltrans, District 2 has hosted a full service Rural TMC since 2000. With over 220 associated field elements, many practical implementation and design lessons have been learned. Mr. Turnbull gave an overview of the technical architecture of the Rural TMC in Redding and Mr. Pearce discussed in detail the architecture and configuration of the associated Internet Protocol Field Element Network (FEN). The presentation focused on the details of implementing a FEN in a challenging rural environment.

Figure 44: Ian Turnbull, Caltrans District 2

Figure 45: Jeremiah Pearce, Caltrans District 2

Travel Times Using Bluetooth

Lynne Randolph, Southwest Research Institute

Ms. Randolph and her team from the Southwest Research Institute in San Antonio, Texas, investigated potential issues with Bluetooth technology used for the purpose of traveler information, including the capabilities of various Bluetooth devices, adapters, and range extending antennas. She presented the detailed findings of the research concerning such questions as validating whether an adequate number of data points can be gathered from devices at high speeds and what mode a device must be in to read a signal. Based on the results of her research, Ms. Randolph provided recommendations and lessons learned for potential deployers of Bluetooth technology used for determining travel times.

Figure 46: Lynne Randolph, Southwest Research Institute

Technical Development of the Western States One Stop Shop for Rural Traveler Information

Doug Galarus, Dan Richter, Western Transportation Institute

The One-Stop-Shop (OSS) web application provides travelers with comprehensive, real-time data that can be used in planning their trips. Currently covering California, Oregon, Washington and Nevada, OSS presents routing functionality, camera images, weather information, elevation profiles, rest areas, points of interest and more, in a consistent, easily accessible and intuitive interface that allows travelers to plan instate trips as well as trips that cross state borders. OSS brings in data from four states and ten different organizations, providing over 25 separate layers.

Figure 47: Doug Galarus, Western Transportation Institute

Figure 48: Dan Richter, Western Transportation Institute

Mobile ITS Hotspot Trailers, an Evolving Technology

Jon Dickinson, Mark Aragon, Nevada Department of Transportation

After seeing WTI/MSU's Portable ITS Trailer and Communications demonstration at the 2008 Western States Forum, the Nevada DOT developed a similar mobile ITS hotspot trailer. NDOT recognized the portable ITS hotspot trailer as a valuable asset for construction zones, special events, and even emergency situations. Mr. Dickinson and Mr. Aragon, along with Jim Whalen, discussed how the trailers were originally procured and the modifications that have since been made for a second group of trailers. The NDOT team had a trailer onsite at the Forum and demonstrated its capabilities during their presentation. Forum participants were able to get a close-up look at the trailer components and configuration.

Figure 49: Jon Dickinson, Nevada Department of Transportation

Figure 50: Mark Aragon, Nevada Department of Transportation

Using Wireless Data Collection Units as Point Detection Systems

Amirali Saeedi, SeJoon Park, David S. Kim*, J. David Porter*, Oregon State University

*speakers

Within the past several years, Bluetooth technology has been utilized as the foundation for wireless data collection systems created to collect travel time data. In these systems, the MAC address of an enabled Bluetooth device present in a vehicle is used as an identifier that can be detected by Bluetooth data collection units installed at various locations along a road or highway. If signal strength (RSSI) is also measured at the same time the MAC address is read, the point location of the Bluetooth device can be identified with acceptable accuracy.

Figure 51: J. David Porter, Oregon State University

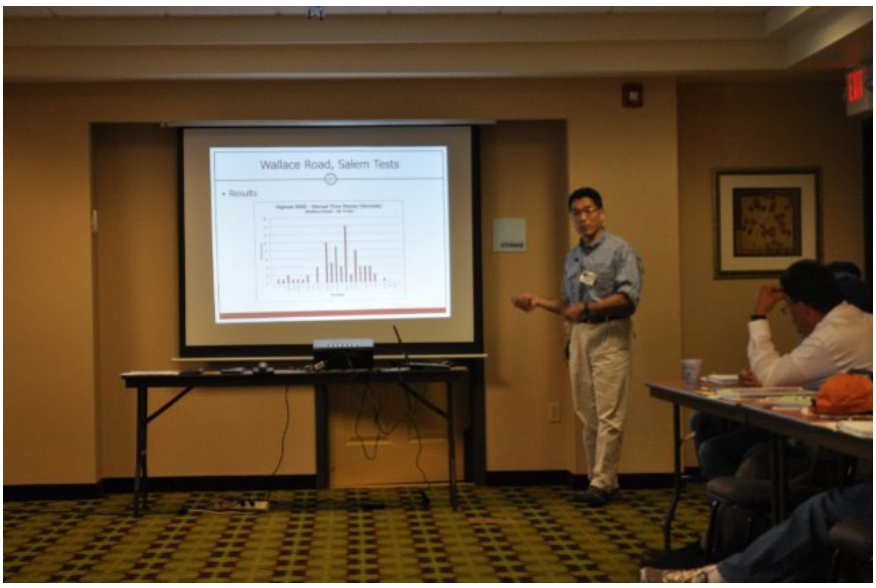

Figure 52: David Kim, Oregon State University

California Highway Patrol (CHP) Rapid Response Vehicle (RRV)

Hanna V. (John) Batarseh, Brian Guthrie, California Highway Patrol

The Rapid Response Incident Command Vehicles (RRV) are the product of extensive research by the California Highway Patrol (CHP) into the disaster preparedness needs of the CHP. The RRV can deploy quickly, enabling on-scene control of multi-agency radio interoperability and bridging the communication gap between law enforcement and public service agencies. Mr. Batarseh and Mr. Guthrie had an RRV on-site and Forum participants were able to see it fully deployed and operational.

Figure 53: Hanna V. (John) Batarseh, California Highway Patrol

Figure 54: Brian Guthrie, California Highway Patrol

5.8. 2013 Western State Forum

Date, Location: June 18 – 20, 2013; Yreka, California

Technical Content

CCTV Image Relay

Keith Koeppen, P.E. Caltrans District 2

In California, one of the most used publicly available data assets are the CCTV images on the Caltrans public web portal. Typically, the image data is retrieved from field elements and deposited on the Caltrans public web portal server using two types of communication networks (field element network, administrative network). In order to retrieve data from the field elements and deposit that data on a web server located on the administrative network, Caltrans District 2 uses an Information Relay. In rural ITS deployments there are several key factors that must be overcome to provide timely, accurate, and perceived reliable data. Mr. Koeppen explained how the CCTV Image Relay was designed to be robust enough to effectively deal with slow or unreliable rural field communications. He described and demonstrated the additional add-on features of the relay including geo-location, timestamps, general image processing, and image integrity validation. The technical architecture, software development, and deployment difficulties associated with the Caltrans District 2 CCTV Image Relay were all discussed.

Figure 55: Keith Koeppen, Caltrans District 2

Design and Implementation of Video for Rural ITS – Nevada Department of Transportation

Israel Anthony Lopez, Nevada Department of Transportation

The Nevada Department of Transportation has deployed ITS video devices at several remote locations throughout the state to provide better roadway information for the department, Public Safety Officials, and the public. This system provides video to two different audiences with varying requirements – the public and public safety officials. Mr. Lopez gave a detailed description of the design and implementation of the video system including background theory, design criteria, system description and components, maintenance requirements, and initial and lifecycle costs. Calculations used to determine system requirements (e.g., bandwidth, licensing, resource allocation) were presented and discussed. Mr. Lopez included a live demonstration of the system that allowed participants to observe the actual output of the video system and how it applies to the different audiences.

Figure 56: Israel Anthony Lopez, Nevada Department of Transportation

Automated Wind Warning System – Caltrans, District 9

Phil Graham, Caltrans District 9

Mr. Graham from Caltrans District 9 presented their practical, economical, and high value Automated Wind Warning System. The system includes a solar power system, flashing beacons, RWIS, unlicensed RF links, and a cell modem for IP communication. Mr. Graham described the design considerations, system components, and the challenges associated with deploying the system. Examples of data and the related notifications were also included.

Figure 57: Phil Graham, Caltrans District 9

Bike Detection in California

Martha V. Styer, P.E., Kai Leung, P.E.; Caltrans, Headquarters Division of Traffic Operations

California vehicle law 21450.5 (2008) mandates that new or upgraded traffic actuated signals must detect bicycles and motorcycles. Martha Styer and Kai Leung from Caltrans Headquarters explained the various issues and solutions currently being used for reliable bicycle detection particularly in rural areas. One solution being tested is a microwave radar detector that can distinguish between bikes and cars. The most recent testing results for the system were presented and discussed. The team also discussed emerging technologies, in particular a system that can detect any vehicle already inside an intersection and then operate a signal accordingly.

Figure 58: Martha Styer and Kai Leung, Caltrans, Headquarters Division of Traffic Operations

Procuring the Advanced Transportation Controller (ATC) for the Oregon Department of Transportation and the State of the National Standards

Doug Spencer, P.E., Oregon Department of Transportation

The Oregon DOT recently issued a Request for Proposals (RFP) to establish a long-term price agreement for the Advanced Transportation Controller (ATC) and an additional RFP for ramp metering firmware, other firmware, and programming services for the ATC. The second RFP allows ODOT to use off the shelf software built for the ATC or develop custom firmware to run the agency's ATC. ITS Standards Engineer Doug Spencer explained ODOT's need for a Controller, the relevant standards and requirements, the proposal process, subsequent testing, and the challenges that arose throughout.

Figure 59: Doug Spencer, Oregon Department of Transportation

Field Element Data Quality Control from the Perspective of Data Redistribution

Doug Galarus, Western Transportation Institute

The Western Transportation Institute, in partnership with Caltrans and other members of the Western States Rural Transportation Consortium, have conducted a number of research and development projects over the past 10 years in which DOT field element data and other third party data has been aggregated and redistributed for the provision of traveler information and support of maintenance and operations activities. A challenge in all of these efforts has been the assessment and control of quality of the data presented. Common problems are incorrect metadata, including incorrect station locations, and the inclusion of erroneous data from sensors. Mr. Galarus discussed the data quality control efforts to date on these projects as well as the quality control methods used by other data providers. He also demonstrated the potential for further automation of quality control processes through the use of archived, multi-provider data.

Figure 60: Doug Galarus, Western Transportation Institute

Design and Implementation of Nevada DOT's Wireless Point to Point and 3G/4G Rural Networks

Jim Whalen, Nevada Department of Transportation

The Nevada Department of Transportation has deployed ITS devices at several remote locations throughout the state where commercial wired telecommunication infrastructure sources were either unavailable or cost prohibitive. Mr. Whalen provided a detailed description of the design and implementation of working wireless Point to Point (PTP) and 3G/4G cellular systems for a rural ITS installation, including background theory, system description, and selection of system components based on ITS device communications requirements and cost. He described the design methods used to determine best practices and the appropriate system for ITS Smart Zones in addition to network performance and capabilities for ITS device requirements. Mr. Whalen included a demonstration of both platforms used in NDOT's rural ITS application to allow participants to observe the actual output of the photovoltaic system components under varying environmental conditions.

Figure 61: Jim Whalen, Nevada Department of Transportation

Idaho's Winter Performance Measures

Dennis Jensen, Idaho Transportation Department

Timely and efficient winter road maintenance is a high priority for the Idaho Transportation Department and a variety of treatment materials are employed by a winter maintenance operation fleet of over 500 vehicles. ITD also has a statewide network of Road Weather Information Systems (RWIS) used to monitor atmospheric and pavement conditions. Until recently, the analysis and maintenance decisions and procedures driven by the RWIS data were not standardized across the state. Dennis Jensen, ITD's Winter Maintenance Coordinator, described how ITD has developed two winter maintenance performance measures that are calculated from the RWIS data and how those measures are being implemented in operations activities. He provided details on the development of the performance measures, data collection, and the calculations involved, as well as 2012-2013 winter statistics and the web presentation of the performance measures.

Figure 62: Dennis Jensen, Idaho Transportation Department

Error Assessment for Emerging Traffic Data Collection Devices

Yegor Malinovskiy*, Jonathan Corey*, Yinhai Wang; University of Washington
Ted Bailey, Ron Vessey; Washington State DOT
Bahar Namaki, Aalborg University

*speakers

The ability to produce reliable and accurate performance measures of transportation facilities is becoming increasingly important while the relatively new capability of relaying traveler information back to the users through smart devices and in-vehicle systems is gaining interest. The Washington State DOT has instrumented two corridors to evaluate the effectiveness of several different data collection devices side by side. The University of Washington (UW) is conducting the study. Yegor Malinovskiy and Jonathan Corey from UW presented an overview of the project and the technologies being studied and then delved into the project methodology, data analysis, and detailed study results.

Figure 63: Jonathan Corey (left) and Yegor Malinovskiy (right) , University of Washington

5.9. 2014 Western State Forum

Date, Location: June 17 – 19, 2014; Yreka, California

Technical Content

The Field Element Communications End Game: From POTS to Licensed Microwave

Jeremiah Pearce, P.E., Caltrans District 2

Field element connectivity and reliability has long been an issue when communicating with critical remote roadside field elements within Caltrans District 2's rural environment. The demand for higher bandwidth connections to the roadside continues to grow as technology trends continue to offer more data at faster speeds. Consequently, TMC operators and the public expect more information more frequently from roadside field elements. Additionally, there is a general lack of high-bandwidth, low-cost services for most of the district. To address this challenge, Caltrans District 2 has developed a private point-to-point microwave system capable of serving high-bandwidth connections to remote roadside sites. At past Forums, Caltrans District 2 has presented different aspects of their system. This year, ITS Engineer Jeremiah Pearce brought everything together by presenting the development and evolution of the overall microwave system. He discussed strategy, design, implementation, construction, and maintenance issues of Caltrans District 2's point-to-point microwave system, the licensed 11 GHz microwave backbone project, and the current 4.9 GHz licensed mountain-top-to-roadside radio upgrade project.

Figure 64: Jeremiah Pearce, P.E., Caltrans District 2

WSDOT LED Adaptive Roadway Lighting and Illumination Reform

Keith Calais, Washington State Department of Transportation

Each year millions of dollars are spent on illumination system repairs, preventative maintenance and utility costs. In addition, for many agencies the ongoing preservation funding needed to perform life cycle replacement of these systems far surpasses current and projected funding. With thousands of miles of state, county and city owned roadways and intersections with and without illumination, a more strategic approach is needed to when, where and why to provide roadway illumination. Consequently, Washington State DOT (WSDOT) is reviewing and reforming their illumination guidelines in an effort to reduce illumination without significant negative impacts to safety and mobility. WSDOT Signal and Illumination Engineer Keith Calais explained WSDOT's need for illumination reform and the agency's efforts to reduce associated electricity consumption and maintenance costs. The agency installed an adaptive LED lighting system pilot project with dimming and on/off operation by time of day at the US 101 interchange with Black Lake Boulevard in Olympia. Mr. Calais described the installation, testing and evaluation of the system, and shared results of the pilot project. He also discussed a number of practical lessons learned and how they are benefiting other projects as well.

Figure 65: Keith Calais, Washington State Department of Transportation

Control of DMS, CCTV, HAR, and 511

Phil Braun, Idaho Transportation Department

Phil Braun, an IT Systems Analyst and iNET Systems Administrator for the Idaho Transportation Department (ITD), discussed ITD's statewide integration project for DMS, CCTV, HAR, and 511. He explained some of the background behind the project, the past and current management environment, the contracting process, and effects on design, procurement, deployment, and operations. Phil discussed the technical challenges encountered by ITD and the various Districts and reported on integration efforts for CCTV, DMS, HAR and 511. A number of lessons learned were shared with the group along with future plans and opportunities for ITS applications along Idaho's roads.

Figure 66: Phil Braun, Idaho Transportation Department

Traveler Information – The Preamble

Mike Jenkinson, Caltrans, Traffic Operations

Commercial Wholesale Web Portal 2: Providing Caltrans' Traveler Information Data to Third Party Developers

Sean Campbell, Caltrans, Division of Research, Innovation, and System Information (DRISI)

In order to provide more timely, accurate and reliable traveler information to ISPs while allowing equitable access and consistent business and use practices, Caltrans developed the Commercial Wholesale Web Portal (CWWP) in 2004. The CWWP2 addresses the limitations of the original portal, simplifies and standardizes data output and retrieval, provides accurate geospatial information, and retrieves the District status data as close to the source as possible. Mike Jenkinson from Caltrans Traffic Operations opened the CWWP2 presentation with a history of traveler information in California. Sean Campbell, Caltrans DRISI, went into detail on how the CWWP2 was designed, what it took to build and the various tools used, and how the system works. Sean discussed who is using and applying the CWWP2 data, lessons learned during development and deployment, and next steps for the system.

