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Advanced Highway Maintenance and Construction Technology Research Center

Department of Mechanical and Aerospace Engineering
University of California at Davis

Responder Study Phase 3: Testing and Support

Stephen M. Donecker, Kin S. Yen, Travis Swanston, Bahram Ravani, &
Ty A. Lasky: Principal Investigator

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This report documents the research project "Responder Study Phase 3: Testing and Support." The goal of the research was to have a working Responder system that is deployable by the end of the project. Responder is a communication tool that integrates hardware, software, and communications to provide incident responders—particularly those in rural areas with sparse communication coverage—with an easy-to-use means to accurately collect and communicate at-the-scene information with their managers and the Transportation Management Center (TMC). The core of the current research was field testing the Responder system in four Caltrans districts. Based on the field testing feedback, Caltrans Maintenance operators generally find the Responder system useful and are pleased with it. The system, as specified in the Caltrans committee-developed and approved system requirements, is ready for implementation. Efforts are underway through a related AHMCT research project to transition Responder system manufacturing to a third-party contractor. However, multiple districts have requested that additional functionality, outside of the system requirements, be added to the system before it can be used in a fully-operational manner in their respective incident response workflows.

EXECUTIVE SUMMARY

Incident response is a critical function for the California Department of Transportation (Caltrans). It is important to provide relevant and timely information to responders. In addition, it is important for first responders to be able to provide relevant information from the scene and the incident to others in the organization. Reliable and always available communication is a key component for incident response. Under the Responder Phase II research project [1], a system was developed by the Western Transportation Institute (WTI) of Montana State University (MSU) at Bozeman to meet these communication needs for Caltrans. The goal of the overall Responder effort is to provide Caltrans with a field-ready system to support first responders in rural environments in a manner that is also effective in urban scenarios.

Under the previous Responder Phase III research project, researchers at the Advanced Highway Maintenance and Construction Technology (AHMCT) Research Center migrated the prototype Responder system to the latest computing and communications technologies [2]. As part of this Phase III research project, AHMCT designed and developed this next-generation Responder system. The goal of that effort was to provide Caltrans with a field-ready system ready for full deployment to support first responders in rural environments. While the Responder system is designed to work anywhere in the state, a significant portion of the previous effort was dedicated to providing a communications platform in rural areas where traditional terrestrial communications systems (i.e., cellular or two-way radio) are unavailable.

Research Objectives and Methodology

As of the end of the Responder Phase III research, additional field testing by Caltrans districts was needed to validate the performance of the Responder system in real world conditions and to identify any deficiencies. The goal of the current research was to evaluate and validate the Responder system by way of extensive field testing and to address identified issues that are needed to assure compliance with the requirements of the previous research project.

The intent of the current research was to have a working product that is deployable by the end of the project. More specifically, by the end of this research effort, the Responder system should be through Stage 4 of Caltrans' Five Stages of Research Deployment,[1] specifically it should be through "First Application (Contract) Field Pilot Stage." In some respects, the system will have progressed partially into Stage 5, "Specification & Standards with Full Corporate Deployment Stage."

The research methodology included:

- Support for Round 1 field testing
- Revise the Responder system based on Round 1 field testing

[1] Caltrans Division of Research and Innovation – DRI: Deployment Services Business Plan, http://www.dot.ca.gov/research/deployment_support/docs/deployment_business_plan_ks.pdf

- Support for Round 2 District 2 field testing
- Document the Responder system

Results and Recommendations

The Round 1 and Round 2 field testing is complete. Based on the Round 1 field testing, Caltrans Maintenance operators generally found the Responder system useful and were pleased with its implementation. On the whole, Round 1 testing yielded requests for specific software revisions related mainly to the look and feel of the system. These revisions were completed prior to Round 2 testing. The substantive functional request from Round 1 testing came from District 2 and involved improvements to status notifications for email transmission. The notification system was substantially improved before Round 2 testing. Based on District 2's feedback from Round 2, these revisions have addressed the initial concerns, and the district is satisfied with the email status notification. The feedback received from Round 2 field testing was very positive and is provided in Appendix A.

The system was developed and tested according to the Caltrans committee-developed and approved system requirements. Based on the maturity of the system and the general acceptance of Caltrans Maintenance for it, AHMCT recommends that Caltrans now takes steps to fully implement the Responder system throughout the organization. AHMCT also recommends that new incident response operational needs discovered through hands-on district-level field testing be seriously considered and appropriate research and development commence to address these additional district requirements in a future, parallel effort. Implementation efforts are currently underway through a related AHMCT research project to transition the Responder system manufacturing to a third-party contractor. AHMCT has provided Caltrans with the requirements for such a vendor, and Caltrans is in the process of developing a bid for a contractor. The ultimate goal will be to produce at least ten more portable Responder systems through the combined efforts of AHMCT and this vendor. At that time, the Responder system will be fully deployed within Caltrans, and the overall Responder effort will be a substantial success for all parties.

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym	Definition
3D	Three-dimensional
AHMCT	Advanced Highway Maintenance and Construction Technology Research Center
API	Application Programming Interface
ATMS	Advanced Transportation Management System
Caltrans	California Department of Transportation
CCTV	Closed-Circuit TV
CHP	California Highway Patrol
CMS	Changeable Message Sign
COTS	Commercial Off–The-Shelf
CWWP	Commercial Wholesale Web Portal
DOE	Division of Equipment
DOT	Department of Transportation
DRISI	Caltrans Division of Research, Innovation and System Information
GPS	Global Positioning System
HMI	Human Machine Interface
HTTP	Hypertext Transfer Protocol
ID	Identification
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
IR	Infrared
IRIS	Intelligent Roadway Information System
ITS	Intelligent Transportation Systems
LTE	Long-Term Evolution
LRS	Linear Reference System
MSU	Montana State University
OES	Office of Emergency Services
OS	Operating System
OSS	One-Stop-Shop
PIO	Public Information Office
PRS	Portable Responder System
RF	Radio Frequency
SR	State Route
SWR	Standing Wave Ratio
TAG	Technical Advisory Group
TCP/IP	Transmission Control Protocol / Internet Protocol
TMC	Transportation Management Center
UCD	University of California – Davis
VRS	Vehicular Responder System
Wi-Fi	Wireless Fidelity
WTI	Western Transportation Institute

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CHAPTER 1:
INTRODUCTION

Incident response is a critical function for the California Department of Transportation (Caltrans). It is important to provide relevant and timely information, such as weather conditions, to responders. In addition, it is important for first responders to be able to provide relevant information from the scene and the incident to others in the organization who are involved in the process. Reliable and always available communication is a key component for proper incident response. Under the Responder Phase II research project [1] a system was developed by the Western Transportation Institute (WTI) of Montana State University (MSU) at Bozeman to meet these communication needs for Caltrans. The goal of the overall Responder effort is to provide Caltrans with a field-ready system to support first responders in rural environments in a manner that is also effective in urban scenarios.

Under the previous Responder Phase III research project, researchers at the Advanced Highway Maintenance and Construction Technology (AHMCT) Research Center redesigned and developed the prototype Responder system for the latest computing and communications technologies, including smartphone and tablet systems [2]. As part of this Phase III research project, AHMCT designed and developed this next-generation Responder system. The project included review of previous phase efforts, update of requirements, review of commercial systems, design and development of the Phase III Responder system, and testing and reporting. The purpose of that effort was to provide Caltrans with a field-ready system ready for full deployment to support first responders in rural environments. While the Responder system is designed to work anywhere in the state, a significant portion of the previous effort was dedicated to providing a communications platform in rural areas where traditional terrestrial communications systems (i.e., cellular or two-way radio) are unavailable.

As of the end of the Responder Phase III research, additional field testing by Caltrans districts was needed to validate the performance of the Responder system in real world conditions and to identify any deficiencies. The goal of the current research was to evaluate the Responder system by way of extensive field testing and to address identified issues that needed to be solved to assure compliance with the requirements of the previous research project.

The intent of the current research was to have a working product that meets all system requirements and would be deployable by the end of the project. More specifically, by the end of this research effort the Responder system should be through Stage 4 of Caltrans' Five Stages of Research Deployment,[2] specifically it should be through "First Application (Contract) Field Pilot Stage." In some respects, the system will have progressed partially into Stage 5, "Specification & Standards with Full Corporate Deployment Stage." It will be partially into Stage 5 due to the nature of the planned field testing, which will meet all of the following:

- "End users select site(s) and deploy the method/process/equipment using resident management, supervision, staff, and contracting forces (where applicable)." This was

[2] Caltrans Division of Research and Innovation – DRI: Deployment Services Business Plan, http://www.dot.ca.gov/research/deployment_support/docs/deployment_business_plan_ks.pdf

the case in this research, except AHMCT installed the system in the Caltrans vehicles or provided the portable system for Caltrans to install. Therein, AHMCT provided the same service that a contractor or company would concerning system installation and can do so in the future should Caltrans require it.

- "Deployment is without research supervision or direction." This was the case in this research, with the exception of initial briefing and training prior to Round 1 testing, which likely matches the intent of this clause.

- "On call assistance is available upon request." This was the case in this research, wherein AHMCT was available for consultation and troubleshooting by email and/or phone during all of the field testing.

- "Assesses results." The field testing assessment is provided as a part of this report.

Hence, one might conclude that the Responder system is in Stage 5 at the end of this research. As a conservative estimate, it is certainly in Stage 4. A follow-up research project to transition design information to a third-party vendor to allow them to reproduce the system for Caltrans is in progress; this effort will certainly put the system in Stage 5, full corporate deployment, as each district will have a fully functional Responder system.

Due to the nature of the Responder system design, it should now be quite feasible for the Responder system to be commercialized and available to Caltrans for use throughout the organization. The Responder system is composed of commercial off-the-shelf (COTS) components. A few components are customized. One example is the electronics case, which was custom ordered from a manufacturer. Such a case would be simple to obtain, or could be produced directly by a capable company. Several brackets in the portable unit were created using three-dimensional (3D) printing. The designs for these components are available, and components could be reproduced by a company using 3D printing or more traditional manufacturing approaches. Vehicle integration of the Responder system could be provided by a third party. On the other hand, the integration as embodied in the current Responder-equipped vehicle is also well within the capabilities of Caltrans Division of Equipment (DOE) or the Department of General Services (DGS). Currently, this may not be an issue, as Caltrans appears more interested in broad deployment of the portable system, which does not require vehicle integration. Finally, the Responder software is available for Caltrans' use per the governing contract IA65A0560, Exhibit E, Section C. This includes the right for a third party to incorporate AHMCT's software for Caltrans' use. If this overall approach is followed, as is currently planned in the follow-on Responder transition research effort, system maintenance should be available from the Responder system manufacturer.

Research Approach

This work builds on AHMCT's experience with winter maintenance operations, our experience and detailed design and implementation knowledge of Responder, our strength in sensing and system integration, and our established Mechatronic hardware and software knowledge base [2-11].