Figure 67: Mike Jenkinson, Caltrans

Figure 68: Sean Campbell, Caltrans

Model 2070 Controller and ATC: Present and Future

Herasmo Iniguez, Caltrans, Headquarters

Herasmo Iniguez, Branch Chief for the Traffic Control Systems Branch at Caltrans, reviewed Caltrans' current deployment of the Model 2070 Controller, along with its history in California and lessons learned over the course of its deployment. The presentation discussed the Advanced Transportation Controller (ATC) and Caltrans' involvement with the national ITE standards development. Herasmo explained the objectives and development of Caltrans' Transportation Electrical Equipment Specifications (TEES) 2009 regarding the 2070 Controller and the ATC. Over the last couple years, Caltrans has been working with the Department of Homeland Security to tighten security on the Model 2070 Controller. Herasmo discussed the TEES requirements for cyber security and the impact they will have on end users.

Figure 69: Herasmo Iniguez, Caltrans, Headquarters

Organized Chain-Up: Save the Space – Bringing Order to Chaos

James Todd Daley, Washington State Department of Transportation

I-90 crossing Snoqualmie Pass is a critical high volume freight corridor serving Seattle and the greater Puget Sound area. It receives an average annual snowfall of 457 inches creating conditions which obscure pavement markings and require chains approximately 70 times per year. 7000 trucks cross the pass daily and during peak hours over 300 trucks all trying to chain-up causes congestion, chaos, and un-safe conditions. After a worldwide search to see what others are doing to address similar situations, WSDOT's South Central Region developed a first of its kind system to increase safety, reduce delays, and allow for snow removal during chain-up conditions. James Todd Daley, the Assistant Regional Traffic Engineer for the South Central Region, described the conditions that existed prior to the organized chain up system's implementation and reviewed the different design proposals that were considered. He then went into detail on the design, construction, and operation of the current system. He shared results of the first season of use and described the future operation and continued enhancement of the system.

Figure 70: James Todd Daley, Washington State Department of Transportation

5.10. 2015 Western State Forum

Date, Location: June 16 – 18, 2015; Yreka, California

Technical Content

Multnomah Falls Parking Management System

Dennis Mitchell, Doug Spencer; Oregon Department of Transportation

Multnomah Falls is the second highest year-round waterfall in the United States and is located in the Columbia River Gorge National Scenic Area, approximately 30 miles east of Portland. The falls attract approximately two million visitors each year. Due to the popularity of the falls, especially during the summer months, demand often exceeds available parking at the two primary parking lots. One of these parking lots is located in a center median of Interstate 84. When this parking lot approaches capacity, queueing can occur along the I-84 eastbound exit ramp (entrance to the parking lot). This queueing has led to several incidents and has required ODOT maintenance crews to manually close the exit ramp under these conditions. The safety concerns associated with this parking issue have led ODOT to develop an automated parking system for Multnomah Falls, capable of detecting lot occupancy thresholds, notifying travelers of lot closure, and barricading the off-ramp. Dennis Mitchell and Doug Spencer, Oregon DOT ITS Engineers, discussed the design of the system including signage, detection, gate systems, ITS hardware and software, and the operational observations (as well as resulting improvements) of the system made to date.

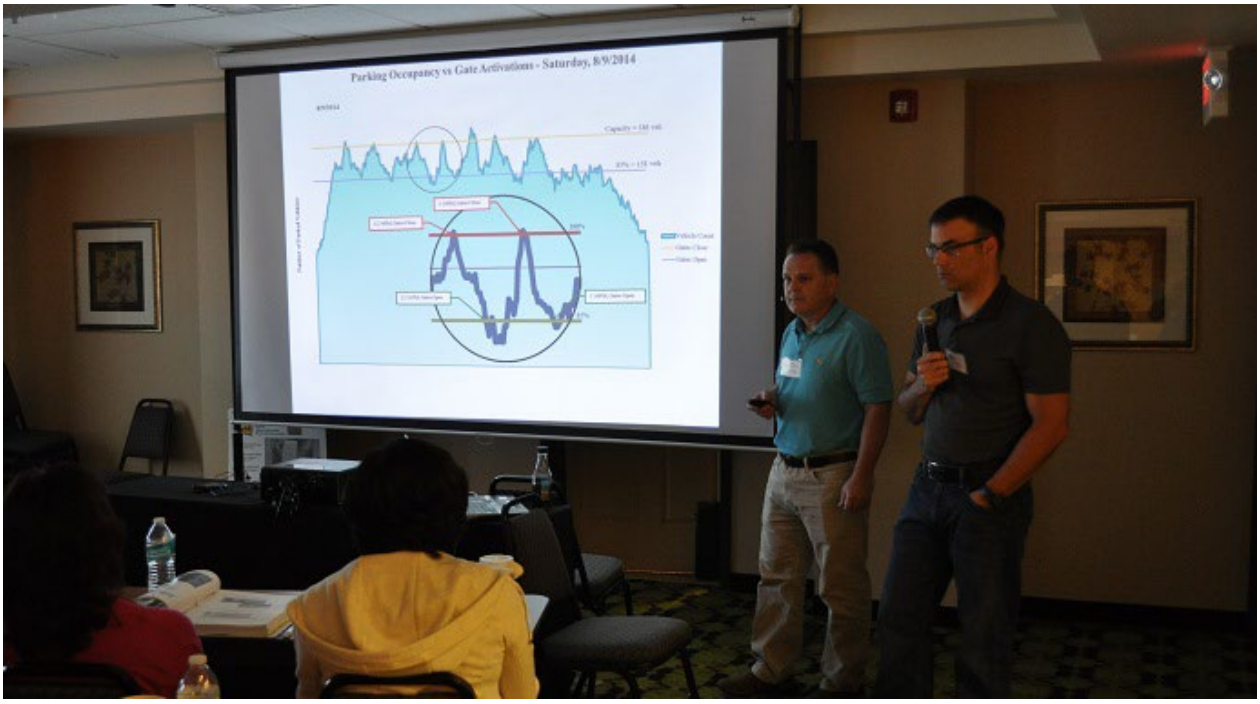

Figure 71: Dennis Mitchell (l) and Doug Spencer (r), Oregon DOT

The Nevada Data Exchange (NDEX): An Internet Portal for Public and Strategic Partners to Publish Their Data and Subscribe to NDOT's Traveler Information

Israel Lopez, Nevada DOT

Israel Lopez from Nevada DOT's Traffic Operations Technology Section presented the Nevada Data Exchange (NDEX). The NDEX uses the Traffic Management Data Dictionary (TMDD) standard to create a data exchange to aggregate the States' data, create a data archive for historical data queries, and create an effective visualization dashboard to display current metrics / key performance indicators (KPIs). Mr. Lopez explained the problem and need for the project along with the resulting technical needs and requirements. He also described the purpose and functionality of the NDEX in relation to various NDOT data sources such as RWIS, CCTV, DMS, and HAR, and discussed the soon to be released data visualization module.

Figure 72: Israel Lopez, Nevada DOT

WYDOT Roadside WiFi and Tablet App

Mark Kelly, Wyoming Department of Transportation

In an effort to improve information management during weather events and post road conditions more quickly on the WYOROAD website, Wyoming DOT developed a tablet reporting app for use by maintenance personnel (i.e., snow plows, foreman trucks). At the same time, WYDOT also installed WiFi hotspots at various locations to complement Wyoming's statewide low speed "P25 data" communications network. Prior to this system, plow drivers across the state reported road conditions and incidents, and requested speed limit (VSL) and Dynamic Message Sign (DMS) changes, pace speeds, and wind speeds via radio from the WYDOT Transportation Management Center (TMC) dispatcher. The dispatcher would then record/give requested information, transfer information to Wyoming Highway Patrol (WHP) and then the information could be posted to the web site and other information systems for the public. The in-vehicle app and Wi-Fi system significantly streamlines the gathering of information from WYDOT personnel and posting to the WYOROAD website, improves timeliness and accuracy of condition reports, and provides more information to maintenance personnel. Mark Kelly, Communications Systems Supervisor for WYDOT, explained the need and goals for the tablet app and reviewed its development. He discussed the functionality of the app and then gave a live demonstration of the system.

Figure 73: Mark Kelly, Wyoming DOT

Advanced Variable Message Sign

David Wells, Caltrans Headquarters

Faced with the need for hundreds more variable message signs (VMS), Caltrans considered advantages and disadvantages of different procurement options before choosing to develop and build its own advanced VMS. David Wells, Caltrans Senior Transportation Electrical Engineer and AVMS Project Manager, discussed the development of the AVMS specification, and the design, manufacturing, and testing of the new sign and its control software. He reviewed the various off-the-shelf components of the sign as well as the custom Pixel Matrix Modules, the Remote I/O Box, and the Test Box. Along with the design advantages of the new sign, Mr. Wells also described the features and benefits of the improved custom sign control software. The Caltrans AVMS is non-proprietary, has interchangeable parts between manufacturers, provides a color option, uses less power and a safer low voltage design, and has improved operating capabilities. Mr. Wells demonstrated several of the Pixel Matrix Modules during breaks and networking sessions.

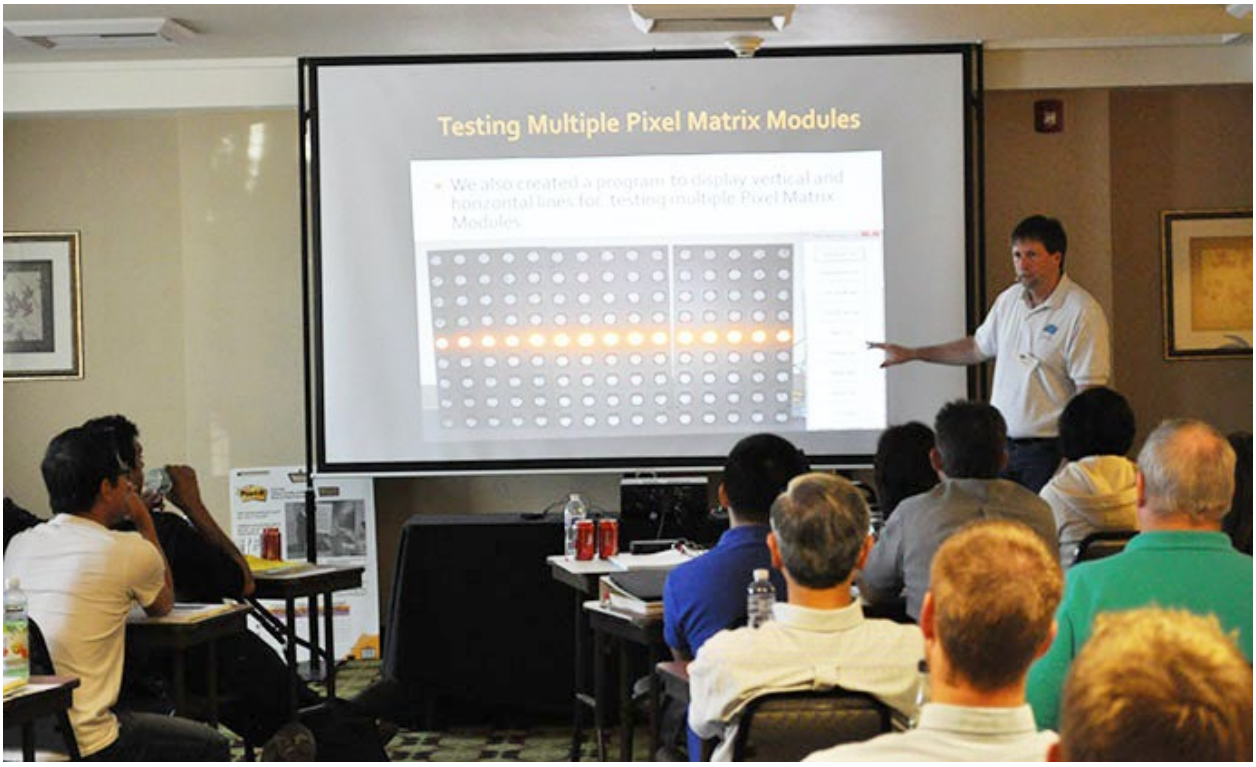

Figure 74: David Wells, Caltrans Headquarters

Utah Department of Transportation (UDOT) Citizen Reporting Program

Corey Coulam*, Lisa Miller, Utah Department of Transportation

*Speaker

The Utah Citizen Reporter Program enlists trained volunteers to report road conditions along specific roadway segments across Utah. The long term goal of adding Citizen Reporters to UDOT's weather operations road reporting is to supplement current condition reporting on segments where drivers are already traveling. Many of the segments selected for the program are critical rural routes where there is no infrastructure to install traffic cameras or an RWIS. The citizen reporters are intended to enhance UDOT's coverage of road weather reporting on under-reported segments throughout the state of Utah. Citizen Reporters submit their observations through an industry-first reporting app. Corey Coulam, a program manager for the Utah Traffic Operations Center, presented the need for the program, the program's goals, technical and ideological structure and integration with Utah's traveler information system, and participation statistics.

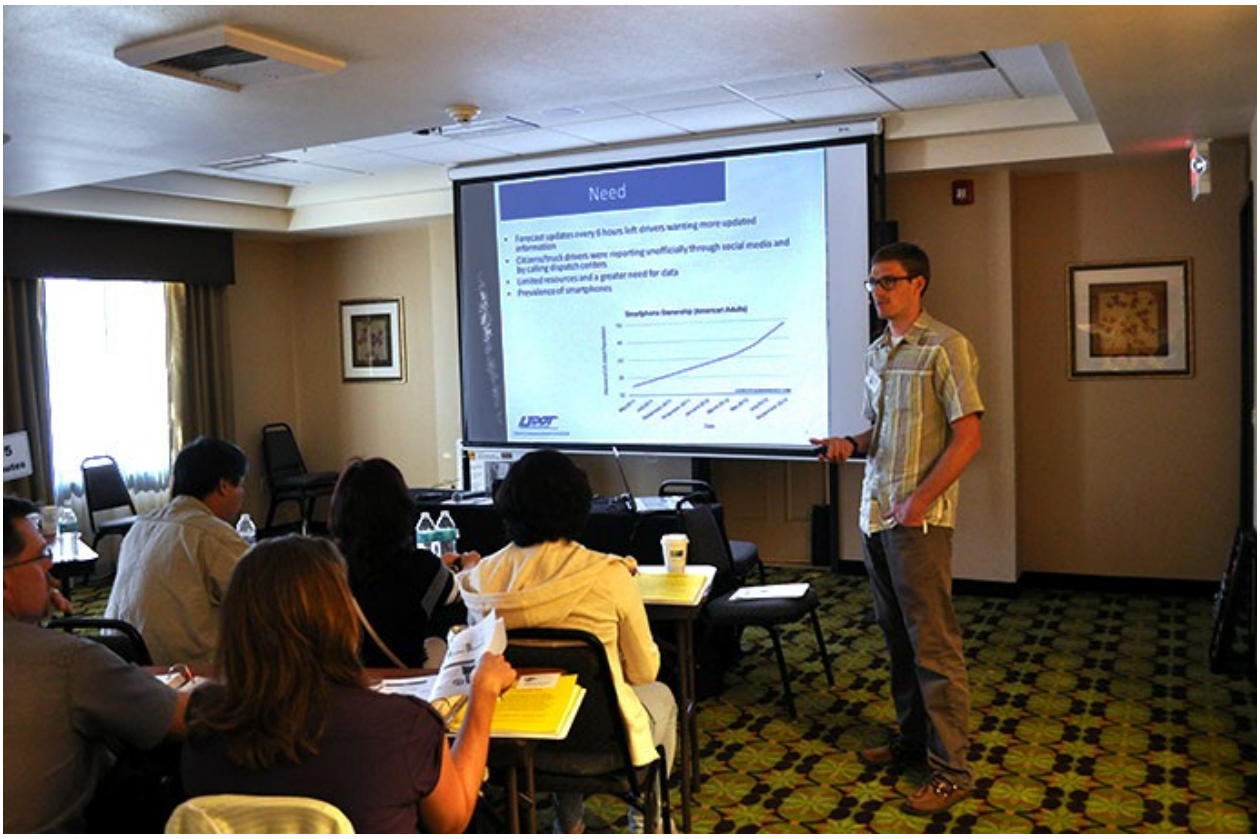

Figure 75: Corey Coulam, Utah DOT

Safety Chain Control System

Keith Koeppen, Caltrans District 2

Winter operations can be dangerous due to low visibility, severe weather, and icy roadway conditions. This is further compounded when chain conditions exist and field maintenance workers are on foot near live traffic. This is the case along Interstate 5 in Yreka, California, where signs that display current chain conditions to the motoring public are routinely changed during storms. Traditionally, field maintenance workers must traverse the freeway several times whenever a chain control condition changes. This exposes workers to oncoming traffic in snowy and icy roadway conditions. ITS engineer Keith Koeppen, of Caltrans District 2, discussed and demonstrated the Safety Chain Control System that he and his project team developed to enhance worker safety in these conditions. The new system is semi-automated and allows field maintenance workers to activate the chain condition signs remotely from a cell phone or traffic cabinet. Mr. Koeppen explained the technical architecture of the system, described the system's details, and discussed the deployment of the system and associated challenges.

Figure 76: Keith Koeppen, Caltrans District 2

TranSync Mobile Tool (Traffic Signal Management and Retiming Tool) Pilot Project in Auburn and San Francisco Bay Area (Caltrans Districts 3 and 4): Improving Signal Timing and Coordination

Martha Styer, Dali Wei, Caltrans Headquarters

Martha Styer, a Senior Transportation Electrical Engineer for Caltrans Division of Traffic Operations, and Dr. Dali Wei, a post doc researcher at UC Davis and software developer for Trans Intelligence, presented and demonstrated the TranSync Mobile Tool. The tool was developed by Trans Intelligence to provide an easy to use app for signal timing diagnosis, traffic progression evaluation, traffic signal timing verification, and bandwidth optimization functions. Instead of using personnel observation of traffic, TranSync is a useful tool for signal operations engineers to verify and quantify signal timing improvements, in real-time. Ms. Styer reviewed the basics of signal timing and the current practices for optimization, as well as how the TranSync tool could improve upon the current techniques. Dr. Wei demonstrated the app and discussed the results of case studies completed in Auburn, Yuba City, and Mountain View, California.

Figure 77: Martha Styer, Caltrans Headquarters

Figure 78: Dali Wei, University of California Davis

Idaho Transportation Department Winter Performance Measures

Robert Koeberlein*, Dennis Jensen, Idaho Transportation Department

*Speaker

At the 2013 Forum, Dennis Jensen presented Idaho's Winter Performance Measures program. Since that time significant development and research have taken place, and the program has evolved. This year, Bob Koeberlein, Headquarters Operations Engineer for the Idaho Transportation Department, provided an update on the Winter Performance Measures program and the latest results of the program's implementation. He reviewed the concept behind the program, the transition from testing to full implementation, and growth of the system. Mr. Koeberlein explained the various calculations involved in the winter performance measures and discussed how the system has been implemented in terms of RWIS sensors and "scoring" algorithms to monitor the "grip" coefficient on Idaho's roads during winter weather events. He also discussed the success of the program regarding cost and operational benefits, lessons learned, and next steps for the program.

Figure 79: Robert Koeberlein, Idaho Transportation Department

5.11. 2016 Western State Forum

Date, Location: June 21 – 23, 2016; Yreka, California

Technical Content

RWIS Deployment Update for Campbell-Datalogger-Based-RPU

Jeff Worthington, Caltrans District 2

For the first section of Caltrans District 2's RWIS topic, Jeff Worthington explained their design for a new RWIS RPU (remote processor unit). He provided some background on the project and discussed the reasons for proceeding with their own RPU redesign. He described the subsequent implementation of the new RPU, providing details and discussion about what worked and what didn't work. He concluded with future plans for the system and a lead-in to Mike Beyer's presentation on in-pavement versus non-invasive pavement sensors.

Figure 80: Jeff Worthington, Caltrans District 2

Comparison of In-Pavement Versus Non-Invasive Pavement Sensor Technologies (AKA: The Lesser of Two Evils)

Mike Beyer, Caltrans District 2

In the second section of the Caltrans District 2 RWIS presentation, Mike Beyer reviewed the process of deploying pavement sensors with the new RWIS RPU design. He discussed the challenges associated with in-pavement sensor technologies and District 2's consequent investigation of out-of-pavement sensor technology. He further compared the two technologies and discussed the lessons learned for best practice implementation for both types of technology.

Figure 81: Mike Beyer, Caltrans District 2

Joint Base Lewis-McChord (JBLM) Bluetooth Traveler Information and Integration

Tony Leingang, Tom Stidham, Washington State Department of Transportation

Olympic Region's Freeway Operations Manager, Tony Leingang, and Information Technology Specialist, Tom Stidham, discussed the Bluetooth traveler information project recently deployed around the JBLM corridor. WSDOT partnered with multiple agencies to implement ITS congestion management solutions along the I-5/JBLM corridor. One element required improved traveler information to encourage use of a variety of routes more efficiently, reduce severity of bottlenecks, and eliminate unnecessary short freeway trips. Tony and Tom discussed project coordination, selection of Bluetooth technology, installation, and data processing. They demonstrated the system software and reviewed some of the project's challenges and lessons learned.

Figure 82: Tony Leingang (l) and Tom Stidham (r), Washington State DOT

Local Adaptive Signal Timing on US 101 in Lincoln City, Oregon

Julie Kentosh, Doug Spencer, Oregon Department of Transportation

Region 2's Signal Operations Engineer, Julie Kentosh, teamed up with ODOT's ITS Standards Engineer Doug Spencer to present the Local Adaptive Signal Timing project implemented on US101 Hwy in Lincoln City, Oregon. The system was designed to address the significant seasonal traffic fluctuations experienced along that segment of highway. Julie and Doug provided background on the project and adaptive signal timing in general. They then discussed the design of the Lincoln City system, and its installation, operation, evaluation, and results to date.

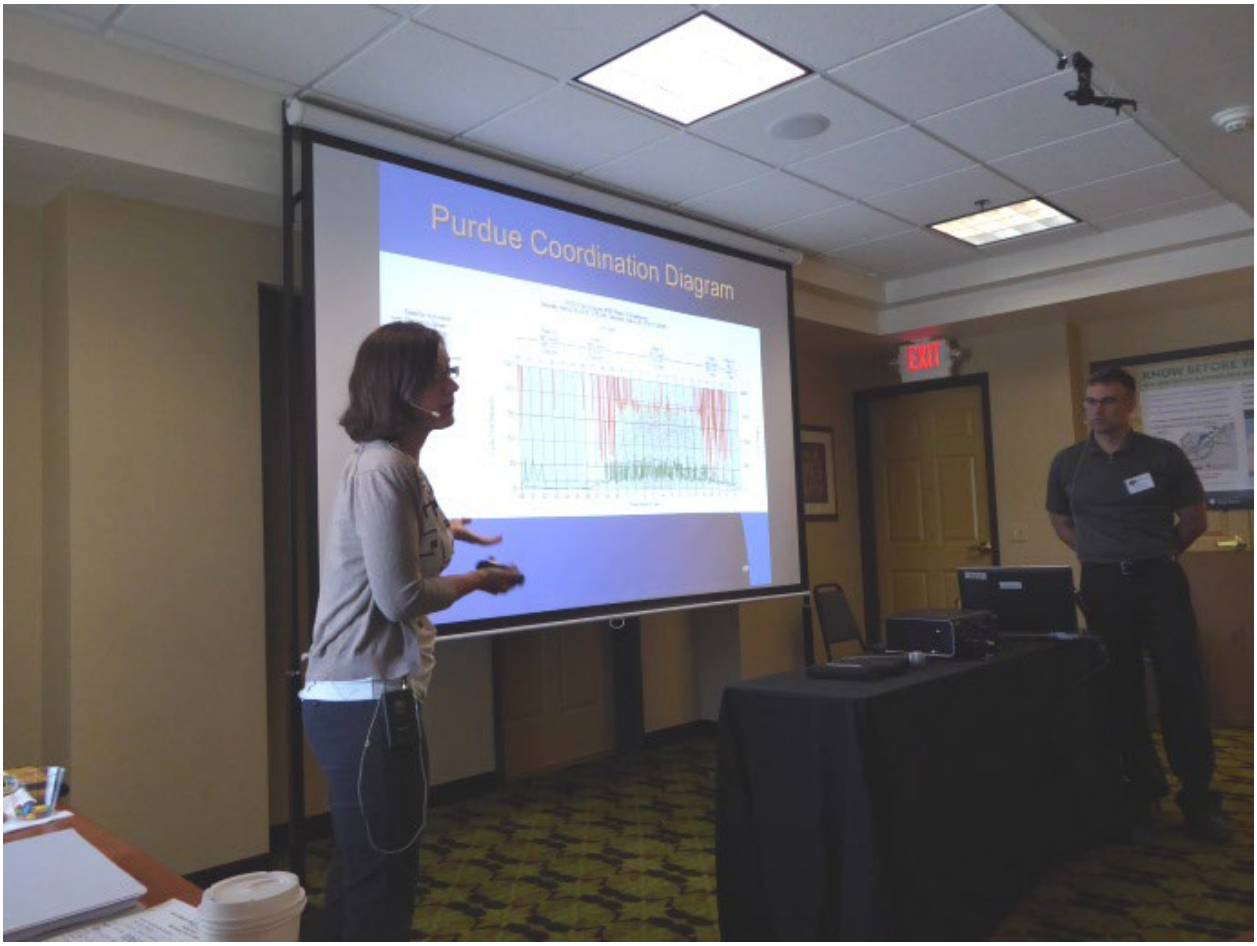

Figure 83: Julie Kentosh (l) and Doug Spencer (r), Oregon Department of Transportation

Using iPads for Field Data Collection

Joe Schmit, Washington State Department of Transportation

To modernize and create a more efficient maintenance department, the Washington State Department of Transportation Maintenance Division deployed over 1000 iPads to highway maintenance employees. These iPads are equipped with a WSDOT-developed application called the Highway Activities Tracking System (HATS). A dynamic user interface is combined with onboard GPS and mobile GIS to help in documenting maintenance work activities and tracking highway features. WSDOT Technology Resource Manager, Joe Schmit, discussed the project from development to field deployment and then gave a live demonstration of the application.

Figure 84: Joe Schmit, Washington State Department of Transportation

Portable Work Zone Data Collection

Blaine Van Dyke, Oregon Department of Transportation

Oregon DOT developed four solar powered portable data collection trailers to monitor traffic in work zones. Each trailer is equipped with traffic sensors, Bluetooth travel time units, and cameras. ODOT uses the data collected by the trailers to inform travelers in real time of any delays through the work zone. Messages are posted to changeable message signs and the TripCheck traveler information website. The data collected will also be used to improve traffic flow in future work zones. Blaine Van Dyke reviewed the trailer specifications and components, deployment and data collection, and lessons learned. He included a walk-around video of an actual trailer as well.

Figure 85: Blaine Van Dyke, Oregon Department of Transportation

Caltrans' Controller Cabinet Standards: Models 33x, 33xL and 34xLX Present and Future

Herasmo Iniguez, Caltrans Headquarters

Herasmo Iniguez, Traffic Controls Systems Branch Chief, presented some of Caltrans' controller cabinet standards. He reviewed the history of Caltrans cabinet standards and then discussed the features and benefits for the newer LX cabinet. Herasmo had a cabinet on-site and spent several networking sessions describing and demonstrating its features to Forum attendees.

Figure 86: Herasmo Iniguez, Caltrans Headquarters

Dedicated Short Range Communications (DSRC) Radio for Rural ITS

Rodney Schilling, Jim Whalen, Nevada Department of Transportation

In an effort to demonstrate a more viable and effective method of providing mobile weather data, Nevada DOT has deployed 18 DSRC roadside radio units along the I-580 corridor between Reno and Carson City. Onboard units were also fitted on nine District II snowplows and a Freeway Service Patrol van. Rodney Schilling and Jim Whalen described the design and implementation of the various components and the overall system. They reviewed results to date for the project and discussed data integration with the Nevada Data Exchange.

Figure 87: Rodney Schilling (l) and Jim Whalen (r), Nevada Department of Transportation

Connected Vehicle CRADA Partnership

Bob Koeberlein, Ira Pray, Idaho Transportation Department, Idaho National Laboratory

Ira Pray and Bob Koeberlein. Bob Koeberlein, Headquarters Operations Engineer for the Idaho Transportation Department (ITD), and Ira Pray, Fleet Manager for the Idaho National Laboratory (INL), collaborated to present their ongoing Cooperative Research And Development Agreement (CRADA) partnership for connected vehicles. The INL has installed mobile data collection sensors on five vehicles which patrol routes ahead of INL buses. These scouting vehicles record data such as atmospheric measurements, road surface conditions, and grip. This data is uploaded to the Vaisala Navigator website, where it can be easily viewed by INL and ITD management. The team gave some background on CRADA partnerships, DSRC, and the project's needs and objectives. Bob explained the various related RWIS installations along with the communications systems and basic data security. Ira provided details on the instrumented vehicles, data collection, challenges encountered, and how they are determining whether the project's goals are being met.

Figure 88: Ira Pray (l), Idaho National Laboratory, and Bob Koeberlein (r), Idaho Transportation Department

5.12. 2017 Western State Forum

Date, Location: June 20 – 22, 2017; Yreka, California

Technical Content

PPPoE Security on Networks Utilizing Ethernet Interfaces

Lonnie Hobbs, Jeremiah Pearce, Caltrans District 2

Though network security has become a significant issue in technology industries, it has been an afterthought at best in the transportation and industrial networking fields. Caltrans District 2 Office of ITS Engineering identified a commonly overlooked vulnerability and mitigated the problem using off the shelf hardware and configuration tools. ITS engineers Jeremiah Pearce and Lonnie Hobbs discussed the District 2 Field Element Network (FEN) and the Point-to-Point Protocol over Ethernet (PPPoE) link security protocol that has been implemented.

Figure 89: Jeremiah Pearce, Caltrans District 2

Figure 90: Lonnie Hobbs, Caltrans District 2

Installing DSRC Systems for Vehicle to Infrastructure Applications

Blaine Leonard, Utah Department of Transportation

The Federal government has recently begun rule-making to require vehicle-to-vehicle (V2V) communication systems on new light vehicles. These V2V systems will likely be Dedicated Short Range Communication (DSRC) radios in the 5.9GHz range. As infrastructure owners and operators, this opens up the opportunity for vehicle-to-infrastructure (V2I) systems, including a broad variety of safety, mobility, and data applications and improvements. Utah DOT Technology and Innovation Engineer, Blaine Leonard, started his presentation with an overview of connected vehicle systems and then explained their DSRC deployment near Salt Lake City. Blaine discussed location selection, software, hardware, installation and project costs. He then demonstrated the system and closed with a discussion about the challenges faced and recommendations based on lessons learned.

Figure 91: Blaine Leonard, Utah Department of Transportation

ITS Firmware for the Advanced Transportation Controller

Doug Spencer, Oregon Department of Transportation

Over the years, ODOT's ITS Unit has developed custom systems to support a variety of roadside applications such as road and weather information systems (RWIS), high wind warning systems, ice warning systems, speed/curve warning systems, overlength and over height warning systems, and remotely controlled interstate gates. These systems were developed with a variety of hardware and software making them difficult to support over time as products and the agency's IT environment changed. After adoption of the Advanced Transportation Controller (ATC), ODOT worked with the ATC vendor to develop firmware that allows the user to customize one application to support a variety of ITS systems. ODOT ITS Standards Engineer, Doug Spencer, provided some background on the project including a review of key points from several previous Forum presentations related to the ATC and custom ITS applications. He reviewed the various needs for the ITS firmware, uses of the ATC, and the many different sensors and devices that can be operated in a standardized way utilizing the ATC and the controller's application programming interface (API).

Figure 92: Doug Spencer, Oregon Department of Transportation

An Iterative Approach to Intelligent Traffic Systems Asset Management

Jim Whalen, Nevada Department of Transportation

To manage the asset life cycles more effectively of more than 2000 pieces of network-connected ITS field equipment, the Nevada DOT deployed a GIS-based, mobile asset management system. NDOT Technology Manager, Jim Whalen, first reviewed the need for the project and then explained the steps taken to assess what equipment was deployed where, and what information needed to be collected relative to the various assets. He described how NDOT configured activity-based workflows to tie service requests and work orders to these assets using internet-connected and disconnected mobile platforms. Jim demonstrated the various features of the system and discussed how NDOT is using the information to better manage traffic system assets.

Figure 93: Jim Whalen, Nevada Department of Transportation

WeatherShare Phase 4

Doug Galarus, Western Transportation Institute

Now in its fourth phase, this multi-phase research project is aimed at combining functionality of WeatherShare, SCAN Web™ and SCAN Sentry™ into a single, open system. In this phase, the project team has continued work on the retrieval, storage and presentation mechanisms, developed alerting and user profile mechanisms for the system, and worked with Caltrans to test and evaluate the system during the bad weather season. WTI Principal Investigator, Doug Galarus, reviewed the history of the project and the need that led to this fourth phase. He discussed the concept, requirements, design and implementation of the system, including some example use cases. Doug walked through the various features of the system, as well as the administrative functionality and technical details related to implementation.