The research methodology included:

- Support for Round 1 field testing
- Revise Responder system based on Round 1 field testing
- Support Round 2 District 2 field testing
- Document the Responder system (User's Manual, Reference Guide)

Overview of Research Results and Benefits

The key deliverables of this project include:

- Updated project fact sheet
- Documentation of Round 1 field test results
- Documentation of Responder deficiencies found in Round 1
- Updated Responder system ready for Round 2 of District 2's field testing
- Documentation of Round 2 of District 2's field test results
- Documentation of Responder deficiencies found in Round 2 of District 2's field testing
- Updated User's Manual
- Updated Quick Reference Guide

CHAPTER 2:
RESPONDER SYSTEM CONCEPT

Caltrans maintenance staff is the first responder to incidents on state roadways. They must collect information, determine the appropriate response, and access and manage resources at-the-scene. These events must be done in concurrence with providing transportation management services to respond to and recover from the incident. Caltrans currently does not have an efficient means to collect at-the-scene incident information or the capacity to share this information with transportation management centers and other emergency responders. In most Caltrans districts, emergency responders rely on voice communications to exchange information. In addition, many districts lack the ability to distribute incident support information to responders via data networks. Such information could better prepare responders for incident support, provide assistance for incident management, and guide responders in making good decisions. Caltrans needs a communication tool for first responders to allow photos, drawings, weather information, and maps to be shared between responders and a transportation management center (TMC) during an incident via Wireless Fidelity (Wi-Fi), cellular, satellite, or other forms of communication.

As a key element of a recent project, AHMCT developed the third-generation of the Responder system. This is a communication tool that integrates hardware, software, and communications to provide incident responders with an easy-to-use means to accurately collect and communicate at-the-scene information with their managers and the TMC. The system is particularly useful for those in rural areas with sparse communication coverage. The incident responder will use a smart device such as a tablet or cell phone. The Responder system provides access to critical information, such as weather, fire, and TMC field element status, to responders. It manages communications via multiple channels, selecting the best channel based on availability, bandwidth, and cost. Responder includes a store-and-forward architecture to address situations where communications are temporarily unavailable. The Responder system does not rely on any centralized server as it must function in situations where there is a complete communications degradation.

Unique features of the system include the ability for users to capture, annotate, and transmit images. Using Global Positioning System (GPS) readings, the system automatically downloads local weather data, retrieves maps and aerial photos, and pinpoints the responder's location on maps. By simply clicking the "SEND" button, an email message is automatically composed and sent to the TMC operator or other emergency/first responder parties. The system connects to the most efficient and available service (Wi-Fi, cellular, satellite, or other communication) on its own; photos and sketches are compressed to minimize transmission time. With an emphasis on ease of use, the system allows responders to concentrate on work at-the-scene without burdening them with data input and reporting. The high-level Responder concept and architecture is shown in Figure 2.1.

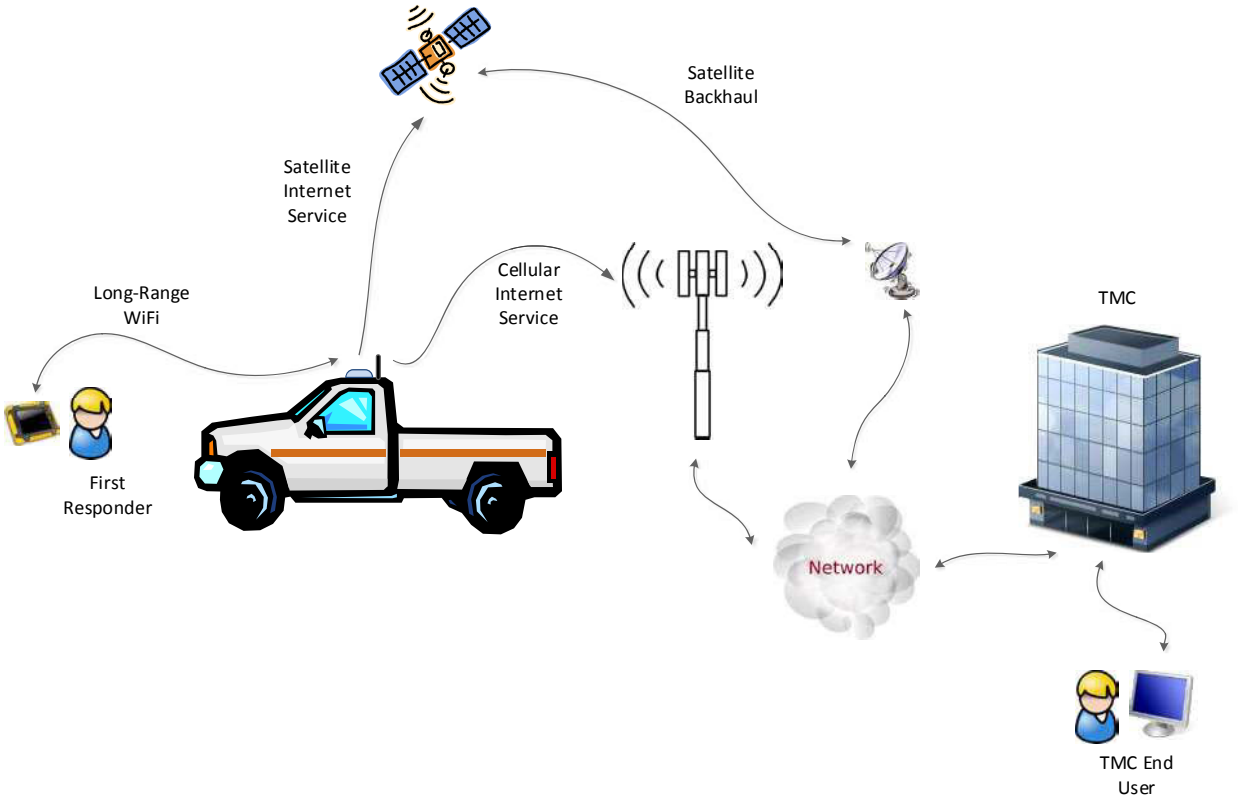


Figure 2.1: Responder concept

The Responder system allows first responders to collect and share at-the-scene information quickly and efficiently. It is especially valuable in:

- Major incidents, such as landslides, floods, and earthquakes, where the damage could be extensive;
- Remote rural areas where communication is often limited to voice and coverage is sparse;
- When the first responder is new or inexperienced in responding to certain situations.

The use of this system will save resources by:

- Allowing for the ability to evaluate what is happening at-the-scene from a maintenance yard/location or TMC without extended delay;
- Sending the correct employees and equipment to an incident in a timely manner based on the initial information that can be seen in the photo(s) and/or report(s) submitted by Caltrans staff at the incident scene;
- Being able to provide real-time information to other staff, such as the Public Information Office (PIO), who may have to answer to outside agencies regarding what is happening at the incident.

- Supporting simultaneous reporting to the TMC and to partner agencies, such as the California Highway Patrol, to facilitate their response activities and improved coordination.

CHAPTER 3:
RESPONDER SYSTEM FIELD TESTING

The primary purpose of this research was to support field testing in four Caltrans districts, specifically Districts 2, 3, 4, and 9. Each of the districts performed one round of field testing. District 2 also performed a second round of field testing. At the outset of each round of testing in each district, the intent was for AHMCT to provide an overview of the system, including specific training on how to interact with Responder. This was not possible in all cases due to scheduling conflicts within the districts. This introduced some confusion in terms of understanding the available system features. AHMCT also debriefed Maintenance staff at the end of each test round to obtain their feedback on the benefits of the Responder system, as well as note any deficiencies or feature requests. In addition to this informal debriefing, AHMCT provided a feedback form to the districts. This form is shown in Appendix A along with results received. Filling out the form was not mandatory, and it did not occur in some cases.

For purposes of this testing, District 2 and District 9 are considered rural, District 3 is semi-rural, and District 4 is urban. Thus, the Responder system, while intended and designed mainly for rural use, was tested across a broad spectrum of Caltrans operating conditions. In addition, the system was tested in a wide range of weather conditions, including some snowy operations in District 2 and extreme heat in District 9. Most districts tested the Vehicular Responder System (VRS); District 4 tested the Portable Responder System (PRS) [2].

Round 1 in District 2

The VRS was transferred to District 2 for their Round 1 month-long testing beginning May 22, 2017 and concluding July 7, 2017. The Responder system was tested in several communications-challenged areas throughout the district. It was also used during live incident events.

The VRS was tested in several rural locations, including the following locations. In each of these locations an incident report was generated, sent, and successfully received by the intended recipients.

1. Small fire SR 299 road open with 2-way traffic control
    a. Lat/Lon: 40° 43' 39.53" / -123° 3' 18.36"
    b. Direction: WB
    c. County: TRI
    d. Route: SR 299
    e. Postmile: 43.666R
2. Caltrans truck over bank
    a. Lat/Lon: 40° 44' 43.58" / -123° 10' 29.24"

   b. County: TRI
   c. Route: SR 299
   d. Postmile: 33.296L
3. Eastbound lane Buckhorn had sunk a couple of inches
   a. Lat/Lon: 40° 38' 47.83" / -122° 42' 57.42"
   b. Direction: EB
   c. County: SHA
   d. Route: SR 299
   e. Postmile: 1.780L
4. TEST down river, paving dig-outs
   a. Lat/Lon: 40° 45' 22.22" / -123° 16' 59.69"
   b. County: TRI
   c. Route: SR 299
   d. Postmile: 26.356R
5. TEST (very rural location)
   a. Lat/Lon: 40° 44' 21.4" / -123° 14' 34.5"
   b. Direction: EB
   c. County: TRI
   d. Route: SR 299
   e. Postmile: 29.066R
6. TEST (very rural location)
   a. Lat/Lon: 40° 47' 6.39" / -122° 53' 31.02"
   b. County: TRI
   c. Route: SR 3
   d. Postmile: 37.053L

7. TEST (very rural location)
    a. Lat/Lon: 40° 44' 31.28" / -123° 12' 47.19"
    b. Direction: NB/SB
    c. County: TRI
    d. Route: SR 299
    e. Postmile: 30.856L

Reports 1-4 were generated by the Weaverville maintenance yard staff, while Reports 5-7 were created by Responder project Caltrans management. Shown below in Figure 3.1 are the primary locations of the VRS evaluation in the area surrounding Weaverville, CA. Aside from the actual incident situations, the evaluation locations were deliberately chosen to be outside cellular coverage so that the satellite communication functionality in various geographically challenging locations could be tested. Report locations 1 and 2 were actual incident locations (fire and big rig over bank, respectively), while locations 3 and 4 were selected for evaluation purposes by the Weaverville maintenance yard staff. Report locations 5-7 were selected for test evaluation purposes by project management to verify system functionality in very rural locations. Figures 3.2-3.8 provide Street View[3] satellite-facing views for each location.

[3] https://www.google.com/streetview/

Figure 3.1: District 2 VRS evaluation locations near Weaverville, CA

Figure 3.2: District 2 Report 1 generated and sent from TRI 299 43.666R

Shown above in Figure 3.2 is the satellite-facing view from the coordinates contained in the first incident report. The actual incident report lists the incident as a small fire. The purpose of this view is to show the unobstructed view of the sky. The report was sent successfully over the satellite communications system. In this, and all subsequent similar views, the image is shown in the direction of the communications satellite.

Figure 3.3: District 2 Report 2 generated and sent from TRI 299 33.296L

Shown above in Figure 3.3 is the satellite-facing view from the coordinates contained in the second incident report. The actual incident report lists the incident as a big rig over the bank in the river below. The purpose of this image is to show the unobstructed view of the sky, although a reasonably tall mountain is just ahead. The report was successfully sent over the satellite communications system.

Figure 3.4 District 2 Report 3 generated and sent from SHA 299 1.780L

Shown above in Figure 3.4 is the satellite-facing view from the coordinates contained in the third incident report. The purpose of this image is to show the partially obstructed view of the sky due to the nearby foliage and the reasonably tall mountain in the background. The report was successfully sent over the satellite communications system.