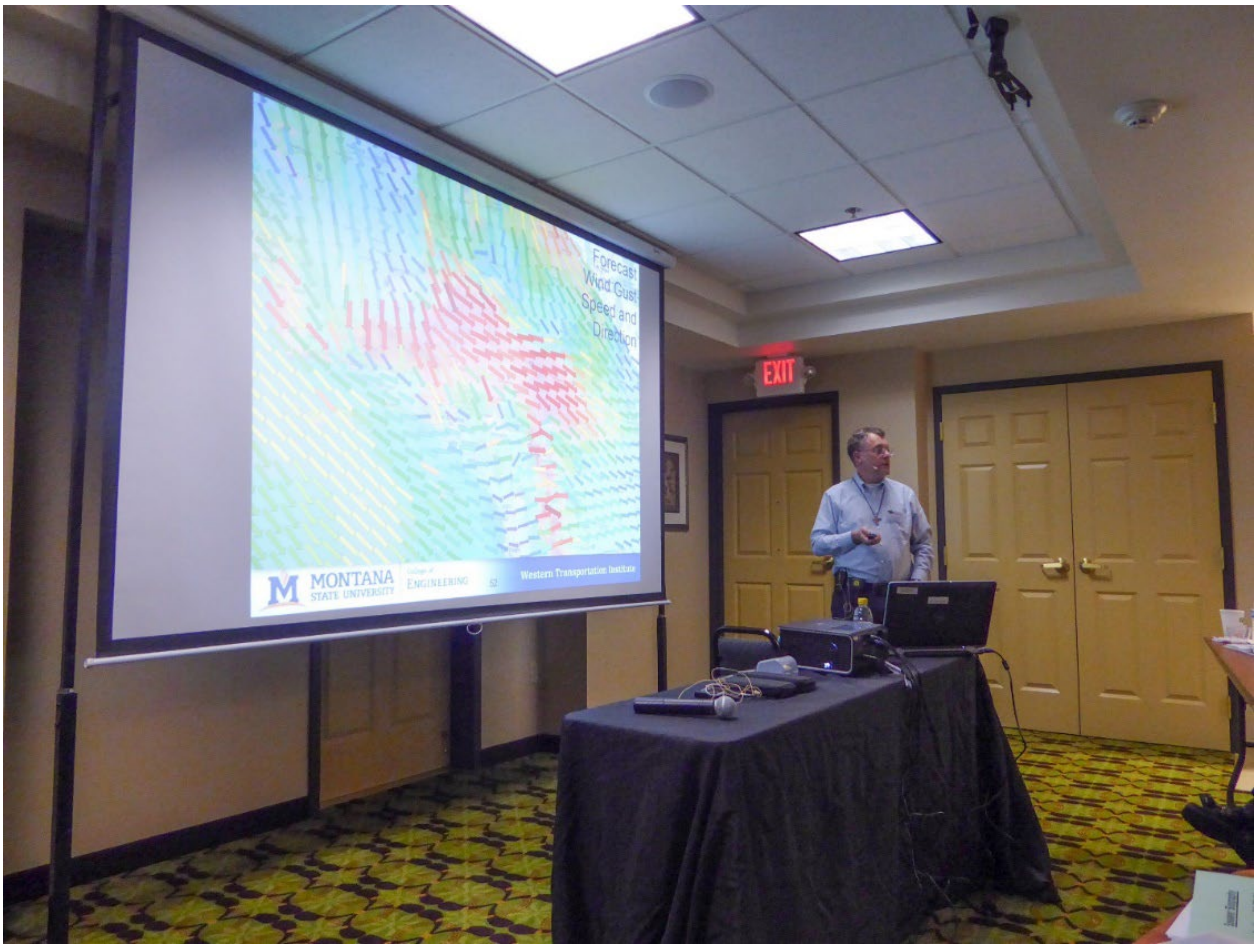

Figure 94: Doug Galarus, Western Transportation Institute

UDOT Automated Traffic Signal Performance Measures

Jamie Mackey, Utah Department of Transportation

Automated signal performance metrics show real-time and historical functionality at signalized intersections. Accurate decision-making about signal performance and timing helps signal management personnel identify vehicle and pedestrian detector malfunctions. This cost-effective solution also measures vehicle delay and the volume, speeds and travel time of vehicles. Utah DOT's Statewide Signal Engineer, Jamie Mackey, described how UDOT has used these metrics to detect operational deficiencies, optimize mobility, and manage signal timing and maintenance. She discussed the hardware requirements, described the system and its features, demonstrated the UDOT system, and explained how other agencies can acquire and use the software.

Figure 95: Jamie Mackey, Utah Department of Transportation

Relating Naturalistic Global Positioning System (GPS) Driving Data with Long-Term Safety Performance of Roadways

Dr. Anurag Pande, Stephen Lakowske, Cal Poly, San Luis Obispo

Traffic safety analysis generally relies on historical traffic crashes to identify hazardous roadway locations. This data is collected over long periods of time. However, recent research efforts are seeking to define better and more efficient methods for identifying such locations, including the use of naturalistic driving studies and identification of near crashes or crash surrogates. In this presentation, Dr. Anurag Pande and Stephen Lakowske from Cal Poly, San Luis Obispo, described their research study that is utilizing naturalistic GPS driving data.

Figure 96: Dr. Anurag Pande, Cal Poly, San Luis Obispo

Figure 97: Stephen Lakowske, Cal Poly, San Luis Obispo

Radar Technology for Distinguishing Between Bicycles and Cars

Martha Styer, John Slonaker, Caltrans Headquarters, Traffic Operations

California vehicle law 21450.5 mandates that new/upgraded traffic actuated signals must detect bicycles and motorcycles. Continuing the work presented at the 2013 Western States Forum, Caltrans has been testing a microwave radar detector that can distinguish between bicycles and cars or trucks. Martha Styer, Caltrans Senior Transportation Electrical Engineer, described the project and testing being done with the radar detectors. She shared the results of studies in West Sacramento and Huntington Beach including lessons learned. She also discussed the C1 traffic detector reader and analyzer which is an inexpensive tool developed by Caltrans to diagnose and troubleshoot vehicle detector problems. John Slonaker, also a Senior Transportation Electrical Engineer, showed the C1 reader and its components and demonstrated the VideoSync software used for this project.

Figure 98: John Slonaker, Caltrans Headquarters, Traffic Operations

Figure 99: Martha Styer, Caltrans Headquarters, Traffic Operations

5.13. 2018 Western State Forum

Date, Location: June 19 – 21, 2018; Yreka, California

Technical Content

Cellular Communications in Rural Applications

Keith Koeppen, P.E., Caltrans District 2

Wireless cellular communications technology has become a suitable candidate to replace circuit-switched networks for backhauling field telemetry data. However, successfully deploying reliable cellular backhauls in rural areas can be challenging because cellular sites are often sparse. Over the last few years, Caltrans District 2 has deployed fourteen cellular field sites to test system reliability and deployment strategies. ITS engineer Keith Koeppen provided background on the project and discussed current and future challenges, system needs/requirements, and potential solutions. He then detailed District 2's experience deploying the cellular test sites, discussing practical tools, installation techniques, configurations, network topologies, risks, and carrier diversification.

Figure 100: Keith Koeppen, Caltrans District 2

DWR Hydrology Data Acquisition System (HyDAS)

Bryan Prestel, California Department of Water Resources

There is a growing need for climate data for many purposes, including water and road management. Bryan Prestel from the California Department of Water Resources reviewed the data needs for hydrology and flood operations, the mission and purpose of his program, how the DWR systems are similar to roadside weather stations, and where the paths for public safety intersect. He discussed the current network infrastructure in context with the challenges of remote locations and what was needed for future integration. Bryan showed the current station design and explained what instrumentation is being used, why this equipment was chosen, and the associated advantages. He described in detail the DCP enclosure, software setup and design, and calibration methods used, given the challenges in accessing the remote sites.

Figure 101: Bryan Prestel, California Department of Water Resources

Active Traffic Management

Blaine Van Dyke, P.E., Michael Burkart, Oregon Department of Transportation

Design Engineer Blaine Van Dyke and ITS Systems Operator Michael Burkart from the Oregon Department of Transportation gave an in-depth review of the applications that make up ODOT's statewide Active Traffic Management System. They discussed how the system generates automated messages to warn of dangerous conditions and provide direction on how to safely navigate those conditions. Blaine and Michael also explained system override options and law enforcement coordination. The automated messages include regulatory and advisory variable speed limits, curve warning, lane and ramp congestion warning, and hazardous weather warning.

Figure 102: Blaine Van Dyke, Oregon Department of Transportation

Figure 103: Michael Burkart, Oregon Department of Transportation

From AWOS/RWIS to Caltrans Aviation Weather Information (AWI)

Douglas Galarus*, Melissa Clark, Derek Kantar, WTI/MSU, USU, Caltrans

*Speaker

Starting in 2008, the Western Transportation Institute (WTI) at Montana State University (MSU) has conducted a research and development study of a proof-of-concept system for integrating Automated Weather Observing System (AWOS) with Roadside Weather Information System (RWIS). This multi-phase project targets small, underserved rural airfields and hospital heliports. The goal is to provide airport managers, air traffic controllers, pilots, and related operators of air ambulance services with more comprehensive and accurate meteorological data by integrating currently used weather systems with systems used by related agencies. Doug summarized the work conducted in the three phases of this project and showed the various features of the website application's functionality. He then explained how the project is culminating with the migration of the system from research and development at MSU to long-term implementation within Caltrans.

Figure 104: Douglas Galarus, Western Transportation Institute

Managing Winter Maintenance Costs and Increasing Safety through an Advanced Weather Visualization Platform

Ira Pray*, Robert Koeberlein, Sarah Lightbody*, Zachary Spielman, Scott Wold, Idaho National Laboratory, Idaho Transportation Department, IBM

*Speakers

As a demonstration in Idaho, the Idaho National Laboratory (INL), the Idaho Transportation Department (ITD), and IBM developed an Advanced Traffic and Weather Visualization Platform to help INL address the transit challenges in and around site facilities. INL Fleet and Maintenance Manager Ira Pray and IBM Senior Consultant Sarah Lightbody provided background on the project and described the RWIS sites and other data sources currently supporting the INL system. They discussed how the model predicts route travel time and road conditions, probability of road closures, and travel measures like the snow drift index and the black ice index. Ira and Sarah demonstrated the model's utility and described anticipated future enhancements to the system.

Figure 105: Ira Pray, Idaho National Laboratory

Figure 106: Sarah Lightbody, IBM

UDOT's Snow and Ice Performance Measure

Jeff Williams, Cody Oppermann, Utah Department of Transportation

In cooperation with Utah DOT Central Maintenance, the UDOT Weather Operations Group developed the Snow and Ice Performance Measure (S&I PM) with the goals of objectively evaluating the success of clearing roads during winter storms and efficiently managing winter maintenance resources. UDOT's Weather Operations RWIS Manager Jeff Williams and Research Meteorologist / RWIS Coordinator Cody Oppermann discussed what the S&I PM is and how it was developed. The team explained in detail how the measure is used with various real storm conditions and described some of the hardware and software that make up UDOT's road weather network. Jeff and Cody also discussed challenges and future improvements for the system.

Figure 107: Jeff Williams, Utah Department of Transportation

Figure 108: Cody Oppermann, Utah Department of Transportation

ITS, Signals, Signage, and Sign Structures Condition Rating Dashboard

Doug Spencer, P.E., Oregon Department of Transportation

Maintenance and replacement of roadside assets for Oregon DOT Operations have not kept pace with the increasing number of devices in the field. Operations did not have a condition rating that would help make the case for additional funding or how best to spend the funding that was obligated. To address this, ODOT developed an asset condition rating dashboard that shows the condition rating of ITS, signage, signals and structures. ITS Standards Engineer Doug Spencer provided background on the project and elaborated on the need for the tool. He showed in detail the various features of the dashboard and how ODOT is using it to make informed decisions about asset maintenance, replacement, and funding.

Figure 109: Doug Spencer, Oregon Department of Transportation

Mobile Device App for Maintaining CMS Field Elements

Stephen M. Donecker, UC Davis

With several hundred changeable message signs (CMS), Caltrans needs diagnostic tools that are handheld, quick, inexpensive, and straightforward for maintenance staff. The University of California Davis AHMCT Research Center is working with Caltrans DRISI to develop an app that can be used with mobile devices as a solution to these needs. Stephen Donecker, a researcher with AHMCT, described the system design that uses mobile devices, wireless interfaces, and an app for field element communications. He started by reviewing the CMS system architecture, protocols, and configurations for representative Caltrans districts. He then discussed details of the overall system architecture, software architecture, and implementation including source code, design considerations, solutions, and challenges.

Figure 110: Stephen M. Donecker, AHMCT at UC Davis

Adapting an Advanced Traffic Management System for Rural Deployment

Ansley Skillern, Amit Misra, Southwest Research Institute

Amit Misra and AJ Skillern from the Southwest Research Institute (SwRI) discussed their work to adapt urban ATMS systems for use in rural settings, specifically the New England states of Maine, New Hampshire, and Vermont. The team reviewed other SwRI ATMS systems and described the various features that were merged to create the New England Compass system. They discussed how the New England Compass system mitigates the challenges of limited staffing, limited infrastructure, and limited collection and provision of weather data. Finally, they demonstrated the features and functionality of the system.

Figure 111: Ansley Skillern (l) and Amit Misra (r), Southwest Research Institute

5.14. 2019 Western State Forum

Date, Location: June 18 – 20, 2019; Yreka, California

Technical Content

Organic vs. Purchased Data for Travel Time Predictions

Andres Chavez, Caltrans District 3

Caltrans District 3 has used several different data sources for calculating travel times. Data has been collected from their own sources such as single and dual loops, radar, Bluetooth, and WiFi. They've also used two external sources – Waze and HERE. Transportation electrical engineer Andres Chavez reviewed how District 3's travel time data sources have moved from loops, to Bluetooth, to Waze and HERE data. He presented pros and cons for the various sources and technical details on how the data was acquired and utilized. He examined the South Lake Tahoe Case Study and concluded with a frank discussion on next steps.

Figure 112: Andres Chavez, Caltrans District 3

UDOT's Region Four Rural Intersection Conflict Warning Systems (RICWS) Design and Implementation

Troy C. Torgersen, P.E., Robert Dowell, P.E., Tyler Turner, P.E., Utah Department of Transportation, Civil Science

In an effort to reduce the number of serious crashes at rural intersections, Utah DOT's Region Four, which is mostly rural, began researching the state of the practice for rural intersection safety. The results ultimately guided the design and deployment of three Rural Intersection Conflict Warning Systems (RICWS). In this presentation, UDOT's Troy Torgersen and Robert Dowell, and Tyler Turner from Civil Science, reviewed the locations of the systems and why they were chosen, then discussed warrants and guidelines including scenarios, sign type and placement, messages, detection type, power supplies, and system monitoring, communications, and data management. They provided details on site planning, equipment, system installation, and operations. They concluded by sharing lessons learned through the development and deployment of the various systems.

Figure 113: Robert Dowell, Troy Torgersen and Tyler Turner, Utah DOT

Design, Development, and Field-Testing of the Caltrans Responder System

Stephen Donecker, Melissa Clark, AHMCT UC Davis; Caltrans Division of Research, Innovation, and System Information

Caltrans maintenance staff respond to incidents on state roadways and collect information, determine appropriate responses, and access and manage resources on the scene. The Caltrans Responder System was designed and developed as a more efficient and effective means to collect and share at-scene incident information with TMCs and emergency responders. The comprehensive tool allows incident responders to communicate photos, drawings, road/weather information, and maps, during an active incident via cellular, satellite, or other communications. UC Davis researcher Stephen Donecker, and Caltrans DRISI project manager Melissa Clark, started with some history and rationale for the system, and then discussed system architecture, hardware, and software. They discussed implementation, design considerations and solutions, and what did and didn't work. Stephen demonstrated the portable system during breaks and networking sessions.

Figure 114: Melissa Clark, Caltrans DRISI

Figure 115: Stephen Donecker, AHMCT at UC Davis

Foresight is 2020: NDOT Building an ITS Network for the Next Decade and Beyond

Jim Whalen, Gary Molnar, Mark Aragon, Nevada Department of Transportation

Nevada DOT is looking towards the future and taking steps to ensure their ITS Network can accommodate new and emerging technologies; for example, advanced applications that gather and exchange information in real-time, traveler information, monitoring and security, or connected and autonomous vehicles. Jim, Gary, and Mark shared what they did to build their ITS Network for the future and lessons learned. The team discussed project planning, requirements definition, lifecycle needs and cost-benefits, logistics around a wholesale upgrade, resource requirements and allocation, equipment, and operational challenges and solutions. They shared details on the progress made in the last year and the tools they now have to successfully meet the demands of the future.

Figure 116: Jim Whalen, Mark Aragon and Gary Molnar, Nevada Department of Transportation

Fiber Optic Systems in Rural Areas: Building and Leveraging Fiber Systems

Lynne G. Yocom, Utah Department of Transportation

Utah DOT's Fiber Optics Manager Lynne Yocom shared UDOT's strategies for installing and accessing fiber optic systems in rural areas. The system they have put together through installation and trades with private telecommunication companies now allows UDOT to monitor and manage small pockets of traffic signals in rural towns, gather robust weather data to support plowing and maintenance operations, and install traffic cameras in areas with higher numbers of crashes and/or weather incidents. Lynne provided some background and history behind the work being done, discussed basic information on fiber optics systems, including typical installation and costs, and showed the growth and extent of UDOT's fiber network. She then focused on how the trade agreements are structured and reviewed the details for several examples from Utah.

Figure 117: Lynne Yocom, Utah Department of Transportation

ODOT Connected Vehicle Applications

Julie Kentosh, P.E., PTOE, Doug Spencer, P.E., Oregon Department of Transportation

Traffic Operations Engineer Julie Kentosh and ODOT's ITS Standards Engineer Doug Spencer teamed up to discuss ODOT's work with connected vehicle applications and the pilot project deployed in Salem. They started with a brief overview of connected vehicle concepts and industry interest, the AASHTO SPaT Challenge, and MAP data. They discussed how ODOT is testing sharing intersection data over the internet from a central connected vehicle (CV) server or through DSRC radios at the roadside via a local CV system. The CV configuration utility uses an integrative approach – Julie and Doug discussed how the system has one setup that is congruent with CV applications in addition to adaptive signal control and signal performance metrics. They showed the In-Car Reference App and reviewed how the MaxView Connected Vehicle application is being used. They concluded with an overview of the local connected vehicle pilot project and the related research questions, along with some of the other projects that are part of Oregon's Smart Mobility Network funding.

Figure 118: Julie Kentosh, Oregon Department of Transportation

Figure 119: Doug Spencer, Oregon Department of Transportation

Miovision Equipment for SPAT Challenge – Intended and Actual Outcomes

Ken Burt, Washington State Department of Transportation

Ken Burt, a signal operations engineer in Washington State DOT's Olympic Region, reviewed the region's experience with Miovision equipment and the AASHTO SPaT Challenge. Ken provided some history and background for the project, the vendor, equipment, and Olympic Region signal system, and how the test route was chosen. He briefly demonstrated some of the system's features and described how the system was used during a major incident. While Miovision chose not to follow through on the equipment and the SPaT Challenge, there were still several beneficial outcomes from the project. Ken discussed the various alerts that are now available to them, as well as the automated traffic signal performance measures (ATSPMs), and remote connections to signals over the Internet to cellular controlled controllers. He finished with a quick review of related projects in the other WSDOT regions.

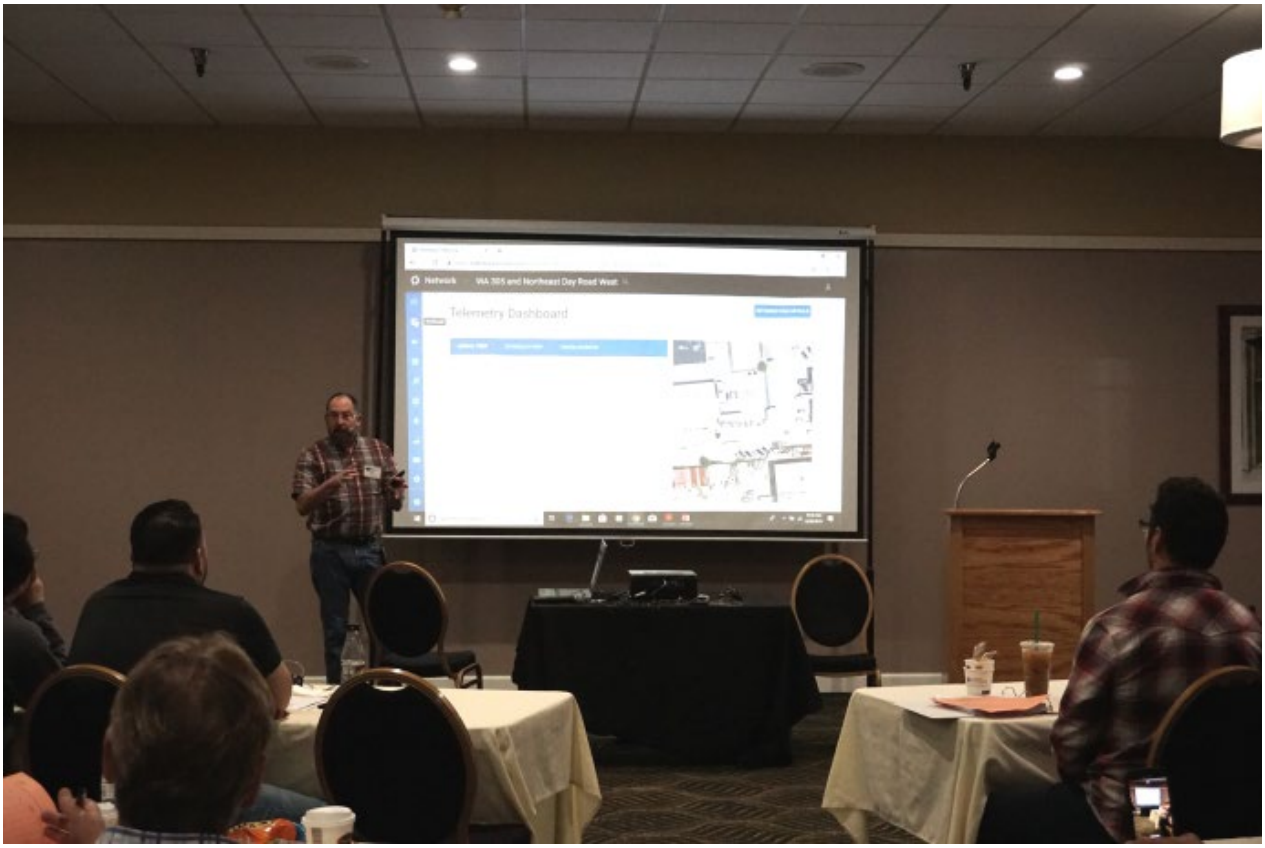

Figure 120: Ken Burt, Washington State Department of Transportation

The Maintenance Decision Support System (MDSS)

Michael J. Adams, Wisconsin Department of Transportation

Upon suggestion from a regular Forum attendee, Michael Adams, the Road Weather Program Manager from the Wisconsin DOT presented the Maintenance Decision Support System (MDSS). Michael started with an overview of the MDSS system, what it is, and what it is used for, along with some history of how the system was first developed and has since evolved. He discussed how the system's output is used by management, field supervisors, and snowplow drivers to enhance winter operations. Michael reviewed the components of the system including weather and pavement forecasts, treatment recommendations, and management tools that allow route-by-route post-storm analysis and the ability to save storm data for future training. A brief demonstration of the system was included.

Figure 121: Michael Adams, Wisconsin Department of Transportation

5.15. 2020 Western State Forum

Scheduled Date, Location: June 16 – 18, 2020; Yreka, California

Not held due to COVID-19 restrictions.

5.16. 2021 Western State Forum

Date, Location: October 5 – 7, 2021; Yreka, California

Technical Content

ASWSC Phase 3: Migration of the Automated Safety Warning System Controller to the Caltrans Advanced Transportation Controller Platform

Douglas Galarus, Montana Tech; Jeremiah Pearce, Jeff Worthington, Caltrans District 2

The Automated Safety Warning System Controller (ASWSC) was developed through a multi-phased research and development effort by Caltrans and the Western States Rural Transportation Consortium (WSRTC). The ASWSC interfaces with roadside sensors and signs to actuate safety warning messages. It makes real-time activation of warning messages and signals possible with automated data collection and application of best practice algorithms to analyze sensor data. Jeremiah Pearce and Jeff Worthington from Caltrans District 2, and Doug Galarus from Montana Tech, discussed the project in detail from early development through current deployment on the Caltrans Advanced Transportation Controller. Jeremiah started with the need and background for the project and Doug discussed the Phase 1 and 2 development work. Jeremiah then discussed the initial bench testing and the Spring Garden deployment. Doug followed up with details on the Phase 3 development and Jeff reviewed the testing and deployment of the system - including what worked, challenges and problems, and solutions. The three closed with a quick review of the current system status and planned next steps.

Figure 122: Jeremiah Pearce (left) and Jeff Worthington (center), Caltrans District 2; Doug Galarus (right), Montana Tech

A Cost-Effective Solution for Truck Parking Based on Artificial Intelligence

Hao (Frank) Yang*, Wei Sun, Yinhai Wang – University of Washington STAR Lab; Karthik Murthy*, Matt Neeley – Washington State DOT

*Speakers

Karthik Murthy from the Washington State DOT and Hao Yang from the University of Washington presented their work developing and installing a Truck Parking Information and Management System (TPIMS). The system uses detection technology to collect parking occupancy data and feeds it to a neural network that utilizes a parking pattern aggregation / similarity analysis to predict parking space availability at various time intervals in the future. The space availability information is then disseminated to the public through a web/phone application. This presentation reviewed the need for the project, the system details, how the pattern analysis and availability prediction work, test findings, and next steps toward statewide deployment.

Figure 123: Karthik Murthy, Washington State Department of Transportation

Figure 124: Hao (Frank) Yang, University of Washington

Deterrence and Detection of Wrong-Way Drivers on California Highways

John Slonaker, Caltrans Division of Research, Innovation, and System Information

Caltrans has been assessing the extent of wrong way driving in California and evaluating technologies and strategies with the potential to reduce it. John Slonaker from Caltrans' Division of Research, Innovation, and System Information, discussed several roadway enhancements that have been installed to warn drivers and notify authorities when vehicles enter off ramps from the wrong direction. These include additional two-way, red/clear retroreflective pavement markers, enlarged and additional DO NOT ENTER/WRONG WAY signs, red LED in-pavement lighting across limit lines, and active monitoring systems with dual radars to detect wrong way drivers and activate local red flashing LEDs bordering separate DO NOT ENTER/WRONG WAY signs. John also reviewed the results of the accompanying research project that studied the effectiveness of the enhancements using custom designed machine vision-based site monitoring systems.

Figure 125: John Slonaker, Caltrans DRISI

Field Site Power Data Acquisition and System Reporting

Kenneth Shipley, Caltrans District 2

Utility power in rural Northern California has been known to be unreliable during inclement weather. To mitigate the effects of power interruptions on sensitive communication electronics, Caltrans District 2 has installed battery back-up systems at each CCTV site. They have since developed a data acquisition relay that polls a site's uninterruptable power system's (UPS) status and presents the information on a graphical user interface. Caltrans District 2 ITS Engineer Kenneth Shipley presented the need of a UPS for ITS elements in rural areas, design decisions, design architecture, implementation, back and front-end code, and system data flow. He discussed how the field site power data relay has been integrated into the District's ITS workflow and concluded with lessons learned.

Figure 126: Kenneth Shipley, Caltrans District 2

Innovative Uses of Unmanned Aerial Vehicle (UAV) Technology

Tony Leingang, Washington State DOT
Alyssa Ryan, University of Massachusetts Amherst

Washington State DOT's Tony Leingang teamed up with Alyssa Ryan from the University of Massachusetts Amherst for a presentation that aimed to provide Forum attendees with an understanding of how they can leverage Unmanned Aerial Vehicle (UAV) technology in transportation applications. Alyssa gave a comprehensive overview of drone operations for transportation data collection purposes, including federal laws, common drone types, licensure requirements, weather considerations, and learned best practices. Tony described the UAV programs that WSDOT and their partners at the Washington State Patrol have developed to take advantage of the efficiencies and benefits this technology can provide. He explained multiple use cases for the technology in both agencies, providing details on the equipment, software, and processes employed. Tony showed the UAV that WSDOT uses and demonstrated how they interact with the Drone Deploy cloud service to produce accurate and repeatable 2D/3D photogrammetric products that save time, exposure, and money for the agencies. Alyssa concluded the presentation with a demonstration of the set-up and start of a UAV flight.

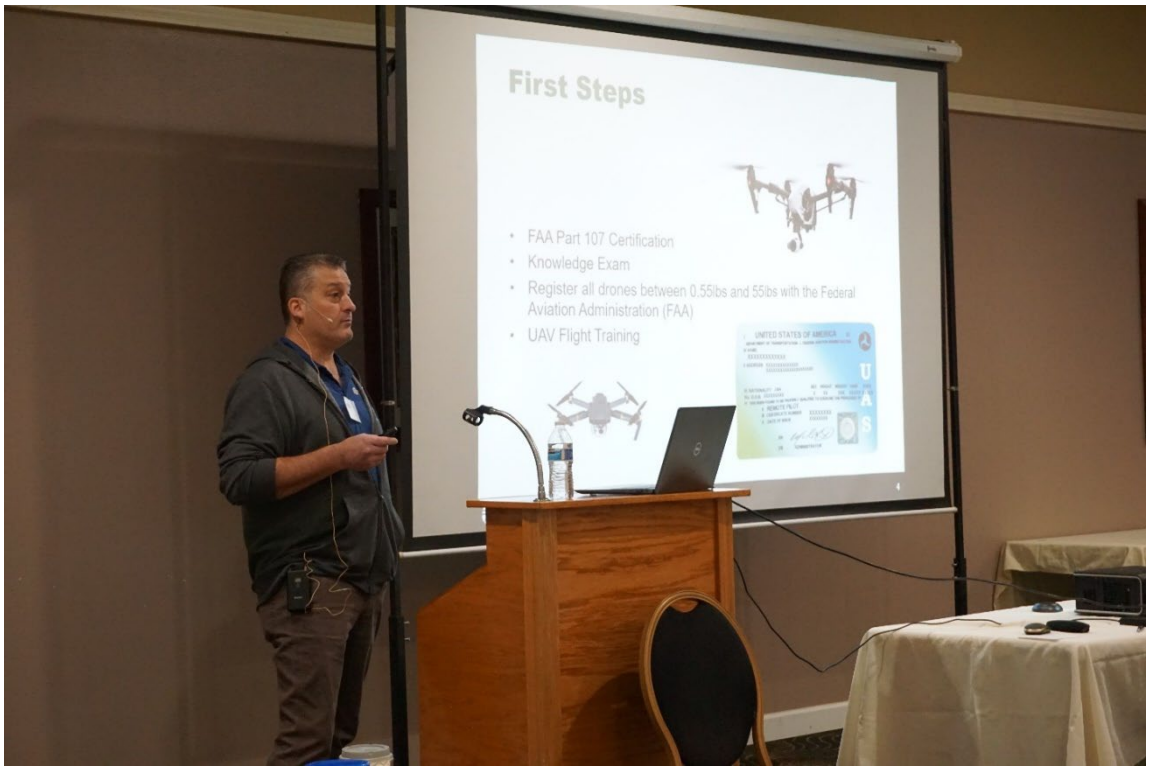

Figure 127: Tony Leingang, Washington State Department of Transportation

Figure 128: Alyssa Ryan, University of Massachusetts Amherst

UDOT's Statewide Wrong-Way Detection Project

Troy Torgersen, Utah Department of Transportation
Brad Lucas, Lochner

Wrong-way driving crashes tend to be more severe than other types of crashes. Considering the safety related issues associated with wrong-way driving incidents, Utah DOT designed and deployed a project in a proactive effort to reduce the number of potential wrong-way driving incidents statewide. In this presentation, Troy Torgersen from Utah DOT Region 4 along with Brad Lucas from Lochner reviewed the project goals, the locations and site details, type of technologies and equipment used, installation, and lessons learned.

Figure 129: Brad Lucas (l), Lochner, Troy Torgerson (r), Utah Department of Transportation

Wrong Way Driver Systems: Technological Solutions for Behavioral Problems

Frederick (Rick) Tydeman, Nevada Department of Transportation

Wrong way driving is a behavioral problem that presents an opportunity for an ITS based technological solution, according to Nevada DOT's Rick Tydeman, as he presented Nevada's approach to reducing wrong-way driving incidents. Rick began with some background on wrong-way driving incidents and current mitigation measures. He then described current NDOT experimentation efforts including red RRFB (Rectangular Rapid Flash Beacon) augmentation and sign height variation, detailing system design and specifications, system integration, and testing locations. Rick reviewed Nevada DOT's wrong-way driver warning system evaluation project with details on the various criteria (detection, activation, validation, notification, etc.), results of the evaluation, updated system specifications, and conclusions / next steps.