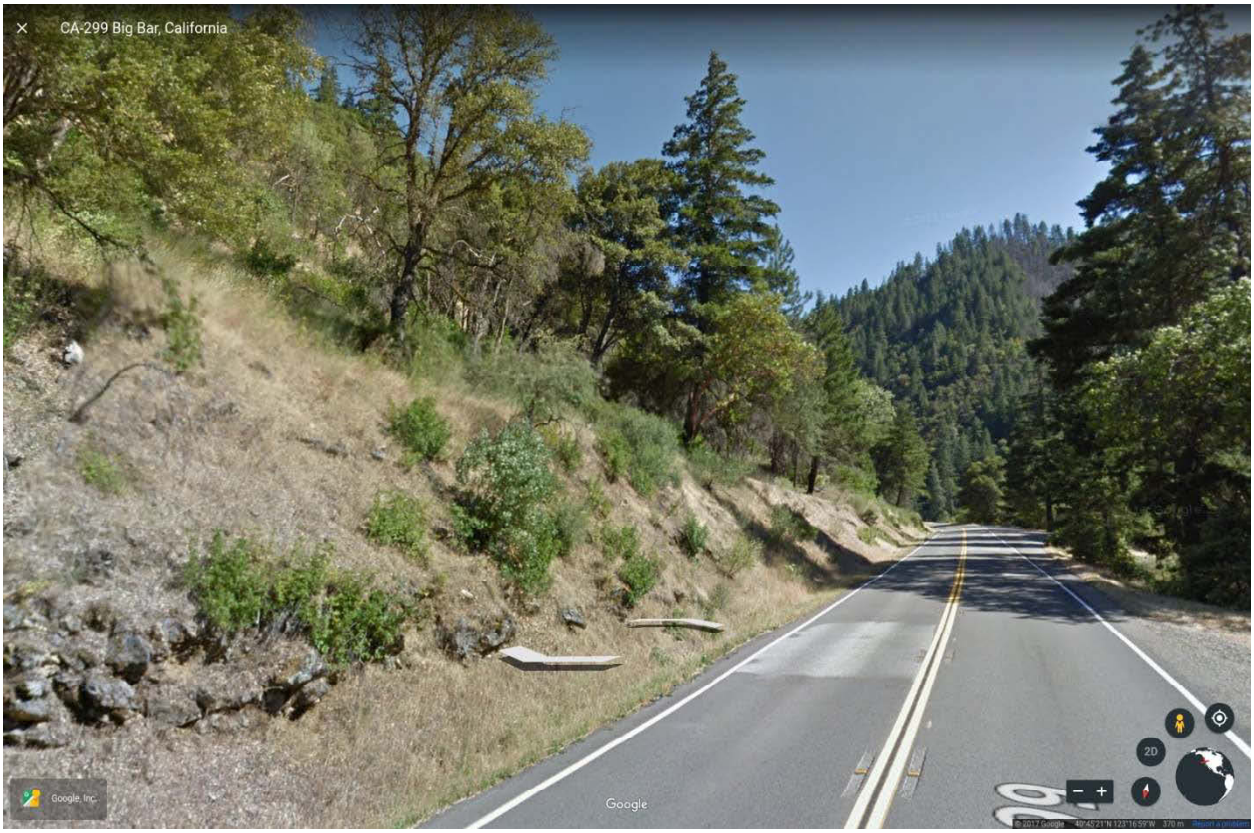


Figure 3.5: District 2 Report 4 generated and sent from TRI 299 26.356R

Shown above in Figure 3.5 is the satellite-facing view from the coordinates contained in the fourth incident report. The purpose of this image is to show the partially obstructed view of the sky due to the nearby foliage, the adjacent hill, and the reasonably tall mountain in the background. The report was successfully sent over the satellite communications system.

Figure 3.6: District 2 Report 5 generated and sent from TRI 299 29.066R

Shown above in Figure 3.6 is the satellite-facing view from the coordinates contained in the fifth incident report. The purpose of this image is to show the partially obstructed view of the sky due to the nearby foliage and the reasonably tall mountain in the background. Although the report was successfully sent over the satellite communications system, multiple copies of the report were received from the Responder system.

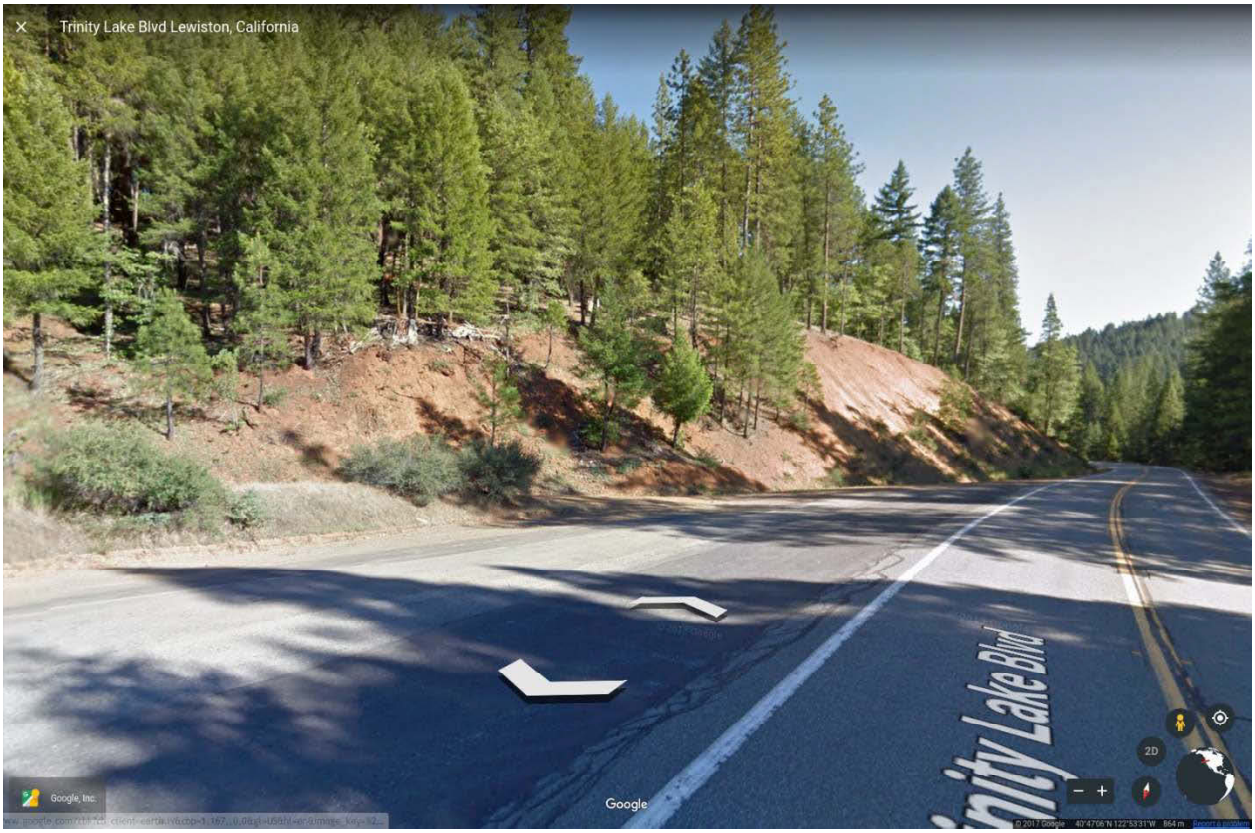


Figure 3.7: District 2 Report 6 generated and sent from TRI 299 37.053L

Shown above in Figure 3.7 is the satellite-facing view from the coordinates contained in the sixth incident report. The purpose of this image is to show the partially obstructed view of the sky due to the nearby foliage. Although the report was successfully sent over the satellite communications system, multiple copies of the report were received from the Responder system.

Upon further investigation, it has been determined that the multiple report receipts were due to a timeout setting that was set arbitrarily low for the test location.

Figure 3.8: District 2 Report 7 generated and sent from TRI 299 30.856L

Shown above in Figure 3.8 is the satellite-facing view from the coordinates contained in the seventh incident report. The purpose of this image is to show the view of the sky with nearby foliage and the mountain in the background. The report was successfully sent over the satellite communications system.

Additionally, it was reported that a single report not listed above was generated and attempts were made to send the report without successful receipt. The cause of the problem is currently inconclusive, and as a result, additional, detailed logging is being added to the mail manager to determine the cause. Aside from failure due to lack of satellite visibility, it is postulated that the cause of the failure to send is again related to timeouts that do not take into account the satellite modem bandwidth throttling due to link quality degradations from local geographic or foliage obstructions.

Following the conclusion of the District 2 VRS testing, we received two completed evaluation questionnaires, one from district management and one from the Weaverville maintenance yard staff. The questionnaires and any additional communications, contained in Appendix A, are summarized here.

Primary comments from Weaverville maintenance yard staff:

a. Great idea, needs some work

b. No opinion on helpfulness of roadway or weather information

c. Improves ability to communicate incidents to the TMC

d. Would like a Responder system

e. Typically field has 30-80 incidents a year depending on weather

f. Would use Responder system 75% of the time to respond to incidents

g. Would definitely use the Responder system for other maintenance work

h. Desire a cell phone option, tablet is somewhat cumbersome on scene

i. Need two-way communication (i.e., notification of report receipt and response from recipient)

Primary comments from district management:

a. Need more user notifications as to the state of the system

b. The system needs clear user feedback on all user interactions

c. Long message transmission times

d. Address reception of duplicate messages

Overall, the system performed as designed. The users were primarily interested in report entry, image capture, email generation, and transmission of the assembled message over the communications system in a send-it-and-forget-it fashion. Valuable feedback was provided from the various evaluators to aid in enhanced user experience, improved/enhanced functionality, and improvements in the incident reporting workflow. In general, the users would like more notifications reflecting the state of the system (i.e., message transmission status), improved transmission times, etc.

Round 1 in District 3

The VRS was delivered to District 3. However, evaluation was not conducted due to district resource issues.

Round 1 in District 4

The PRS was transferred to District 4 for their Round 1 month-long testing beginning August 7, 2017 and concluding September 20, 2017. The Responder system was tested primarily on the SF/Oakland Bay Bridge in several communications-challenged areas, including both the lower and upper decks. It is known that cellular communications over the wide-open top deck of the Bay Bridge is periodic in nature even though line-of-sight visibility to the nearest cell site is available. Cellular telecommunications engineers have stated that this is due to the propagation of the radio waves over water. As such, District 4 is very interested in drastically improving their communications coverage on the SF/Oakland Bay Bridge.

Following the conclusion of the District 4 PRS testing, we conducted a phone discussion with the primary maintenance yard staff performing the system evaluation. The verbal evaluation comments, contained in Appendix A, are summarized below.

Primary comments from SF/Oakland Bay Bridge maintenance yard staff:

a. Magnetic mount satellite blocks the District 4 light bars

b. Installation and removal of the PRS each day is a "pain"

c. The Responder system is "great," very "nice" does everything we need

d. When immediately powering on the system and driving the vehicle, the satellite takes a long time to acquire

Figure 3.9: District 4 light bar

Overall, the system performed as designed. The users were primarily interested in report entry, image capture, email generation, and transmission of the assembled message over the communications system in a send-it-and-forget-it fashion. Valuable feedback was provided from the evaluators to aid in enhanced user experience, improved/enhanced functionality, and improvements in the incident reporting workflow. In general, the District 4 users would like a fully vehicle-integrated system with the satellite mounted in a fashion compatible with their existing light bar.

Round 1 in District 9

The VRS was transferred to District 9 for their Round 1 month-long testing beginning August 14, 2017 and concluding September 26, 2017. The Responder system was tested in several communications-challenged areas throughout the district.