Figure 130: Frederick (Rick) Tydeman, Nevada Department of Transportation

5.17. 2022 Western State Forum

Date, Location: June 14 – 16, 2022; Yreka, California

Technical Content

Controlled Helter-Skelter: A Tale of Chain Controls and Traffic Queuing

Keith Koeppen, Caltrans District 2

Interstate 5 is a major north-south freight corridor. In northern California, it is often impacted by winter operational and safety issues such as low visibility, severe weather, icy roadways, road closures, plowing operations, and chain conditions. When winter restrictions are in place for screening and/or passenger and freight vehicle restrictions through the corridor, significant and unorganized traffic queuing for several miles often results. To enhance worker safety, manage throughput, and reduce queuing while screening and restrictions are in effect, District 2 Office of ITS Engineering and Support collaborated with maintenance and operations to develop a system that would allow maintenance and operations to manage the corridor more efficiently using a system with changeable message signs (CMS), blank out signs (BOS), and Lane Control signs (LCS). Keith provided background on the problems and solutions and discussed project development. He reviewed challenges encountered with a design by committee approach, integration of the project into existing central systems, network and physical architecture, and operation of the system.

Figure 131: Keith Koeppen, Caltrans District 2

UDOT's Region Four Variable Speed Limit (VSL) I-15 Corridor in Rural Utah

Troy C. Torgersen, Utah Department of Transportation

To set the stage for the current VSL project along the I-15 corridor, Region 4's ITS Project Manager Troy Torgersen provided some background, history and lessons learned from the Variable Speed Limit system deployed in the Salt Lake area along Interstate 80. He then discussed the process of designing and implementing a VSL algorithm for the project. He detailed the equipment necessary for a fully autonomous VSL system and how it was designed and implemented. He reviewed system construction and concluded with lessons learned for materials, construction, and site and equipment placement.

Figure 132: Troy Torgersen, Utah Department of Transportation

Evaluation of Road Weather Messages on DMS Using Roadside Pavement Sensors

Skylar Knickerbocker and Zach Hans, Iowa State University

Winter weather and its corresponding surface conditions impact the safety and mobility of thousands of motorists annually. Highway agencies spend millions of dollars in resources and personnel in an effort to ensure safe and efficient travel. One such strategy is to use dynamic message signs (DMS) that have been deployed to alert drivers of conditions ahead based on data from roadside sensors. An Iowa State Research Engineer, Skylar Knickerbocker, described one such system deployed by the Minnesota DOT. Skylar discussed his project that analyzed driver behavior when advisory messages triggered by pavement sensors were displayed on DMSs. He reviewed the methodology and data analysis employed and discussed the results of the analysis. Skylar concluded with potential benefits demonstrated by the system and possible next steps based on the study's results.

Figure 133: Skylar Knickerbocker, Iowa State University

The Nevada TSMO Program – A Modern Approach to Solving Old Problems

LaShonn Ford, Nevada Department of Transportation

This presentation discussed Nevada's efforts to shift its approach for addressing traditional challenges away from capacity building projects to an increased focus on systems management and operations, a strategy known as Transportation Systems Management and Operations, or TSMO. Mr. Ford gave a brief introduction to TSMO, what it is and what specific strategies could be implemented. He then explained where NDOT started with the process, its progress to date, goals, example projects, and next steps. He concluded by sharing some of the challenges faced, NDOT solutions to those challenges, and the lessons learned.

Figure 134: LaShonn Ford, Nevada Department of Transportation

Next Generation Work Zone Data Integration and Dissemination – Work Zone Data Exchange (WZDx) Development from Planning to Operations

Justin Belk and Joshua Hudson, Washington State Department of Transportation

Washington State DOT is proactively developing and integrating a work zone database with increasingly automated confirmation of traffic impacting events as they go live. Justin and Joshua started with a big picture overview of the smart work zone efforts, scope, and goals for the system. They discussed WSDOT work zone deployments and associated data efforts including the WZDx Demonstration Grant in partnership with the North/West Passage Pooled fund. The team discussed experiences integrating third-party devices and schema, and their efforts to deliver an open standard format product for any state to use in a work zone feed. The pair demonstrated the features of the work zone data base as well as a Pi-Lit set-up populating the work zone data feed. They concluded with a review of lessons learned.

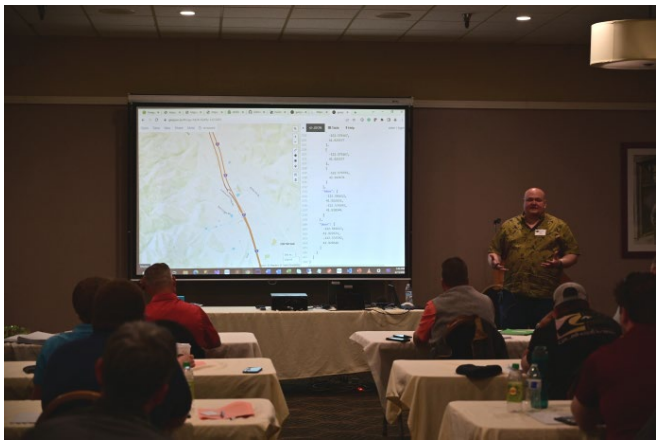

Figure 135: Joshua Hudson, Washington State Department of Transportation

Figure 136: Justin Belk, Washington State Department of Transportation

UDOT's Region Four Conflict Warning System Phase 2

Troy C. Torgersen, Utah Department of Transportation

At the 2019 Western States Forum, Utah DOT detailed the design and implementation of four Rural Intersection Conflict Warning Systems (RICWS) deployed in an effort to reduce the number of serious crashes at rural intersections. Recently tasked with focusing on implementing technology to reduce crashes on rural routes, UDOT Region 4 chose to work on a lower cost solution to the previously installed conflict warning systems. Troy first reviewed what was deployed with the first project. He then discussed the changes made to allow installation of equipment at ten intersections for the same cost of the four intersections covered in the previous project.

Figure 137: Troy Torgersen, Utah Department of Transportation

Commodity Traffic Cameras as Cost-Effective Alternative to Traditional Sensing Hardware

Dan Rossiter, Southwest Research Institute

While sensor deployments along roadways have expanded rapidly over the past decade, the dedicated sensing equipment historically required for real-time traffic pattern and weather condition insights remains too costly for widespread deployment. Mr. Rossiter discussed some of the recent advancements in machine learning and computer vision technology which have the potential to collect some of the real-time data without the need for dedicated sensing equipment. He discussed how agencies could leverage existing traffic cameras, which tend to be relatively cheap and widely deployed, and combine the technology with software able to observe video feeds in real time to get many of the benefits of dedicated sensing equipment without deploying any new field hardware.

Figure 138: Dan Rossiter, Southwest Research Institute

Traffic Monitoring Using Fiber Optic Sensing

Eric MacGill and Jeffrey Bickett, Nevada Department of Transportation

Distributed acoustic sensing is an exciting technology that is using spare or unused fiber optic cable along a roadway to detect traffic. Sensors and associated algorithms capture vehicle noise and vibrations to predict traffic flow indicators such as average speeds and traffic queueing. Eric and Jeff explained how the technology works and then went into detail on their current pilot project along a challenging 25-mile section of I-15 and I-95 in Las Vegas. They concluded with their initial findings from the project – pros, cons, and additional considerations for future deployments throughout the state.

Figure 139: Jefferey Bickett and Eric MacGill, Nevada Department of Transportation

6. APPENDIX B – TASK ORDER SUMMARIES

6.1. WTI Task Order 1 – WSRTC Meeting Coordination and Website Maintenance

Executive Summary

- Coordination of meetings and maintenance of the website for WSRTC.

Duration

- June 1, 2011 – March 31, 2012

Websites

- http://westernstates.org/
- http://westernstates.org/Documents/Default.html
- http://www.westernstatesforum.org/

Research Organization

- Western Transportation Institute at Montana State University

WTI Project Team

- Douglas Galarus - Primary Investigator, Program Manager, Systems Engineering, Development and Integration

Work Plan

- Task 1: Project Management
  - This task covers activities related to project management, including teleconferences as needed to keep the sponsor project manager and the project technical panel apprised of current progress.
- Task 2: Meeting Planning and Coordination
  - This task will focus on the coordination of meetings for members of the WSRTC. The project shall cover travel expenses, lodging and associated registration fees for participants for these meetings.
  - The primary responsibilities of the project team on this task are:
    - Coordination of meeting facility and related arrangements.
    - Communication of meeting logistics and associated guidelines for travel and lodging.
    - Coordination of travel reimbursement for participants.
  - Three meetings are planned during the performance period:

        - Steering Committee Meeting, to be held in conjunction with the Western States Rural Transportation Technology Implementers Forum in Yreka, California on June 14-16, 2011.
        - Steering Committee Meeting, to be held in conjunction with the National Rural Intelligent Transportation Systems (NRITS) Annual Conference in Coeur d'Alene, Idaho on August 28-31, 2011.
        - Steering Committee Meeting, to be held in Yreka, California on November 9-10, 2011.
- Task 3: Website Content and Maintenance
    - This task includes the maintenance and support of a sustained, publicly available web presence for the Consortium over its duration. This will include the staffing necessary to actively manage regular updates of the Consortium's status and make this information available on the web. The website shall contain all relevant information about the Consortium, including its history, goals, status, timeline, milestones, photo library, current activities, documents and a brief profile of the people and organizations involved. Updates will be made to the website to coincide with meetings, both prior to and after meetings, and to include meeting minutes.

6.2. WTI Task Order 2 - Rural Traveler Information (One-Stop Shop) Phase 2

Executive Summary

- The second phase in a multi-phase research project aimed at developing a one-stop shop for rural traveler information. This phase investigates the expansion of a prototype information delivery mechanism throughout the western states region consisting of California, Oregon, Washington and Nevada. The prototype delivery mechanism developed during Phase 1 of this project will be expanded beyond its present coverage area of the COATS region to provide rural traveler information for the entire region consisting of these four states. In subsequent phases of this research project, the delivery mechanism will be further developed and tested, leading to a field demonstration and evaluation.

Duration

- October 1, 2011 – June 30, 2016

Websites

- http://westernstates.org/Projects/OSS/Default.html
- https://oss.weathershare.org/

Research Organization

- Western Transportation Institute at Montana State University

WTI Project Team

- Douglas Galarus - Primary Investigator, Program Manager, Systems Engineering, Development and Integration

Problem Statement

- Real-time traveler information services have thrived in two primary contexts: urban-focused systems and statewide or regional systems. However, neither urban systems nor statewide/regional systems efficiently serve the rural traveler, whose trip may span a great distance between and/or through urban areas. In addition, these types of systems are typically designed to conform to specific jurisdictional lines, whereas rural trips typically span multiple jurisdictions. While many rural agencies and districts have sought to

provide traveler information, there is considerable variation in the level of information provided and how to access it.

- To address these challenges, this project proposes to continue the development a one-stop shop for rural traveler information. At a high level, this is a web-based platform that will provide route-specific, real-time, highway-based traveler information based on an origin–destination specified by the user.

Work Plan

- Task 1: Project Management
  - Keep the project manager and technical panel apprised of project progress.
- Task 2: Concept of Operations and Requirements Documents
  - Provides a high-level, user-oriented perspective on how the One-Stop Shop will work and translates the concept of operations into statements describing what the system shall do.
- Task 3: Review Best Practices and Technologies
  - Involves an examination of existing traveler information websites nationwide and review available technologies that may be employed in the One-Stop Shop.
- Task 4: Development and Coding
  - Creates the regionwide One-Stop Shop system.
- Task 5: Conduct Use and Usability Analysis
  - Examines the manner in which users interact with the website, including navigation paths and selection of information.
- Task 6: Investigate Needs for Expansion into Bordering States
  - Determine what is required to expand One-Stop Shop beyond the four-state region.
- Task 7: Survey of Users
  - Solicit feedback from DOT personnel and travelers who have visited the One-Stop Shop website regarding aspects such as its utility, potential improvements, etc.
- Task 8: Final Report
  - Includes print and electronic deliverables, describing the work completed in the project.

6.3. WTI Task Order 3 – WSRTC Meeting Coordination, Western States Forum Travel Support and Website Maintenance

Executive Summary

- Coordination of meetings and maintenance of the website for WSRTC.as well as support for the Western States Forum.

Duration

- April 1, 2012 – April 30, 2013

Websites

- http://westernstates.org/
- http://westernstates.org/Documents/Default.html
- http://www.westernstatesforum.org/

Research Organization

- Western Transportation Institute at Montana State University

WTI Project Team

- Douglas Galarus - Primary Investigator, Program Manager, Systems Engineering, Development and Integration
- David Veneziano - Research Scientist for the Safety and Operations Program
- Leann Koon - Research Associate for the Systems Engineering, Development and Integration Program

Work Plan

- Task 1: Project Management
  - This task covers activities related to project management, including teleconferences as needed to keep the sponsor project manager and the project technical panel apprised of current progress.
- Task 2: Meeting Planning and Coordination
  - This task will focus on the coordination of meetings for members of the WSRTC. The project shall cover travel expenses, lodging and associated registration fees for participants for these meetings.
  - The primary responsibilities of the project team on this task are:
    - Coordination of meeting facility and related arrangements.

        - Communication of meeting logistics and associated guidelines for travel and lodging.
        - Coordination of travel reimbursement for participants.
    - Three meetings are planned during the performance period:
        - Steering Committee Meeting, to be held in conjunction with the Western States Rural Transportation Technology Implementers Forum in Yreka, California on June 12-14, 2012.
        - Steering Committee Meeting, to be held in conjunction with the National Rural Intelligent Transportation Systems (NRITS) Annual Conference in Biloxi, Mississippi on September 16-19, 2012.
        - Steering Committee Meeting, to be held in Yreka, California in February, 2013.
- Task 3: Western States Forum Support
    - This task includes coverage of general expenses (facility use, catering, etc.) as well as travel support for participants in the 2012 Western States Forum in Yreka, California, on June 12-14, 2012 separate from that provided in Task 2 for WSRTC Steering Committee members.
- Task 4: Website Content and Maintenance
    - This task includes the maintenance and support of a sustained, publicly available web presence for the Consortium over its duration. This will include the staffing necessary to actively manage regular updates of the Consortium's status and make this information available on the web. The website shall contain all relevant information about the Consortium, including its history, goals, status, timeline, milestones, photo library, current activities, documents and a brief profile of the people and organizations involved. Updates will be made to the website to coincide with meetings, both prior to and after meetings, and to include meeting minutes.

6.4. WTI Task Order 4 – WSRTC Meeting Coordination, Western States Forum Travel Support and Website Maintenance

Executive Summary

- Coordination of meetings and maintenance of the website for WSRTC.as well as support for the Western States Forum.

Duration

- May 1, 2013 – October 31, 2014

Websites

- http://westernstates.org/
- http://westernstates.org/Documents/Default.html
- http://www.westernstatesforum.org/

Research Organization

- Western Transportation Institute at Montana State University

WTI Project Team

- Douglas Galarus - Primary Investigator, Program Manager, Systems Engineering, Development and Integration
- David Veneziano - Research Scientist for the Safety and Operations Program
- Leann Koon - Research Associate for the Systems Engineering, Development and Integration Program

Work Plan

- Task 1: Project Management
  - This task covers activities related to project management, including teleconferences as needed to keep the sponsor project manager and the project technical panel apprised of current progress.
- Task 2: Meeting Planning and Coordination
  - This task will focus on the coordination of meetings for members of the WSRTC. The project shall cover travel expenses, lodging and associated registration fees for participants for these meetings.
  - The primary responsibilities of the project team on this task are:
    - Coordination of meeting facility and related arrangements.

        - Communication of meeting logistics and associated guidelines for travel and lodging.
        - Coordination of travel reimbursement for participants.
    - Five meetings are planned during the performance period:
        - Steering Committee Meeting, to be held in conjunction with the Western States Rural Transportation Technology Implementers Forum in Yreka, California on June 18-20, 2013.
        - Steering Committee Meeting, to be held in conjunction with the National Rural Intelligent Transportation Systems (NRITS) Annual Conference in St. Cloud, Minnesota on August 25-28, 2013.
        - Steering Committee Meeting, to be held at the 2014 North West Transportation Conference, anticipated to occur in February, 2014 at a location in Oregon. (The last NWTC was held in Corvallis, OR). This meeting is optional and may alternatively occur via teleconference, depending on availability of funds.
        - Steering Committee Meeting, to be held in conjunction with the Western States Rural Transportation Technology Implementers Forum in Yreka, California in June 2014.
        - Steering Committee Meeting, to be held in conjunction with the 2014 National Rural Intelligent Transportation Systems (NRITS) Annual Conference, date and location to be determined. This meeting is optional and may alternatively occur via teleconference, depending on availability of funds.
- Task 3: Western States Forum Support
    - This task includes coverage of general expenses (facility use, catering, etc.) as well as travel support for participants in the 2013 Western States Forum in Yreka, California, on June 18-20, 2013 separate from that provided in Task 2 for WSRTC Steering Committee members, and for the 2014 Western States Forum in Yreka, California in June 2014.
- Task 4: Website Content and Maintenance
    - This task includes the maintenance and support of a sustained, publicly available web presence for the Consortium over its duration. This will include the staffing necessary to actively manage regular updates of the Consortium's status and make this information available on the web. The website shall contain all relevant information about the Consortium, including its history, goals, status, timeline, milestones, photo library, current activities, documents and a brief profile of the people and organizations involved. Updates will be made to the website to coincide with meetings, both prior to and after meetings, and to include meeting minutes.