The VRS was tested in several rural locations, including the following locations (lat/long county route postmile). In each of these locations an incident report was generated, sent, and successfully received by the intended recipients.

1. 38° 28' 23.26" / -119° 27' 43.56" MNO SR 395 102.793R
2. 37° 16' 20.58" / -118° 9' 6.82" INY SR 168 30.688R
3. 37° 15' 23.8" / -118° 9' 26.1" INY SR 168 28.968R
4. 37° 15' 2.13" / -118° 10' 7.48" INY SR 168 28.048L
5. 37° 13' 39.99" / -118° 12' 44.44" INY SR 168 24.778L
6. 38° 23' 30.88" / -119° 10' 43.32" MNO SR 182 10.406L
7. 38° 21' 35.8" / -119° 12' 6.88" MNO SR 182 7.636L
8. 38° 20' 36.47" / -119° 12' 28.16" MNO SR 182 R6.270L

Each of the listed report locations had no cellular signal available; thus, the Responder system relied solely on the satellite to provide communications. The evaluation locations are shown below in Figure 3.10, followed by Street View satellite-facing views in Figures 3.11-3.15. Reports 6-8 have no Street View imaging, as Google considers them too remote for survey.

The Responder system specification calls for a maximum in-vehicle temperature of 120° F. District 9 was critical in testing Responder operation at higher temperatures. In the period for District 9's Round 1 testing, Caltrans reported ambient temperatures in the range 95° - 100° F. Archival records also note temperatures as high as 103° F in this period for the known testing areas. In-vehicle temperatures are often higher than ambient, and Caltrans estimates maximum in-vehicle temperature during their testing of approximately 110° F. District 9 personnel indicated that the Responder system never failed to operate due to temperature or for any other reason. This is a very positive result. AHMCT plans additional future testing with District 9 in temperatures closer to 120° F in a separate research effort to further confirm system function at the high end of the temperature specification.

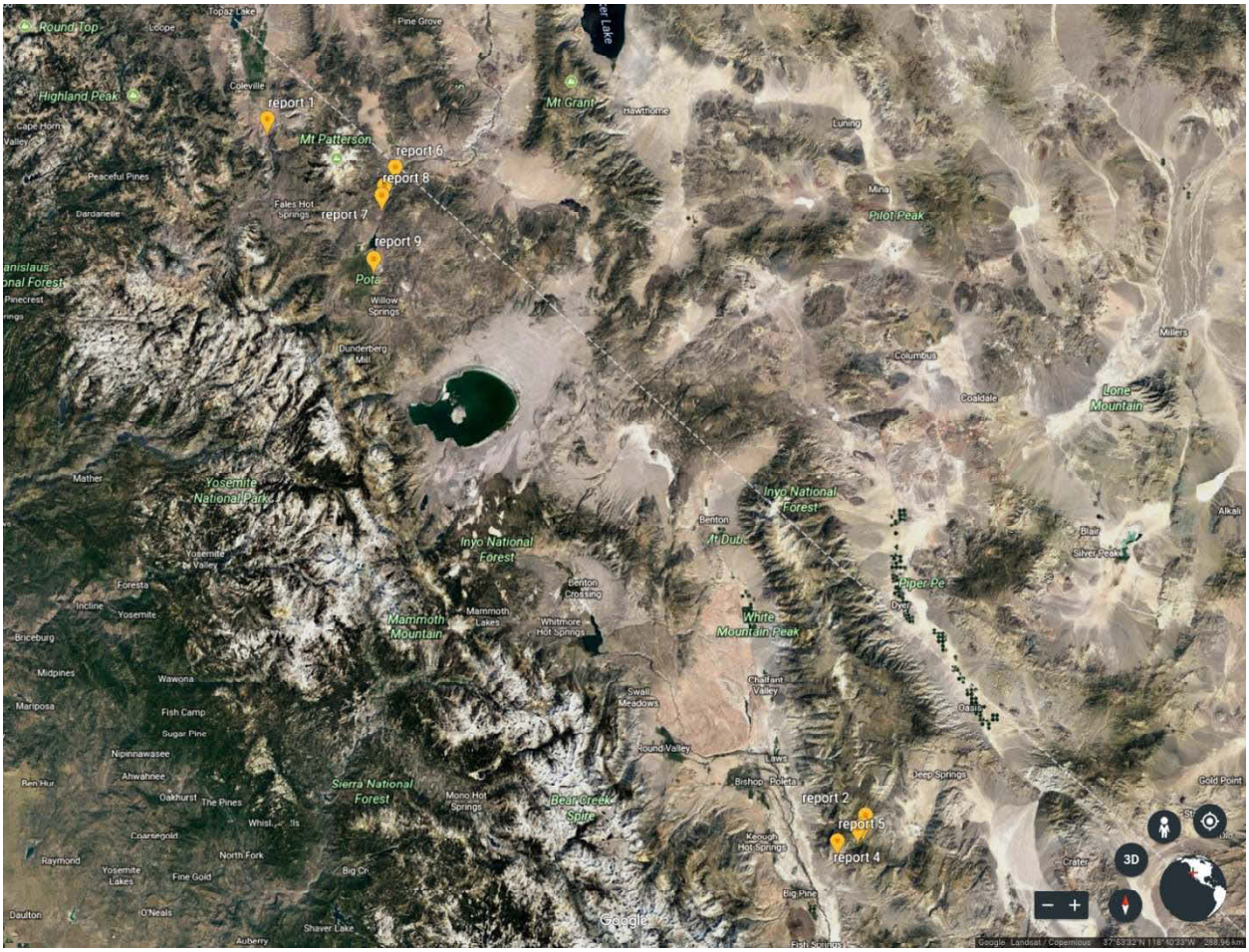


Figure 3.10: District 9 VRS evaluation locations

Figure 3.11: District 9 Report 1 generated and sent from MNO 395 102.793R

Shown above in Figure 3.11 is the satellite-facing view from the coordinates contained in the first incident report. The purpose of this image is to show the view of the sky with a pair of mountains in the background. The report was successfully sent over the satellite communications system.

Figure 3.12: District 9 Report 2 generated and sent from INY 168 30.688R

Shown above in Figure 3.12 is the satellite-facing view from the coordinates contained in the second incident report. The purpose of this image is to show the view of the sky in a remote area of District 9. The report was successfully sent over the satellite communications system.

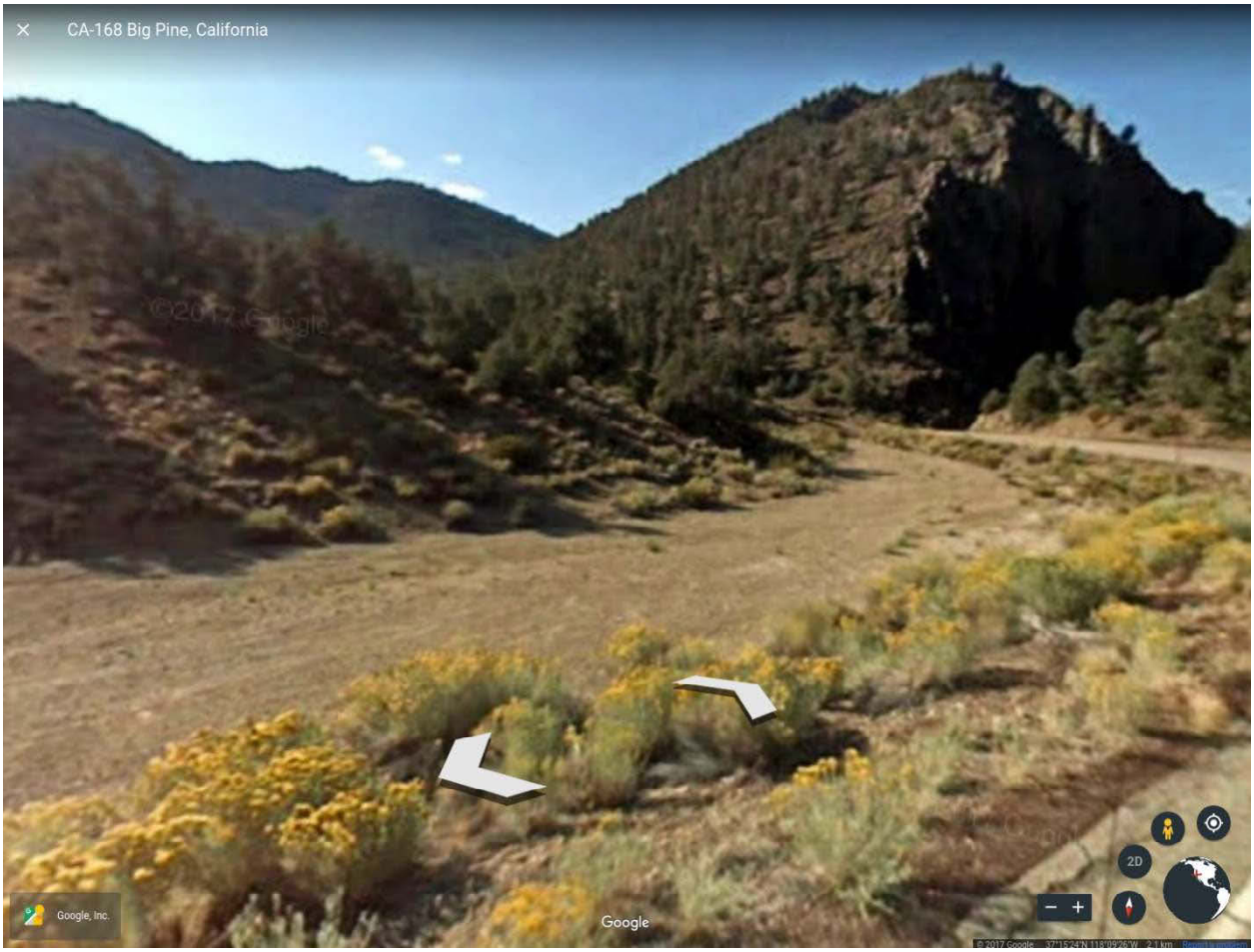


Figure 3.13: District 9 Report 3 generated and sent from INY 168 28.968R

Shown above in Figure 3.13 is the satellite-facing view from the coordinates contained in the third incident report. The purpose of this image is to show the view of the sky and the mountains in the background. The report was successfully sent over the satellite communications system.

Figure 3.14: District 9 Report 4 generated and sent from INY 168 28.048L

Shown above in Figure 3.14 is the satellite-facing view from the coordinates contained in the fourth incident report. The purpose of this image is to show the view of the sky with the mountains in the background. The report was successfully sent over the satellite communications system.

Figure 3.15: District 9 Report 5 generated and sent from INY 168 24.778L

Shown above in Figure 3.15 is the satellite-facing view from the coordinates contained in the fifth incident report. The purpose of this image is to show the view of the sky and the nearby mountain. The report was successfully sent over the satellite communications system.

Following the conclusion of the District 9 VRS testing, we received two completed evaluation questionnaires from district management and maintenance staff. The questionnaires and any additional communications, contained in Appendix A, are summarized here.

Primary comments from district management:

a. Well done, very intuitive

b. Did not use roadway or weather information much

c. Improves ability to communicate incidents to the TMC

d. Would like a Responder system

e. Typically field >10 incidents a year

f. Typically use the Responder system to respond to incidents 50% of the time

g. The Responder system would be used for other maintenance activities where other forms of communication are unavailable

h. Need to be able to conduct two-way communications

i. Satellite is the only communications option

Overall, the system performed as designed. The users were primarily interested in report entry, image capture, email generation, and transmission of the assembled message over the communications system in a send-it-and-forget-it fashion. Valuable feedback was provided from the various evaluators to aid in an enhanced user experience, improved/enhanced functionality, and improvements in the incident reporting workflow. In general, the users found the system to be very intuitive and that it provided enhanced communications coverage but it also needs to provide two-way communications.

Summary of All Round 1 Field Testing

Overall, the system performed as designed. The users were primarily interested in report entry, image capture, email generation, and transmission of the assembled message over the communications system in a send-it-and-forget-it fashion. They expressed less interest in the detailed roadway and weather information. Valuable feedback was provided from the various evaluators to aid in an enhanced user experience, improved/enhanced functionality, and improvements in the incident reporting workflow.

In general, District 2 users would like more notifications reflecting the state of the system (i.e., email message transmission status), recommendations to improve transmission times, etc. District 4 users would like a fully-integrated vehicular system with the satellite mounted in a fashion compatible with their existing light bar. Finally, District 9 users found the system to be very intuitive and that it provided enhanced communications coverage but found it also needs to provide two-way communications.

Round 2 in District 2

The updated Responder system, including improvements to email transmission status notification, was provided to District 2 for an additional round of testing. The system was delivered to District 2 in Redding on December 13, 2017. The vehicle was subsequently picked up from District 2 on February 16, 2018. While District 2 had the vehicle for approximately two months, their testing time was closer to 1.5 months due to holidays. The primary Round 2 testing was performed by the Weaverville Maintenance staff. AHMCT received a feedback form from District 2 for its Round 2 testing. This feedback, all quite positive, is included in Appendix A. Figures 3.16-3.28 provide actual reports including photos and other images as provided by District 2.

Responder
Name: Keith Koeppen Test
Organization: Caltrans
District: 2

Location
Lat/Lon: 40° 39' 16.59" -122° 45' 39.4"
Direction: WB
County: TRI
Route: 299
Postmile: 69.706L
Description: Chay was tired of driving and needed a break.
Infrastructure Type: Rest Area

Incident
Lanes Blocked: Yes
NB/EB total: 2
NB/EB blocked: 2
SB/WB total: 2
SB/WB blocked: 1
Type: Abandoned Vehicle
Vehicle Type: Trailer
Special Considerations: Gas Leak
Description:

Timestamp
Start: December 19, 2017 09:27
Open: December 19, 2017 09:27

Figure 3.16: District 2 Round 2 Report 1 generated and sent from TRI 299 69.706L

Responder Name: Keith Koeppen Organization: Caltrans District: 2 Location Lat/Lon: 40° 44' 19.68" - 122° 59' 27.31" Direction: County: TRI Route: 299 Postmile: 48.106R Description: Oregon Mtn CCTV\RWIS Infrastructure Type: Conventional Highway Incident Lanes Blocked: Yes NB/EB total: 1 NB/EB blocked: 1 SB/WB total: SB/WB blocked: Type: Emergency Closure, Jumper Vehicle Type: Trailer, Truck Special Considerations: Rockslide Description: Testing Responder Unit Timestamp: Start: December 19, 2017 10:49 Open: December 19, 2017 10:49	

Figure 3.17: District 2 Round 2 Report 2 (part 1) generated and sent from TRI 299 48.106R

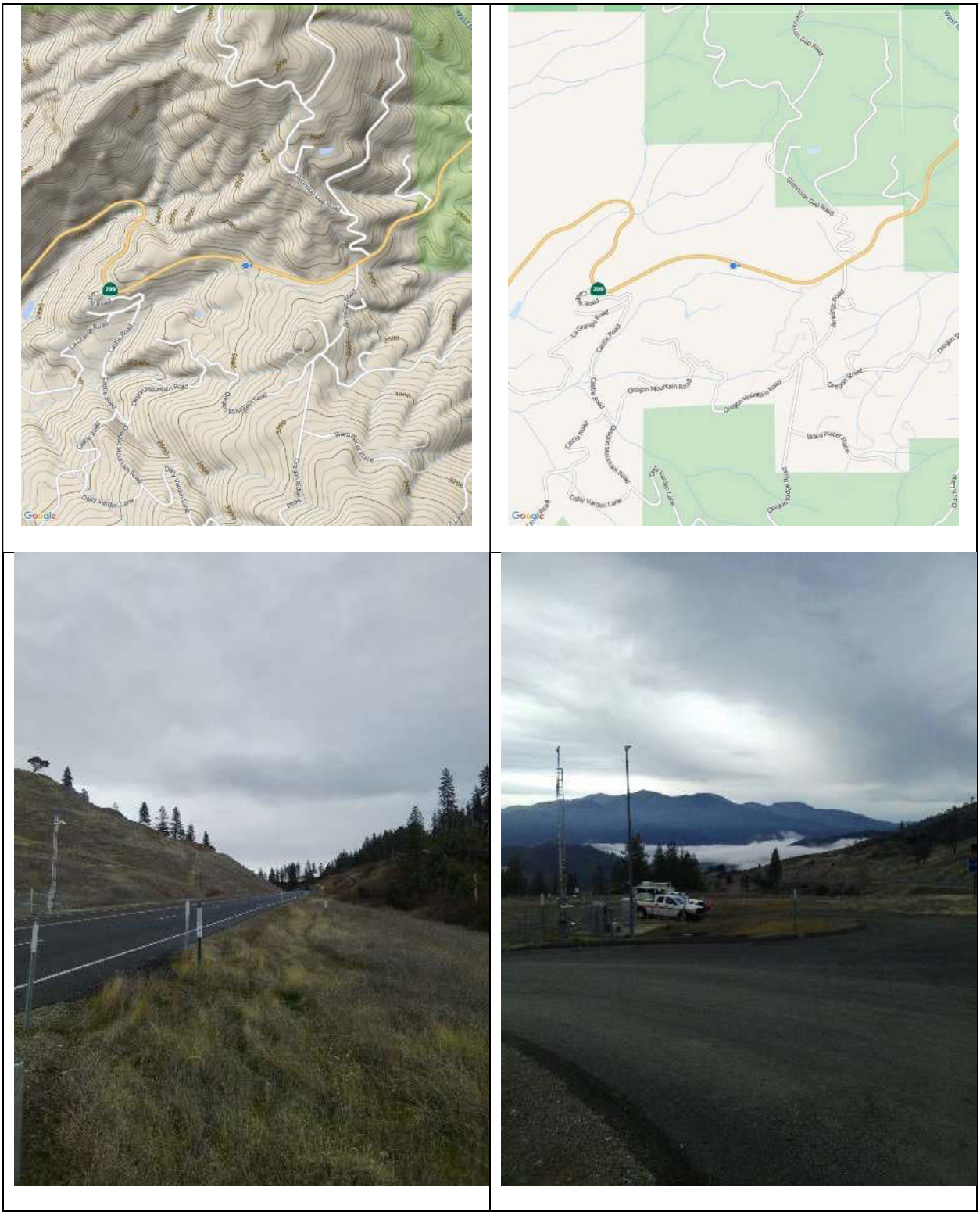


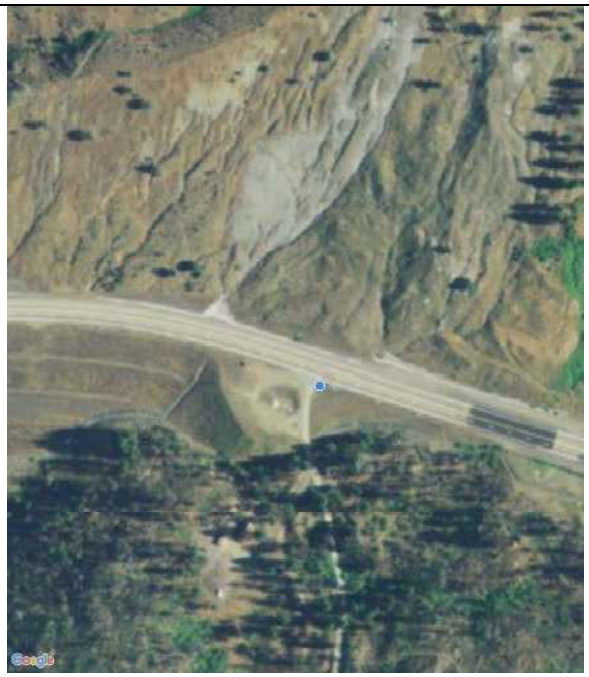
Figure 3.18: District 2 Round 2 Report 2 (part 2) generated and sent from TRI 299 48.106R

Responder
Name: Keith Koeppen
Organization: Caltrans
District: 2

Location
Lat/Lon: 40° 44' 19.68" -122° 59' 27.31"
Direction:
County: TRI
Route: 299
Postmile: 48.106R
Description: Oregon Mtn CCTV\RWIS
Infrastructure Type: Conventional Highway

Incident
Lanes Blocked: Yes
NB/EB total: 1
NB/EB blocked: 1
SB/WB total:
SB/WB blocked:
Type: Emergency Closure, Jumper
Vehicle Type: Trailer, Truck
Special Considerations: Rockslide
Description: Testing Responder Unit

Timestamp
Start: December 19, 2017 10:49
Open: December 19, 2017 10:49



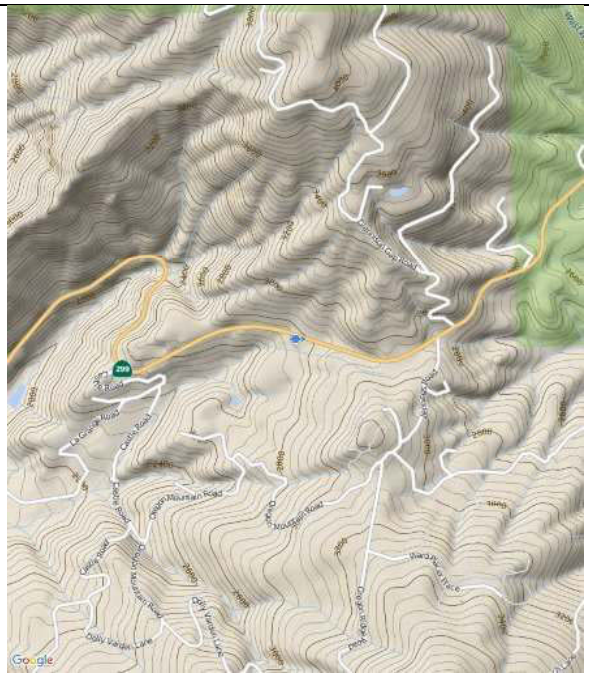


Figure 3.19: District 2 Round 2 Report 3 generated and sent from TRI 299 48.106R

Responder Name: m Crockett Organization: caltrans District: 2 Location Lat/Lon: 40° 38' 32.21" -122° 44' 51.27" Direction: WB County: TRI Route: 299 Postmile: 71.116R Description: old culvert , buckhorn Infrastructure Type: Conventional Highway Incident Lanes Blocked: No Type: Vehicle Type: Special Considerations: Description: Timestamp Start: December 29, 2017 14:05 Open: December 29, 2017 14:05	

Figure 3.20: District 2 Round 2 Report 4 generated and sent from TRI 299 71.116R

Responder Name: m Crockett Organization: caltrans District: 2 Location Lat/Lon: 40° 39' 45.49" -122° 48' 8.24" Direction: County: TRI Route: 299 Postmile: 67.136L Description: hazard tree removal Infrastructure Type: Conventional Highway Incident Lanes Blocked: No Type: Vehicle Type: Special Considerations: Description: Timestamp Start: January 10, 2018 12:39 Open: January 10, 2018 12:39	