6.5. WTI Task Order 5 – WSRTC Meeting Coordination, Western States Forum Travel Support and Website Maintenance

Executive Summary

- Coordination of meetings and maintenance of the website for WSRTC.as well as support for the Western States Forum.

Duration

- August 1, 2014 – June 30, 2016

Websites

- http://westernstates.org/
- http://westernstates.org/Documents/Default.html
- http://www.westernstatesforum.org/

Research Organization

- Western Transportation Institute at Montana State University

WTI Project Team

- Douglas Galarus - Primary Investigator, Program Manager, Systems Engineering, Development and Integration
- David Veneziano - Research Scientist for the Safety and Operations Program
- Leann Koon - Research Associate for the Systems Engineering, Development and Integration Program

Work Plan

- Task 1: Project Management
  - This task covers activities related to project management, including teleconferences as needed to keep the sponsor project manager and the project technical panel apprised of current progress.
- Task 2: Meeting Planning and Coordination
  - This task will focus on the coordination of meetings for members of the WSRTC. The project shall cover travel expenses, lodging and associated registration fees for participants for these meetings
  - The primary responsibilities of the project team on this task are:
    - Coordination of meeting facility and related arrangements.

        - Communication of meeting logistics and associated guidelines for travel and lodging.
        - Coordination of travel reimbursement for participants.
    - As many as six meetings are planned during the performance period, depending on subsequent remaining funding:
        - Steering Committee Meeting, to be held in conjunction with the 2014 National Rural Intelligent Transportation Systems (NRITS) Annual Conference, August 24-27, 2014, Branson, Missouri. This meeting may alternatively occur via teleconference or informally among attendees.
        - Steering Committee Meeting, to be held in sometime between November 2014 and February 2015. This meeting is optional and may alternatively occur via teleconference or may be deferred until the June 2015 meeting.
        - Steering Committee Meeting, to be held in conjunction with the Western States Rural Transportation Technology Implementers Forum in Yreka, California in June 2015.
        - Steering Committee Meeting, to be held in conjunction with the 2015 National Rural Intelligent Transportation Systems (NRITS) Annual Conference, date and location to be determined. This meeting is optional and may alternatively occur via teleconference and depends on availability of funds.
        - Steering Committee Meeting, to be held in November 2015 and February 2016. This meeting is optional and may alternatively occur via teleconference or may be deferred until the June 2016 meeting and depends on availability of funds.
        - Steering Committee Meeting, to be held in conjunction with the Western States Rural Transportation Technology Implementers Forum in Yreka, California in June 2016. This meeting depends on availability of funds.
- Task 3: Western States Forum Support
    - This task includes coverage of general expenses (facility use, catering, etc.) as well as travel support for participants in the 2015 Western States Forum in Yreka, California, in June 2015, separate from that provided in Task 2 for WSRTC Steering Committee members, and for the 2016 Western States Forum in Yreka, California in June 2016, depending on availability of remaining funds.
- Task 4: Website Content and Maintenance
    - This task includes the maintenance and support of a sustained, publicly available web presence for the Consortium over its duration. This will include the staffing necessary to actively manage regular updates of the Consortium's status and make this information available on the web. The website shall contain all relevant information about the Consortium, including its history, goals, status, timeline, milestones, photo library, current activities, documents and a brief profile of the people and organizations involved. Updates will be made to the website to coincide with meetings, both prior to and after meetings, and to include meeting minutes.

6.6. WTI Task Order 6 – Skipped

No task order was executed and named “Task Order 6”.

6.7. WTI Task Order 7 - WeatherShare Phase 4

Executive Summary

- This is the fourth phase in a multi-phase research project aimed at combining functionality of WeatherShare, SCAN Web™ and SCAN Sentry™ into a single, open system. This phase continues the research and development conducted previously to develop the system. Specifically, in this phase the project team will continue work on the retrieval, storage and presentation mechanisms, and will develop the alerting and user profile mechanisms for the system. The project team will work with Caltrans to test and evaluate the system during the bad weather season.

Duration

- March 1, 2016 – December 31, 2017

Websites

- http://westernstates.org/Projects/Weathershare/Default.html
- http://www.weathershare.org/

Research Organization

- Western Transportation Institute at Montana State University

WTI Project Team

- Douglas Galarus - Primary Investigator, Program Manager, Systems Engineering, Development and Integration
- Daniell Richter - Research Associate for the Systems Engineering, Development, and Integration Program

Problem Statement

- Caltrans currently uses the SCAN Web™ application to aggregate and present weather information from RWIS sites to maintenance and operations personnel. Other applications such as SCAN Sentry™ are used by individual districts to provide additional capabilities such as weather-based alerting. There is a desire to combine these functionalities into a single, open system. The purpose of this project is to further develop the capabilities of WeatherShare to include those of SCAN Web™, SCAN Sentry™, and other desirable but currently unavailable functionality into WeatherShare through further development of WeatherShare – Phase 4.

Work Plan

- Task 1: Project Management
  - Keep the project manager and technical panel apprised of project progress.
- Task 2: On-Going System Development
  - Continues development of the prototype system including implementation of alerts and user profiles.
- Task 3: System Testing and Evaluation
  - Includes measures of prototype system use, utility and performance.

6.8. WTI Task Order 8 – WSRTC Meeting Coordination, Western States Forum Travel Support and Website Maintenance

Executive Summary

- Coordination of meetings and maintenance of the website for WSRTC.as well as support for the Western States Forum.

Duration

- March 1, 2016 – February 28, 2017

Websites

- http://westernstates.org/
- http://westernstates.org/Documents/Default.html
- http://www.westernstatesforum.org/

Research Organization

- Western Transportation Institute at Montana State University

WTI Project Team

- Douglas Galarus - Primary Investigator, Program Manager, Systems Engineering, Development and Integration
- Leann Koon - Research Associate for the Systems Engineering, Development and Integration Program

Work Plan

- Task 1: Project Management
  - This task covers activities related to project management, including teleconferences as needed to keep the sponsor project manager and the project technical panel apprised of current progress.
- Task 2: Meeting Planning and Coordination
  - This task will focus on the coordination of meetings for members of the WSRTC. The project shall cover travel expenses, lodging and associated registration fees for participants for these meetings
  - The primary responsibilities of the project team on this task are:
    - Coordination of meeting facility and related arrangements.
    - Communication of meeting logistics and associated guidelines for travel and lodging.

        - Coordination of travel reimbursement for participants.
    - One meeting is planned during the performance period, with additional meetings depending on subsequent remaining funding:
        - Steering Committee Meeting, to be held in conjunction with the Western States Rural Transportation Technology Implementers Forum in Yreka, California in June 2016.
- Task 3: Western States Forum Support
    - This task includes coverage of general expenses (facility use, catering, etc.) as well as travel support for participants in the 2016 Western States Forum in Yreka, California, in June 2016, separate from that provided in Task 2 for WSRTC Steering Committee members.
- Task 4: Website Content and Maintenance
    - This task includes the maintenance and support of a sustained, publicly available web presence for the Consortium over its duration. This will include the staffing necessary to actively manage regular updates of the Consortium's status and make this information available on the web. The website shall contain all relevant information about the Consortium, including its history, goals, status, timeline, milestones, photo library, current activities, documents and a brief profile of the people and organizations involved. Updates will be made to the website to coincide with meetings, both prior to and after meetings, and to include meeting minutes.

6.9. WTI Task Order 9 – Rural Traveler Information (One-Stop Shop) Phase 3

Executive Summary

- This is the third phase in a multi-phase research project aimed at developing a one-stop shop for rural traveler information. This phase investigates further expansion of a prototype information delivery mechanism as well as development of a mobile interface. The prototype delivery mechanism was expanded during Phase 2 of this project beyond its original coverage area of the COATS region (California and Oregon) and subsequent coverage of the WSRTC area (California, Oregon, Washington and Nevada) to provide rural traveler information for the entire mainland Western United States by adding coverage of Arizona, New Mexico, Utah, Colorado, Idaho, Montana and Wyoming. Additional data is available from these new states including CMS messages, incidents, maintenance and construction reports, etc. It is desirable to add this data to the prototype system. It is further desirable to create a mobile interface to the prototype system since users desire access via using smartphones and tablets.

Duration

- March 1, 2016 – March 31, 2018

Websites

- http://westernstates.org/Projects/OSS/Default.html
- https://oss.weathershare.org/

Research Organization

- Western Transportation Institute at Montana State University

WTI Project Team

- Douglas Galarus - Primary Investigator, Program Manager, Systems Engineering, Development and Integration
- Daniell Richter - Research Associate for the Systems Engineering, Development and Integration Program

Problem Statement

- Real-time traveler information services have thrived in two primary contexts: urban-focused systems and statewide or regional systems. However, neither urban systems nor statewide/regional systems efficiently serve the rural traveler, whose trip may span a

great distance between urban areas. In addition, these types of systems are typically designed to conform to specific jurisdictional lines, whereas rural trips typically span multiple jurisdictions. While many rural agencies and districts have sought to provide traveler information, there is considerable variation in the level of information provided and how to access it.

- To address these challenges, this project proposes to continue the development a one-stop shop for rural traveler information. At a high level, this is a web-based platform that provides route-specific, real-time, highway-based traveler information based on an origin–destination specified by the user as well as a global view of conditions across the Western United States.

Work Plan

- Task 1: Project Management
  - Keep the project manager and technical panel apprised of project progress.
- Task 2: Expansion (Data Sources and Coverage)
  - Identifies data sources and implements expansion of the system to include new data and geographic coverage.
- Task 3: Mobile Application Development
  - Involves the development of a mobile interface for the prototype system.
- Task 4: On-Going System Development
  - Conduct on-going development of new application functionality and perform general system maintenance.
- Task 5: System Testing and Evaluation
  - Examine the manner in which users interact with the prototype system, including selection of information, referring sources, etc. and summarize the project in a final report.

6.10. WTI Task Order 10 – WSRTC Meeting Coordination, Western States Forum Travel Support and Website Maintenance

Executive Summary

- Coordination of meetings and maintenance of the website for WSRTC.as well as support for the Western States Forum.

Duration

- March 1, 2017 – February 28, 2018

Websites

- http://westernstates.org/
- http://westernstates.org/Documents/Default.html
- http://www.westernstatesforum.org/

Research Organization

- Western Transportation Institute at Montana State University

WTI Project Team

- Douglas Galarus - Primary Investigator, Program Manager, Systems Engineering, Development and Integration
- Leann Koon - Research Associate for the Systems Engineering, Development and Integration Program

Work Plan

- Task 1: Project Management
  - This task covers activities related to project management, including teleconferences as needed to keep the sponsor project manager and the project technical panel apprised of current progress.
- Task 2: Meeting Planning and Coordination
  - This task will focus on the coordination of meetings for members of the WSRTC. The project shall cover travel expenses, lodging and associated registration fees for participants for these meetings
  - The primary responsibilities of the project team on this task are:
    - Coordination of meeting facility and related arrangements.
    - Communication of meeting logistics and associated guidelines for travel and lodging.

        - Coordination of travel reimbursement for participants.
    - One meeting is planned during the performance period, with additional meetings depending on subsequent remaining funding:
        - Steering Committee Meeting, to be held in conjunction with the Western States Rural Transportation Technology Implementers Forum in Yreka, California in June 2017.
- Task 3: Western States Forum Support
    - This task includes coverage of general expenses (facility use, catering, etc.) as well as travel support for participants in the 2017 Western States Forum in Yreka, California, in June 2017, separate from that provided in Task 2 for WSRTC Steering Committee members.
- Task 4: Website Content and Maintenance
    - This task includes the maintenance and support of a sustained, publicly available web presence for the Consortium over its duration. This will include the staffing necessary to actively manage regular updates of the Consortium's status and make this information available on the web. The website shall contain all relevant information about the Consortium, including its history, goals, status, timeline, milestones, photo library, current activities, documents and a brief profile of the people and organizations involved. Updates will be made to the website to coincide with meetings, both prior to and after meetings, and to include meeting minutes.

6.11. WTI Task Order 11 – WSRTC Meeting Coordination, Western States Forum Travel Support and Website Maintenance

Executive Summary

- Coordination of meetings and maintenance of the website for WSRTC.as well as support for the Western States Forum.

Duration

- February 15, 2018 – February 28, 2019

Websites

- http://westernstates.org/
- http://westernstates.org/Documents/Default.html
- http://www.westernstatesforum.org/

Research Organization

- Western Transportation Institute at Montana State University

WTI Project Team

- Leann Koon - Research Associate II for the Systems Engineering, Development and Integration Program

Work Plan

- Task 1: Project Management
  - This task covers activities related to project management, including teleconferences as needed to keep the sponsor project manager and the project technical panel apprised of current progress.
- Task 2: Meeting Planning and Coordination
  - This task will focus on the coordination of meetings for members of the WSRTC. The project shall cover travel expenses, lodging and associated registration fees for participants for these meetings
  - The primary responsibilities of the project team on this task are:
    - Coordination of meeting facility and related arrangements.
    - Communication of meeting logistics and associated guidelines for travel and lodging.
    - Coordination of travel reimbursement for participants.

    - Three meetings are planned during the performance period, with additional meetings depending on subsequent remaining funding:
        - Steering Committee Meeting, to be held in conjunction with the 2018 North West Transportation Conference, March 13th – 15th, 2018 in Corvallis, Oregon.
        - Steering Committee Meeting, to be held in conjunction with the Western States Rural Transportation Technology Implementers Forum in Yreka, June 19th – 21st, 2018 in Yreka, California.
        - Steering Committee Meeting, to be held in conjunction with the 2018 National Rural Intelligent Transportation System (NRITS) Annual Conference, October 21st – 24th, 2018 in Phoenix / Scottsdale, Arizona
- Task 3: Western States Forum Support
    - This task includes coverage of general expenses (facility use, catering, etc.) as well as travel support for participants in the 2018 Western States Forum in Yreka, California, in June 2018, separate from that provided in Task 2 for WSRTC Steering Committee members.
- Task 4: Website Content and Maintenance
    - This task includes the maintenance and support of a sustained, publicly available web presence for the Consortium over its duration. This will include the staffing necessary to actively manage regular updates of the Consortium's status and make this information available on the web. The website shall contain all relevant information about the Consortium, including its history, goals, status, timeline, milestones, photo library, current activities, documents and a brief profile of the people and organizations involved. Updates will be made to the website to coincide with meetings, both prior to and after meetings, and to include meeting minutes.

6.12. WTI Task Order 12 – WSRTC Meeting Coordination, Western States Forum Travel Support and Website Maintenance

Executive Summary

- Coordination of meetings and maintenance of the website for WSRTC.as well as support for the Western States Forum.

Duration

- March 1, 2019 – March 31, 2020

Websites

- http://westernstates.org/
- http://westernstates.org/Documents/Default.html
- http://www.westernstatesforum.org/

Research Organization

- Western Transportation Institute at Montana State University

WTI Project Team

- Leann Koon - Research Associate II for the Systems Engineering, Development and Integration Program

Work Plan

- Task 1: Project Management
  - This task covers activities related to project management, including teleconferences as needed to keep the sponsor project manager and the project technical panel apprised of current progress.
- Task 2: Meeting Planning and Coordination
  - This task will focus on the coordination of meetings for members of the WSRTC. The project shall cover travel expenses, lodging and associated registration fees for participants for these meetings
  - The primary responsibilities of the project team on this task are:
    - Coordination of meeting facility and related arrangements.
    - Communication of meeting logistics and associated guidelines for travel and lodging.
    - Coordination of travel reimbursement for participants.