Figure 3.21: District 2 Round 2 Report 5 generated and sent from TRI 299 67.136L

Responder Name: m Crockett Organization: caltrans District: 2 Location Lat/Lon: 40° 44' 49.75" -123° 3' 47.2" Direction: County: TRI Route: 299 Postmile: 42.086L Description: truck rollover Infrastructure Type: Conventional Highway, Mainline Incident Lanes Blocked: Yes NB/EB total: 1 NB/EB blocked: 1 SB/WB total: 1 SB/WB blocked: Type: Accident Minor Injuries Vehicle Type: Truck Special Considerations: Description: truck over turned, no load spilled, NO HAZMAT. Timestamp Start: January 11, 2018 10:24 Open: January 11, 2018 10:24	

Figure 3.22: District 2 Round 2 Report 6 generated and sent from TRI 299 42.086L

Responder Name: m Crockett Organization: caltrans District: 2 Location Lat/Lon: 40° 39' 8.21" -122° 56' 32.02" Direction: EB County: TRI Route: 299 Postmile: R57.922L Description: guardrail end treatment damage Infrastructure Type: Conventional Highway Incident Lanes Blocked: No Type: Vehicle Type: Special Considerations: Description: Timestamp Start: January 17, 2018 08:24 Open: January 17, 2018 08:24	

Figure 3.23: District 2 Round 2 Report 7 generated and sent from TRI 299 R57.922L

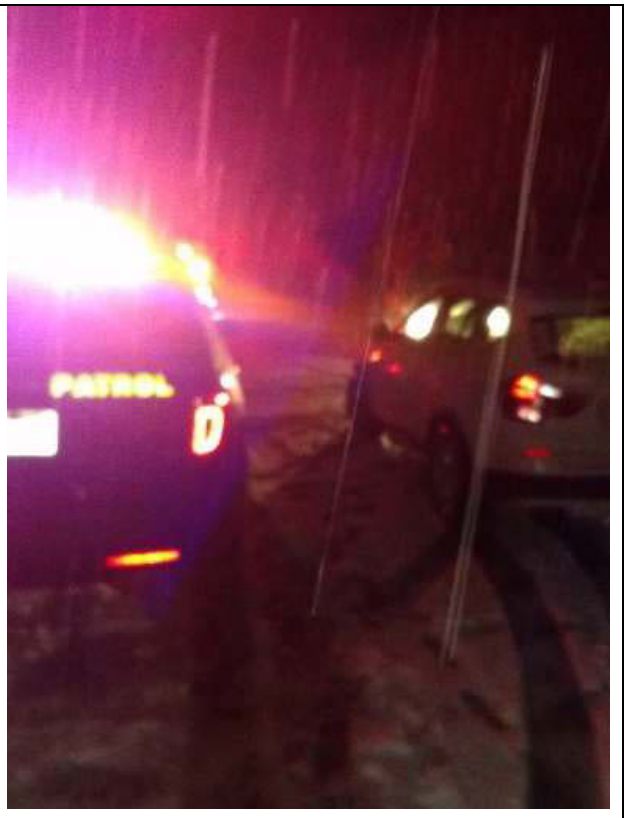
Responder Name: mcrockett Organization: caltrans District: 2 Location Lat/Lon: 40° 40' 11.25" -122° 52' 3.58" Direction: WB County: TRI Route: 299 Postmile: 63.186R Description: spin out Infrastructure Type: Conventional Highway Incident Lanes Blocked: No Type: Accident Property Damage Vehicle Type: Vehicle Special Considerations: Other Description: snow hwy 299 spinout roadway open to r2 Timestamp Start: January 21, 2018 17:24 Open: January 21, 2018 17:24	

Figure 3.24: District 2 Round 2 Report 8 generated and sent from TRI 299 63.186R

Responder Name: m Crockett Organization: caltrans District: 2 Location Lat/Lon: 40° 44' 31.03" -123° 0' 3.04" Direction: WB County: TRI Route: 299 Postmile: 46.996L Description: small slide Infrastructure Type: Conventional Highway Incident Lanes Blocked: No Type: Other Vehicle Type: Special Considerations: Rockslide Description: small slide, no lanes blocked Timestamp Start: January 22, 2018 15:03 Open: January 22, 2018 15:03	

Figure 3.25: District 2 Round 2 Report 9 generated and sent from TRI 299 46.996L

```
Responder
Name: m Crockett
Organization: caltrans
District: 2

Location
Lat/Lon: 40° 38' 21.09" -122° 44' 45.32"
Direction: WB
County: TRI
Route: 299
Postmile: 71.326R
Description: old culvert
Infrastructure Type: Conventional Highway

Incident
Lanes Blocked: No
Type:
Vehicle Type:
Special Considerations:
Description:

Timestamp
Start: January 31, 2018 14:10
Open: January 31, 2018 14:10
```

Figure 3.26: District 2 Round 2 Report 10 generated and sent from TRI 299 71.326R

Responder Name: m Crockett Organization: caltrans District: 2 Location Lat/Lon: 40° 37' 10.4" -122° 58' 58.85" Direction: County: TRI Route: 3 Postmile: 23.700L Description: flat tire Infrastructure Type: Conventional Highway Incident Lanes Blocked: No Type: Vehicle Type: Special Considerations: Description: Timestamp Start: February 08, 2018 10:40 Open: February 08, 2018 10:40	

Figure 3.27: District 2 Round 2 Report 11 generated and sent from TRI 299 23.700L

Responder
Name: Keith Koeppen
Organization: Caltrans
District: 2

Location
Lat/Lon: 40° 44' 19.87" -122° 59' 27.39"
Direction:
County: TRI
Route: 299
Postmile: 48.096L
Description: Oregon Mtn Drainage
Infrastructure Type:
Conventional Highway

Incident
Lanes Blocked: No
Type:
Vehicle Type:
Special Considerations:
Description:

Timestamp
Start: February 13, 2018 09:12
Open: February 13, 2018 09:12

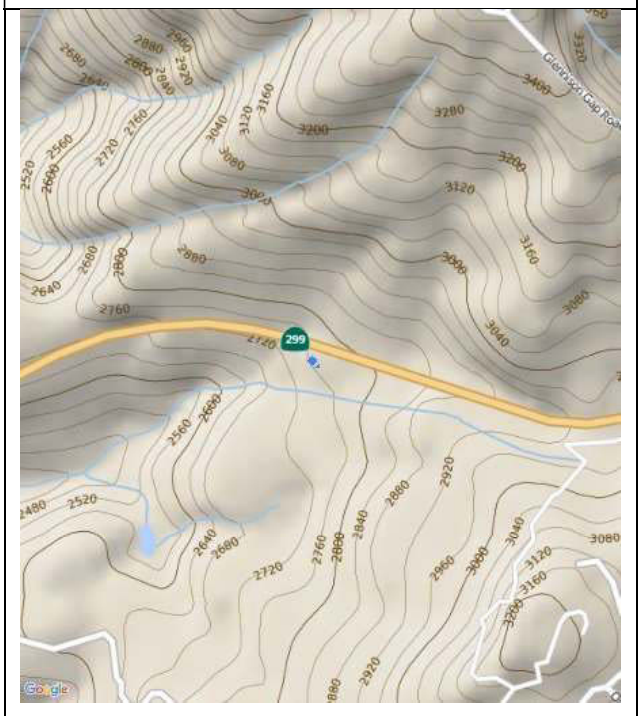


Figure 3.28: District 2 Round 2 Report 12 generated and sent from TRI 299 48.096L

Overall Field Testing Results

Based on the combined results of Round 1 and Round 2 field testing, the Responder system, as implemented, has met with strong acceptance from Caltrans. Round 1 testing certainly identified areas needing improvement, as expected at this stage of development. These issues were addressed or flagged for future research and development, as discussed in Chapter 4, depending on the nature of the issue. Round 2 testing results and feedback were strongly positive. Two significant issues were identified which were outside of the system requirements. These issues were deferred, and would need more detailed discussion with Caltrans staff to further define the needs and develop the system to meet these needs. The key issue identified in Round 1 that was deferred was a desire for two-way communication between the responder and the TMC and/or other report recipients. This was not part of the original vision or requirements; however, it is a clear need (in one case a requirement for adoption of the system) in multiple Caltrans districts and should be addressed in the future. Additionally, many districts expressed a significant need to provide the ability for existing Caltrans internet-capable equipment to leverage the advanced communications resources afforded them by the Responder system, i.e. to have the Responder system act as a Wi-Fi hotspot. Both of these needs, outside the scope of the current system requirements, have been expressed multiple times by multiple districts as a result of both official and unofficial field testing trials and would necessitate a future non-manufacturing research and development effort to implement.

CHAPTER 4:
RESPONDER SYSTEM REVISIONS IN RESPONSE TO FIELD TESTING FEEDBACK

Feedback from Maintenance end users as well as district management provided a list of desired modifications to the Responder system. Based on limited resources, particularly project time, these requests were prioritized in conjunction with the TAG. Some were flagged as required before proceeding to Round 2 field testing. Others were preserved as desired enhancements suited for future research and development. All requests, whether addressed or not, have been documented.

Feedback Requiring System Updates

The following represent feedback requiring system updates:

a. Add incident description to Report screen

b. Add car mount for tablet

c. Increase the "lanes blocked" options

d. Modify the initiated mail send notification

e. Consider reducing the default image size

f. Address reception of duplicate messages

g. Address long message transmission times

h. Add or improve notification details

i. Set Report timestamp default to "now"

j. Add percentage or total lanes blocked

k. Add "toll plaza" option to infrastructure type

l. Auto-populate district number

m. Automatically create Report identification title based on Report contents

n. Rename "open" to "estimated time of opening"

o. Change snapshot icon

p. Add border around selected items in gallery

q. Consider sorting contacts by last name in mail

r. Consider automating attachment size selection

s. Filter data feeds by district

t. Add ability to disable specific feeds

u. Add "cancel request" capability

Feedback Saved for Future Research and Development

Two significant issues were identified which were outside of the system requirements. These issues were deferred, and would need more detailed discussion with Caltrans staff to further define the needs and develop the system to meet these needs. The primary feedback that was received from several districts, and in one case a requirement for adoption of the system, was the desire or requirement for two-way communication between the responder and the TMC and/or other report/message recipients. While this is technically feasible, the Responder system was specified and designed by the TAG to be a uni-directional communications system based on email messaging. Since the Internet is ubiquitous in our daily lives, it is common for end users to wonder why such a common, taken-for-granted feature does not exist in this advanced Responder system. It is important to note that the system was designed for send-it-and-forget-it communication over email in a single direction, from the first responder to the TMC (or others). The system automatically determines the best communication technology (cellular or satellite) and attempts to send the message immediately. If communications are currently unavailable, the Responder system stores and forwards the message when communications are available. The Responder system is purposefully not server-centric by specification and design, and as such, it does not regularly poll the server to see if new messages are available to download. Additionally, satellite communications bandwidth is expensive, and we would not want to utilize standard polling methodologies. The proper solution, considering periodic network availability, costs, and responder workflow, would be to allow manual polling of an endpoint to retrieve email responses. While implementation of this widely-requested need is out of the scope of this current effort, it does constitute highly valuable future non-manufacturing research and development.

Many districts also expressed a significant need to provide existing Caltrans internet-capable equipment the ability to leverage the advanced communications resources afforded them by the Responder system. While the existing Responder hardware and software subsystems can be configured into a mobile hotspot for use with other internet-capable systems, the existing choice would be either 'all on' or 'all off,' leaving resource management to a foreign device. This could easily result in accidental misuse of expensive satellite communications or other undesirable usage. The solution is to research the various end-user use cases and develop an appropriate management interface into the Responder system application that allows enabling/disabling hotspot capabilities based upon communications service bandwidth, date/time, location, total data consumed, device, etc. The research would also develop the associated modifications to the communications arbiter.

Both of these needs, which are outside the scope of the current system requirements, have been expressed multiple times by multiple districts as a result of both official and unofficial field testing trials and would necessitate a future non-manufacturing research and development effort to implement.

CHAPTER 5:
CONCLUSIONS AND FUTURE RESEARCH

Key contributions of this research project included:

- Detailed field testing of the Responder system by Caltrans Maintenance end users;
- Responder system updates based on Maintenance users' feedback;
- Development of a Responder system, meeting the Caltrans committee-developed and approved system requirements, fully ready for deployment based on field testing results. This represents the successful culmination of a long research and development process by both WTI and AHMCT and is a significant milestone for Caltrans.

Future work under the Responder Transition project includes:

- Update Responder manufacturing mechanical documentation;
- Update Responder manufacturing electrical wiring documentation;
- Update Responder software documentation;
- Transition knowledge of the Responder system to a third-party vendor to enable them to reproduce 10+ units and deploy those units to the Caltrans districts.

Several maintenance end-user and supervisor evaluator requests from the district field testing have been flagged as significant future research areas. These include but are not limited to:

- Communications back to the Responder system from the TMC;
- Provide existing Caltrans internet-capable equipment the ability to communicate to the internet through the Responder system.

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APPENDIX A:
RESPONDER FIELD TESTING QUESTIONNAIRE

This appendix provides the Responder field testing questionnaire along with all responses received from Caltrans Maintenance staff.

Responder Field Testing Questionnaire

The researchers at the AHMCT Research Center want to ask you some questions about your opinion of the Responder system. We will not be recording your identity and this information will not associated with you or be used as a means of evaluating your performance. We are only interested in your opinion of the Responder system. We will share our analysis of the anonymous results of all responses as a summary to Caltrans.
Your participation is completely voluntary and much appreciated. Your response could lead to system improvements. Whether or not you participate in this questionnaire will have no bearing on your standing in your job.

Background: The Responder system has been developed to support Caltrans emergency incident response. The purpose of the system is to allow first responders to provide information to get the right equipment and personnel dispatched to the site. The Responder system is meant to provide an easy to use means to accurately collect and communicate at-scene information with their managers and the TMC.

Instructions:

For questions with boxes, please check the box for your answer. For example:

Did you receive training to operate the Responder system (check box)?

☒ Yes ☐ No ☐ No opinion

For questions with numbers, please circle the number for your answer. For example:

How easy do you feel the Responder system is to use (circle number)?

(Difficult) 1 2 3 (4) 5 (Easy)
6 (No opinion)

Responder Field Testing Questionnaire

1. **Which Responder system did you use?**

   ☐ Vehicular (in Dodge truck) ☐ Both

   ☐ Portable ☐ Neither

2. **How easy do you feel the Responder system is to use?**

   (Difficult) 1 2 3 4 5 (Easy)
   6 (No opinion)

3. **Did you receive training to operate the Responder system?**

   ☐ Yes ☐ No ☐ No opinion

4. **How good was the training you received?**

   (Poor) 1 2 3 4 5 (Excellent)
   6 (No opinion)

5. **How easy was it to send a quick abbreviated incident report when you first reach the scene?**

   (Difficult) 1 2 3 4 5 (Easy)
   6 (No opinion)

6. **Were you able to document incidents with photos?**

   ☐ Yes ☐ No ☐ No opinion

7. **How helpful did you feel the roadway information provided by Responder was?**

   (Not helpful) 1 2 3 4 5 (Very helpful)
   6 (No opinion)

8. **How helpful did you feel the weather information provided by Responder was?**

   (Not helpful) 1 2 3 4 5 (Very helpful)
   6 (No opinion)

9. **Were you able to fill out a complete incident report and send the corresponding email?**

   ☐ Yes ☐ No ☐ No opinion

10. **How much do you feel the Responder system improves your ability to respond to incidents?**

    (No improvement) 1 2 3 4 5 (Significant improvement)
    6 (No opinion)

11. **Does the Responder system improve your ability to communicate incidents to the TMC?**

    ☐ Yes ☐ No ☐ No opinion

12. **Would you be interested in having a Responder system available in your district?**

    ☐ Yes ☐ No ☐ No opinion

13. **Would you be interested in having a Responder system available in your maintenance area?**

    ☐ Yes ☐ No ☐ No opinion

Responder Field Testing Questionnaire

14. How often in a typical year does your maintenance area respond to incidents?

Less than two times 2-4 4-6 6-8 8-10 Greater than 10 times

15. For the times your maintenance area responds to incidents, roughly what percentage of the time do you think you would use a Responder system?

- ☐ 100%
- ☐ 75%
- ☐ 50%
- ☐ 25%
- ☐ Never

Responder Field Testing Questionnaire

16. What other types of maintenance work would you use the Responder system?

_____

_____

17. Do you have any suggestions that could improve the effectiveness and ease of use of the Responder system for Caltrans incident response?

_____

_____

_____

18. Do you have any suggestions for additional features or capabilities for the Responder system?

_____

_____

_____

19. Do you have any other comments about the Responder system or your experience with it?

_____

_____

Round 1 D2 Questionnaire Responses

Responder Field Testing Questionnaire

The researchers at the ATIMCT Research Center want to ask you some questions about your opinion of the Responder system. We will not be recording your identity and this information will not associated with you or be used as a means of evaluating your performance. We are only interested in your opinion of the Responder system. We will share our analysis of the anonymous results of all responses as a summary to Caltrans.

Your participation is completely voluntary and much appreciated. Your response could lead to system improvements. Whether or not you participate in this questionnaire will have no bearing on your standing in your job.

Background: The Responder system has been developed to support Caltrans emergency incident response. The purpose of the system is to allow first responders to provide information to get the right equipment and personnel dispatched to the site. The Responder system is meant to provide an easy to use means to accurately collect and communicate at-scene information with their managers and the TMC.

1. Which Responder system did you use (check box)?

☒ Vehicular (in Dodge truck) ☐ Both

☐ Portable ☐ Neither

2. How easy do you feel the Responder system is to use (circle number)?

(Difficult) 1 2 3 4 5 (Easy)

6 (No opinion)

3. Did you receive training to operate the Responder system (check box)?

☒ Yes ☐ No ☐ No opinion

4. How good was the training you received?

(Poor) 1 (2) 3 4 5 (Excellent)

6 (No opinion)

5. How easy was it to send a quick abbreviated incident report when you first reach the scene?

(Difficult) 1 (2) 3 4 5 (Easy)

6 (No opinion)

6. Were you able to document incidents with photos (check box)?

☒ Yes ☐ No ☐ No opinion

7. How helpful did you feel the roadway information provided by Responder was?

(Not helpful) 1 2 3 (4) 5 (Very helpful)

6 (No opinion)

8. How helpful did you feel the weather information provided by Responder was?

(Not helpful) 1 2 3 4 5 (Very helpful)

(6) (No opinion)

You can e-mail additional comments to Ty Lasky at tjlasky@ucdavis.edu.

1

Responder Field Testing Questionnaire

9. Were you able to fill out a complete incident report and send the corresponding email (check box)?

☑ Yes ☐ No ☐ No opinion

10. How much do you feel the Responder system improves your ability to respond to incidents?

(No improvement) 1 2 3 4 5 (Significant improvement)
(6) (No opinion)

11. Does the Responder system improve your ability to communicate incidents to the TMC (check box)?

☒ Yes ☐ No ☐ No opinion

12. Would you be interested in having a Responder system available in your district (check box)?

☐ Yes ☐ No ☑ No opinion

13. Would you be interested in having a Responder system available in your maintenance area (check box)?

☐ Yes ☐ No ☑ No opinion

14. How often in a typical year does your maintenance area respond to incidents?

N/A

15. For the times your maintenance area responds to incidents, roughly what percentage of the time do you think you would use a Responder system?

☐ 100% ☐ 50% ☐ Never
☐ 75% ☐ 25%

16. What other types of maintenance work would you use the Responder system?

You can e-mail additional comments to Ty Lasky at tglasky@ucdavis.edu

Responder Field Testing Questionnaire

17. Do you have any suggestions that could improve the effectiveness and ease of use of the Responder system for Caltrans incident response?

QUICK INCIDENT BUTTON THAT WOULD SEND REPORT WITH A QUICK IMAGE AND MAP W/ IM "PIC" TO DEFAULT CONTACT LIST.

18. Do you have any suggestions for additional features or capabilities for the Responder system?

SEE #17.

19. Do you have any other comments about the Responder system or your experience with it?

THE SYSTEM NEEDS CLEAR FEED BACK ON ALL USER INTERACTIONS.

You can e-mail additional comments to Ty Lasky at tmlasky@ucdavis.edu.

Responder Field Testing Questionnaire

~~AHMCT 6/7/17~~

~~Responder Field Testing Questionnaire~~

The researchers at the AHMCT Research Center want to ask you some questions about your opinion of the Responder system. We will not be recording your identity and this information will not associated with you or be used as a means of evaluating your performance. We are only interested in your opinion of the Responder system. We will share our analysis of the anonymous results of all responses as a summary to Caltrans.

Your participation is completely voluntary and ~~very~~much appreciated. Your response could lead to system improvements. Whether or not you participate in this questionnaire will have no bearing on your standing in your job.

Background: The Responder system has been developed to support Caltrans emergency incident response. The purpose of the system is to allow first responders to provide information to get the right equipment and personnel dispatched to the site. The Responder system is meant to provide an easy to use means to accurately collect and communicate at-scene information with their managers and the TMC.

1. Which Responder system did you use (check box)?

☒ Vehicular (in Dodge truck) ☐ Both

☐ Portable ☐ Neither

2. How easy do you feel the Responder system is to use (circle number)?

(Difficult) 1 2 3 (4) 5 (Easy)

6 (No opinion)

3. Did you receive training to operate the Responder system (check box)?

☒ Yes ☐ No ☐ No opinion

4. How good was the training you received?

(Poor) 1 2 3 (4) 5 (Excellent)

6 (No opinion)

5. How easy was it to send a quick abbreviated incident report when you first reach the scene?

(Difficult) 1 2 3 (4) 5 (Easy)

6 (No opinion)

Responder Field Testing Questionnaire

~~AHMCT 6/7/17~~

6. Were you able to document incidents with photos (check box)?

☒ Yes ☐ No ☐ No opinion

7. How helpful did you feel the roadway information provided by Responder was?

(Not helpful) 1 2 3 4 5 (Very helpful)
6 (No opinion)

8. How helpful did you feel the weather information provided by Responder was?

(Not helpful) 1 2 3 4 5 (Very helpful)
6 (No opinion)

9. Were you able to fill out a complete incident report and send the corresponding email (check box)?

☒ Yes ☐ No ☐ No opinion

10. How much do you feel the Responder system improves your ability to respond to incidents?

(No improvement) 1 2 3 4 5 (Significant improvement)
6 (No opinion)

Responder Field Testing Questionnaire

~~AHMCT 6/7/17~~

~~15.~~11. **Does the Responder system improve your ability to communicate incidents to the TMC (check box)?**

☒ Yes ☐ No ☐ No opinion

~~16.~~12. **Would you be interested in having a Responder system available in your district (check box)?**

☒ Yes ☐ No ☐ No opinion

~~17.~~13. **Would you be interested in having a Responder system available in your maintenance ~~yard~~area (check box)?**

☒ Yes ☐ No ☐ No opinion

~~18.~~14. **How often in a typical year does your maintenance ~~yard~~ area respond to incidents?**

30 - 80 A YEAR,
DEPENDING ON WEATHER
ROCK SLIDES AND TRUCK WRECKS
TREES THAT FALL, GUARDRAIL HITS ETC,

~~9.~~15. **For the times your maintenance area~~yard~~ responds to incidents, roughly what percentage of the time do you think you would use a Responder system?**

☐ 100% ☐ 50% ☐ Never

☒ 75% ☐ 25%

~~16.~~ **~~For w~~What other types of maintenance work would you use the Responder system?**

FOR MECHANIC
BRAKE DOWNS ON THE JOB FOR PARTS/REPAIRS
SAFETY ISSUES THAT NEED TO BE REPAIRED
OR SAFETY ISSUES THAT HAVE BEEN DONE.
FOR DOCUMENTATION.