  - Three meetings are planned during the performance period, with additional meetings depending on subsequent remaining funding:
    - Steering Committee Meeting, to be held in conjunction with the Western States Rural Transportation Technology Implementers Forum in Yreka, June 18th – 20th, 2019, in Yreka, California.
    - Steering Committee Meeting, to be held in conjunction with the 2019 National Rural Intelligent Transportation System (NRITS) Annual Conference, July 21st – 24th, 2019, in Austin, Texas.
    - Steering Committee Meeting, to be held in conjunction with the 2020 North West Transportation Conference, March 2020, in Corvallis, Oregon.
- Task 3: Western States Forum Support
  - This task includes coverage of general expenses (facility use, catering, etc.) as well as travel support for participants in the 2019 Western States Forum in Yreka, California, in June 2019, separate from that provided in Task 2 for WSRTC Steering Committee members.
- Task 4: Website Content and Maintenance
  - This task includes the maintenance and support of a sustained, publicly available web presence for the Consortium over its duration. This will include the staffing necessary to actively manage regular updates of the Consortium's status and make this information available on the web. The website shall contain all relevant information about the Consortium, including its history, goals, status, timeline, milestones, photo library, current activities, documents and a brief profile of the people and organizations involved. Updates will be made to the website to coincide with meetings, both prior to and after meetings, and to include meeting minutes.

6.13. WTI Task Order 13 – WSRTC Meeting Coordination, Western States Forum Travel Support and Website Maintenance

Executive Summary

- Coordination of meetings and maintenance of the website for WSRTC.as well as support for the Western States Forum.

Duration

- April 15, 2020 – March 31, 2021

Websites

- http://westernstates.org/
- http://westernstates.org/Documents/Default.html
- http://www.westernstatesforum.org/

Research Organization

- Western Transportation Institute at Montana State University

WTI Project Team

- Leann Koon - Research Associate II for the Systems Engineering, Development and Integration Program

Work Plan

- Task 1: Project Management
  - This task covers activities related to project management, including teleconferences as needed to keep the sponsor project manager and the project technical panel apprised of current progress.
- Task 2: Meeting Planning and Coordination
  - This task will focus on the coordination of meetings for members of the WSRTC. The project shall cover travel expenses, lodging and associated registration fees for participants for these meetings
  - The primary responsibilities of the project team on this task are:
    - Coordination of meeting facility and related arrangements.
    - Communication of meeting logistics and associated guidelines for travel and lodging.
    - Coordination of travel reimbursement for participants.

    - Three meetings are planned during the performance period, with additional meetings depending on subsequent remaining funding:
        - Steering Committee Meeting via teleconference in June 2020.
        - Steering Committee Meeting, to be held in conjunction with the 2020 ITE Annual Meeting, National Rural Intelligent Transportation System (NRITS) Conference Plus Exhibit, August 9th – 12th, 2020, in New Orleans, Louisiana.
        - Steering Committee Meeting, to be held in conjunction with the ITS World Congress 2020, October 4th – 8th, 2020, in Los Angeles, California.
- Task 3: Western States Forum Support
    - The 2020 Western States Forum has been canceled. However, planning for the 2021 Forum will commence. This task includes coverage of general expenses for the Western States Forum applicable during the contract period.
- Task 4: Website Content and Maintenance
    - This task includes the maintenance and support of a sustained, publicly available and compliant web presence for the Consortium over its duration. This will include the staffing necessary to actively manage regular updates of the Consortium's status and make this information available on the web. The website shall contain all relevant information about the Consortium, including its history, goals, status, timeline, milestones, photo library, current activities, documents and a brief profile of the people and organizations involved. Updates will be made to the website to coincide with meetings, both prior to and after meetings, and to include meeting minutes.

6.14. WTI Task Order 14 – WSRTC Meeting Coordination, Western States Forum Travel Support and Website Maintenance

Executive Summary

- Coordination of meetings and maintenance of the website for WSRTC.as well as support for the Western States Forum.

Duration

- April 26, 2021 – March 31, 2023

Websites

- http://westernstates.org/
- http://westernstates.org/Documents/Default.html
- http://www.westernstatesforum.org/

Research Organization

- Western Transportation Institute at Montana State University

WTI Project Team

- Leann Koon - Research Associate II for the Systems Engineering, Development and Integration Program

Work Plan

- Task 1: Project Management
  - This task covers activities related to project management, including teleconferences as needed to keep the sponsor project manager and the project technical panel apprised of current progress.
- Task 2: Meeting Planning and Coordination
  - This task will focus on the coordination of meetings for members of the WSRTC. The project shall cover travel expenses, lodging and associated registration fees for participants for these meetings
  - The primary responsibilities of the project team on this task are:
    - Coordination of meeting facility and related arrangements.
    - Communication of meeting logistics and associated guidelines for travel and lodging.
    - Coordination of travel reimbursement for participants.

  - Six meetings/event participation and one site visit are planned during the performance period, with additional meetings depending on remaining funding:
    - WSRTC participation in the virtual 2021 ITE Annual Meeting, National Rural Intelligent Transportation Systems (NRITS) Conference Plus Exhibit, July 20th -29th, 2021.
    - Steering Committee Meeting, to be held in conjunction with the Western States Rural Transportation Technology Implementers Forum, October 5th – 7th, 2021, in Yreka, California.
    - Steering Committee Meeting, to be held in conjunction with the Northwest Transportation Conference, March 2022, in Corvallis, Oregon.
    - Steering Committee Meeting, to be held in conjunction with the Western States Rural Transportation Technology Implementers Forum, June 2022, in Yreka, California.
    - Steering Committee Meeting, to be held in conjunction with the ITS World Congress 2022, September 18th – 22nd, 2022, in Los Angeles, California.
    - Steering Committee Meeting, to be held in conjunction with the National Rural ITS Conference, fall 2022, North Carolina.
    - Site Visit, Caltrans District 2 personnel to Montana Technological University, Butte, Montana, summer 2021; Automated Safety Warning System Controller laboratory set-up.
    - Tentative meeting: Steering Committee Meeting, to be held in conjunction with ITS America Annual Meeting, December 7th – 10th, 2021, in Charlotte, North Carolina.
    - Tentative meeting: Steering Committee Meeting, to be held in conjunction with the 2022 ITE Annual Meeting + Exhibit, July 31st – August 3rd, 2022, in New Orleans, Louisiana.
- Task 3: Western States Forum Support
  - This task includes coverage of general event expenses (facility use, catering, etc.) for the 2021 and 2022 Western States Forums, and a portion of the 2023 event. It includes travel support for speakers and participants in these events separate from that provided in Task 2 for WSRTC Steering Committee members. The Western States Forum will be held in Yreka, California in October 2021 and June of 2022 and 2023.
- Task 4: Website Content and Maintenance
  - This task includes the maintenance and support of a sustained, publicly available, and compliant web presence for the Consortium over its duration. This will include the staffing necessary to actively manage regular updates of the Consortium's status and make this information available on the web. The website shall contain all relevant information about the Consortium, including its history, goals, status, timeline, milestones, photo library, current activities, documents and a brief profile of the people and organizations involved. Updates will be made to the website to coincide with meetings, both prior to and after meetings, and to include meeting minutes.

6.15. USU Task Order 1 – Automated Safety Warning System Controller (ASWSC) Phase 3, ATC Migration

Executive Summary

- This is the third phase of research and development of an "Automated Safety Warning Controller" (ASWC) that interfaces with roadside devices such as sensors and signs. The Controller allows for automated data collection and application of best practice algorithms to analyze sensor data and to actuate related warning messages and signals. For instance, wind warning messages may be actuated on a changeable message sign (CMS) when wind speed, as read from a sensor, exceeds a given threshold. The anticipated product of Phase 3 will be an updated version of the ASWSC software, modified to run on the ATC.

Duration

- September 1, 2018 – August 31, 2020

Websites

- http://westernstates.org/Projects/Controller/Default.html

Research Organization

- Computer Science Department at Utah State University (USU)

USU Project Team

- Douglas Galarus - Primary Investigator, Assistant Professor Computer Science Department

Problem Statement

- Caltrans provided the following problem statement for Phase 1 of this project:
  - *In order to provide better safety warning information to motorists, how can roadside condition sensor data be automatically analyzed, and real-time road condition information be displayed to the traveling public?*

Work Plan

- Task 1: Project Management
  - Keep the project manager and technical panel apprised of project progress.
- Task 2: Review Phase 2 Result

    - Identify issues and recommendations regarding architectural or performance issues.
- Task 3: ATC Hardware Installation
    - Receive and install ATC hardware, provided by Caltrans.
- Task 4: ASWSC Development for the ATC
    - Re-factor system software and port it to the ATC, and to add functionality and make the system robust and ready for production use.
- Task 5: Field Testing
    - Determine the utility of the system.

6.16. USU Task Order 2 – One-Stop-Shop (OSS) Phase 4

Executive Summary

- This is the fourth phase in a multi-phase research project aimed at developing a one-stop shop for rural traveler information. This phase transitions development and support of the System to Utah State University and investigates long term maintenance of the System. The prototype delivery mechanism was expanded during Phase 2 of this project beyond its original coverage area of the COATS region (California and Oregon) and subsequent coverage of the WSRTC area (California, Oregon, Washington and Nevada) to provide rural traveler information for the entire mainland Western United States by adding coverage of Arizona, New Mexico, Utah, Colorado, Idaho, Montana and Wyoming. It was desirable to create a mobile interface for the prototype system since users desired access via using smartphones and tablets, so a mobile interface was developed in Phase 3.

Duration

- September 1, 2018 – August 31, 2020

Websites

- http://westernstates.org/Projects/OSS/Default.html
- https://oss.weathershare.org/

Research Organization

- Computer Science Department at Utah State University (USU)

USU Project Team

- Douglas Galarus - Primary Investigator, Assistant Professor Computer Science Department

Problem Statement

- Real-time traveler information services have thrived in two primary contexts: urban-focused systems and statewide or regional systems. However, neither urban systems nor statewide/regional systems efficiently serve the rural traveler, whose trip may span a great distance between urban areas. These types of systems are typically designed to conform to specific jurisdictional lines, whereas rural trips typically span multiple jurisdictions. While many rural agencies and districts have sought to provide traveler information, there is considerable variation in the level of information provided and how to access it.
- To address these challenges, this project proposes to continue the development of a one-stop shop for rural traveler information. At a high level, this is a web-based platform that

provides real-time, highway-based traveler information and a global view of conditions across the Western United States.

Work Plan

- Task 1: Project Management
  - Keep the project manager and technical panel apprised of project progress.
- Task 2: Review System and Phase 3 Results
  - Assess the status of the system in terms of architecture and performance;
- Task 3: System Update
  - Bring up development support at USU, implement new features like smart switch-over to the mobile version for mobile users, develop other new application functionality, and add further data.
- Task 4: Ongoing System Maintenance and Monitoring
  - Maintain and support the system and monitor its usage.
- Task 5: Long Term Maintenance Plan
  - Develop a plan for the system that extends beyond the end of this phase including cost estimation, assessment of funding/revenue sources, and identification of alternatives.

6.17. MT Task Order 1 – ASWSC / OSS / WeatherShare Maintenance

Executive Summary

- This is a combined maintenance phase for the Automated Safety Warning System Controller (ASWSC), One-Stop-Shop for Rural Traveler Information (OSS), and WeatherShare projects.
    - Developed over three phases, the ASWSC interfaces with roadside devices such as sensors and signs. The ASWSC allows for automated data collection and application of best practice algorithms to analyze sensor data and to actuate related warning messages and signals. For instance, wind warning messages may be actuated on a changeable message sign (CMS) when wind speed, as read from a sensor, exceeds a given threshold.
    - OSS is a web-based application that provides traveler information covering the Western United States. In the prior four phases, OSS was expanded to display roadside camera images (CCTV), CMS, incidents, current and forecast weather conditions, and more across 11 western states. OSS usage exceeds 10,000 user sessions on bad weather winter days, delivering traveler information via an easy-to-use interface that works on all devices ranging from smart phones to desktops.
    - The five-phase WeatherShare project aggregates and presents data from road weather information systems (RWIS) and other data sources via a web interface to Caltrans maintenance and operations personnel. WeatherShare combines functionality including weather data reporting and weatherbased alerting into a single open system, replacing several proprietary systems that had been used previously used by Caltrans.
- ASWSC Phase 3 and OSS Phase 4 concluded at USU in August 2020 and WeatherShare Phase 5 concludes in June 2021. These three systems continue to be used by Caltrans and, in the case of OSS, the general public. Maintenance and support are necessary to keep these systems functioning.

Duration

- July 1, 2021 – March 31, 2023

Websites

- http://westernstates.org/Projects/Controller/Default.html
- http://westernstates.org/Projects/OSS/Default.html
- https://oss.weathershare.org/
- http://westernstates.org/Projects/Weathershare/Default.html
- http://www.weathershare.org/

Research Organization

- Department of Computer Science Department at Montana Technological University (MTU)

MTU Project Team

- Douglas Galarus - Primary Investigator, Assistant Professor, Department of Computer Science

Work Plan

- Task 1: Project Management
  - Kickoff
    - The project champion, project manager, principal investigator (PI), and the project team will participate in an initial kick-off meeting to review and discuss project objectives and to address project issues. This kickoff meeting may be conducted via phone conference or video conference,or in person.
  - Other Regular Project Meetings
    - Through all phases of the project, the project team will communicate regularly with the Caltrans project champion and project manager to ensure that Caltrans' and the WSRTC's needs are fully understood and addressed. In addition to the kick-off meeting and other meetings described above, subsequent project meetings will be conducted as needed, either in-person or via phone or video conference.
  - One or more trips will be made individually by the Caltrans project manager and/or project champion
    - To assist the project team with system configuration, development, and evaluation in Dr. Galarus' Lab at Montana Tech. The project team may make several trips for meetings in California.
  - National Meetings
    - Conference attendance is included to conduct outreach to other states and define prospective relationships and project interest. It is anticipated that there will be significant interest in this project from other rural states. The National Rural Intelligent Transportation Systems (NRITS) conference and the Western States Rural Transportation Technology Implementers Forum are the most appropriate venues.
  - Quarterly Reports (deliverable)
    - Throughout the project, the Project Team will submit periodic (quarterly) progress and financial reports as required by Caltrans and the WSRTC. These progress reports will highlight status of the project in terms of work accomplished, future work to be completed, and will disclose any technical delays or issues for discussion.
  - Final Report (deliverable)

        - A final report will be submitted to Caltrans and the WSRTC electronically (MS-Word and/or Adobe Acrobat) near the end of the project. The report will follow the standard format. A draft of the report will be provided to Caltrans and the WSRTC with ample time for review and comment prior to finalizing the final report. The final report will provide summary and detail for the entire project, including a compilation of other project reports submitted throughout the project.
    - Website
        - The Project Team will build a sustained, publicly available, web presence for the project's duration. The Project Team will host this informational website to include all relevant information about the project's history, goals, status, timeline, milestones, photo library, current activities and a brief profile of the people and organizations involved. It will be professional and will have marketing appeal. It will provide detailed information about the project and will be kept update.
- Task 2: Lab Setup
    - Receive and Install ASWSC Hardware
        - Caltrans will provide and configure replacement modems to ensure compatibility with existing Caltrans policies and preferences, will replace failed equipment in the ASWSC lab, and will configure the system to use new phones, etc. at its new location at Montana Tech. The project team will work with Caltrans to install the modems in the ASWSC lab for subsequent development and testing.
    - ASWSC Lab Enhancement
        - The development and testing lab for the Controller project, developed in Phases 1, 2, and 3 will be enhanced to include additional device types and configurations. The project team will work with Caltrans to enhance the lab. Additional equipment may be purchased via this project or loaned to the project by Caltrans, as has been done with much of the current lab equipment. The project manager or project champion will make at least one related trip to Montana Tech for lab enhancement.
    - Install Local OSS and WeatherShare Development Server
        - A local development server will be setup for OSS and WeatherShare at Montana Tech. This server will be used for primary development and testing for these Systems.
    - Configure Hosted OSS and WeatherShare Staging Server
        - A hosted server will be setup for staging purposes for OSS and WeatherShare. This server will allow for code and interface changes to be tested prior to deployment on the hosted production server for these projects.
- Task 3: Review Prior Results
    - System Review
        - Results from prior project phases will be used to conduct a review of the systems in terms of architecture and performance. Recommendations will be made to address identified architectural or performance issues.

  - Evaluation Review
    - Prior evaluation data will be reviewed to identify gaps in system functionality, particularly items described in the original project design that deferred for subsequent development. These gaps will be documented, and recommendations will be made regarding resolution.
  - Solicit Input
    - Further input will be solicited from Caltrans and the WSRTC, including prospective user groups, to determine functionality and performance issues that may need to be addressed prior to deployment. These issues will be documented, and recommendations will be made regarding resolution.
  - Review Summary and Recommendations (deliverable)
    - A review summary and recommendations memorandum will be prepared to summarize the system review, evaluation review, and the input otherwise gathered from Caltrans and the WSRTC, along with the recommendations for resolution.
- Task 4: Ongoing System Maintenance and Monitoring
  - The purpose of this task is to perform general system maintenance and monitoring, and to conduct on-going development of new application functionality, as needed. Updates and repairs will be made as needed.