~~17.~~ **Do you have any suggestions that could improve the effectiveness and ease of use of the Responder system for Caltrans incident response?**

CELL PHONE OPTION - TABLET CAN
BE CUMBERSOME ON ACCIDENT SCENE.
TABLET NEEDS DOCKING STATION IN
TRUCK.

You can e-mail additional comments to Ty Lasky at talasky@ucdavis.edu

Responder Field Testing Questionnaire

~~AHMCT 6/7/17~~

18. **Do you have any suggestions for additional features or capabilities for the Responder system?**

WHEN MAKING A REPORT IT NEEDS A TITLE AREA SO WHEN YOU HAVE SEVERAL REPORTS YOU CAN FIND IT.
~~WHEN SENDING REPORT THERE IS~~ NO WAY TO KNOW IT WAS RECIEVED.
NEED TO BEABLE TO RECIEVE ANSWER BACK FROM WHO YOU SEND REPORT TO.

19. **Do you have any other comments about the Responder system or your experience with it?**

GREAT IDEA, NEEDS SOME WORK.

Round 1 D4 Questionnaire Response

District 4 Evaluation Comments (Verbal Conversation)

1. Satellite blocks the light bars, need something smaller.
2. Would love to see the truck installation.
3. Installation and removal of the portable responder system each day is a "pain."
4. The responder system is "great," very "nice," does everything we need.
5. When immediately powering on the system and driving the vehicle the satellite takes a long time to acquire.
6. Consider installing satellite on top of the existing light bar.

Round 1 D9 Questionnaire Responses

PHILIP GRAHAM (760) 937-0565 V9

Responder Field Testing Questionnaire

The researchers at the ATIMCT Research Center want to ask you some questions about your opinion of the Responder system. We will not be recording your identity and this information will not associated with you or be used as a means of evaluating your performance. We are only interested in your opinion of the Responder system. We will share our analysis of the anonymous results of all responses as a summary to Caltrans.

Your participation is completely voluntary and much appreciated. Your response could lead to system improvements. Whether or not you participate in this questionnaire will have no bearing on your standing in your job.

Background: The Responder system has been developed to support Caltrans emergency incident response. The purpose of the system is to allow first responders to provide information to get the right equipment and personnel dispatched to the site. The Responder system is meant to provide an easy to use means to accurately collect and communicate at-scene information with their managers and the TMC.

Instructions:

For questions with boxes, please check the box for your answer. For example:

Did you receive training to operate the Responder system (check box)?

☒ **Yes** ☐ **No** ☐ **No opinion**

For questions with numbers, please circle the number for your answer. For example:

How easy do you feel the Responder system is to use (circle number)?

(Difficult) 1 2 3 (4) 5 (Easy)
6 (No opinion)

You can e-mail additional comments to Ty Lasky at tlasky@ucdavis.edu 1

Responder Field Testing Questionnaire

1. Which Responder system did you use?

☒ Vehicular (in Dodge truck) ☐ Both

☐ Portable ☐ Neither

2. How easy do you feel the Responder system is to use?

(Difficult) 1 2 3 (4) 5 (Easy)
6 (No opinion)

3. Did you receive training to operate the Responder system?

☑ Yes ☐ No ☐ No opinion

4. How good was the training you received?

(Poor) 1 2 3 4 (5) (Excellent)
6 (No opinion)

5. How easy was it to send a quick abbreviated incident report when you first reach the scene?

(Difficult) 1 2 3 (4) 5 (Easy)
6 (No opinion)

6. Were you able to document incidents with photos?

☒ Yes ☐ No ☐ No opinion

7. How helpful did you feel the roadway information provided by Responder was?

(Not helpful) 1 2 3 (4) 5 (Very helpful)
6 (No opinion)

8. How helpful did you feel the weather information provided by Responder was?

(Not helpful) 1 2 3 (4) 5 (Very helpful)
6 (No opinion)

LITTLE USE

9. Were you able to fill out a complete incident report and send the corresponding email?

☒ Yes ☐ No ☐ No opinion

10. How much do you feel the Responder system improves your ability to respond to incidents?

(No improvement) 1 2 3 (4) 5 (Significant improvement)
6 (No opinion)

11. Does the Responder system improve your ability to communicate incidents to the TMC?

☒ Yes ☐ No ☐ No opinion

12. Would you be interested in having a Responder system available in your district?

☒ Yes ☐ No ☐ No opinion

13. Would you be interested in having a Responder system available in your maintenance area?

☒ Yes ☐ No ☐ No opinion

You can e mail questions, comments to Ty Lasky at tjlasky@mtdava.edu 2

Responder Field Testing Questionnaire

14. How often in a typical year does your maintenance area respond to incidents?

Less than two times 2-4 4-6 6-8 8-10 Greater than 10 times

15. For the times your maintenance area responds to incidents, roughly what percentage of the time do you think you would use a Responder system?

☐ 100% ☒ 50% ☐ Never

☐ 75% ☐ 25%

16. What other types of maintenance work would you use the Responder system?

ANY WORK IN AREAS W/O CELL OR CT RADIO SERVICE

17. Do you have any suggestions that could improve the effectiveness and ease of use of the Responder system for Caltrans incident response?

NEED TO BE ABLE TO RECEIVE EMAIL FOR TWO-WAY COMMUNICATIONS WHERE SATELLITE IS THE ONLY COMMS OPTION (THIS FROM DISTRICT HAZMAT COORD & MAINT. YARD SUPERVISOR)

18. Do you have any suggestions for additional features or capabilities for the Responder system?

WI-FI TO CELLULAR INTERNET ACCESS TO USE FAMILIAR APPS ON USERS CELL PHONES.

19. Do you have any other comments about the Responder system or your experience with it?

* AUTO POPULATE TIME AND DATE W/ CURRENT DATA BY DEFAULT (ALREADY DONE - SO I HEAR)
* DOES NEED TO CHK DG CT RADIO PROGRAMMING

You can e-mail additional comments to Ty Lasky at tlasky@ucdavis.edu 3

EXAMPLE: BISHOP MAINT CHNL UP IN BISHOP!

09

Responder Field Testing Questionnaire

The researchers at the AHMCT Research Center want to ask you some questions about your opinion of the Responder system. We will not be recording your identity and this information will not associated with you or be used as a means of evaluating your performance. We are only interested in your opinion of the Responder system. We will share our analysis of the anonymous results of all responses as a summary to Caltrans.

Your participation is completely voluntary and much appreciated. Your response could lead to system improvements. Whether or not you participate in this questionnaire will have no bearing on your standing in your job.

Background: The Responder system has been developed to support Caltrans emergency incident response. The purpose of the system is to allow first responders to provide information to get the right equipment and personnel dispatched to the site. The Responder system is meant to provide an easy to use means to accurately collect and communicate at-scene information with their managers and the TMC.

Instructions:

For questions with boxes, please check the box for your answer. For example:

Did you receive training to operate the Responder system (check box)?

☒ Yes ☐ No ☐ No opinion

For questions with numbers, please circle the number for your answer. For example:

How easy do you feel the Responder system is to use (circle number)?

(Difficult) 1 2 3 (4) 5 (Easy)
6 (No opinion)

You can e-mail additional comments to Ty Lasky at tylasky@ucdavis.edu

Responder Field Testing Questionnaire

1. **Which Responder system did you use?**

   [X] Vehicular (ie. Dodge truck) [ ] Both

   [ ] Portable [ ] Neither

2. **How easy do you feel the Responder system is to use?**

   (Difficult) 1 2 3 (4) 5 (Easy)

   6 (No opinion)

3. **Did you receive training to operate the Responder system?**

   [X] Yes [ ] No [ ] No opinion

4. **How good was the training you received?**

   (Poor) 1 2 3 (4) 5 (Excellent)

   6 (No opinion)

5. **How easy was it to send a quick abbreviated incident report when you first reach the scene?**

   (Difficult) 1 2 3 4 (5) (Easy)

   6 (No opinion)

6. **Were you able to document incidents with photos?**

   [X] Yes [ ] No [ ] No opinion

7. **How helpful did you feel the roadway information provided by Responder was?**

   (Not helpful) 1 2 (3) 4 5 (Very helpful)

   6 (No opinion)

8. **How helpful did you feel the weather information provided by Responder was?**

   (Not helpful) 1 2 (3) 4 5 (Very helpful)

   6 (No opinion)

9. **Were you able to fill out a complete incident report and send the corresponding email?**

   [X] Yes [ ] No [ ] No opinion

10. **How much do you feel the Responder system improves your ability to respond to incidents?**

    (No improvement) 1 2 (3) 4 5 (Significant improvement)

    6 (No opinion)

11. **Does the Responder system improve your ability to communicate incidents to the TMC?**

    [ ] Yes [ ] No [X] No opinion

12. **Would you be interested in having a Responder system available in your district?**

    [ ] Yes [ ] No [X] No opinion

13. **Would you be interested in having a Responder system available in your maintenance area?**

    [ ] Yes [ ] No [X] No opinion

You can e-mail additional comments to Ty Lasky at tylasky@davis.org

2

Responder Field Testing Questionnaire

14. How often in a typical year does your maintenance area respond to incidents?

Less than two times 2-4 4-6 6-8 (8-10) Greater than 10 times

15. For the times your maintenance area responds to incidents, roughly what percentage of the time do you think you would use a Responder system?

☐ 100% ☒ 50% ☐ Never

☐ 75% ☐ 25%

16. What other types of maintenance work would you use the Responder system?

17. Do you have any suggestions that could improve the effectiveness and ease of use of the Responder system for Caltrans incident response?

Can you make it possible to add contacts to tablet from responder app. Allow minimal type edits from Responder mail.

18. Do you have any suggestions for additional features or capabilities for the Responder system?

Allow for the system to receive communications.

19. Do you have any other comments about the Responder system or your experience with it?

In non-radio and non-cell area you may need more equipment to communicate with TMC.

You can e-mail additional comments to Ty Lasky at tlasky@uidaho.edu

3

Round 2 D2 Questionnaire Responses

Responder Field Testing Questionnaire

1. **Which Responder system did you use?**

   ☒ Vehicular (in Dodge truck) ☐ Both

   ☐ Portable ☐ Neither

2. **How easy do you feel the Responder system is to use?**

   (Difficult) 1 2 3 4 (5) (Easy)

   6 (No opinion)

3. **Did you receive training to operate the Responder system?**

   ☒ Yes ☐ No ☐ No opinion

4. **How good was the training you received?**

   (Poor) 1 2 3 (4) 5 (Excellent)

   6 (No opinion)

5. **How easy was it to send a quick abbreviated incident report when you first reach the scene?**

   (Difficult) 1 2 3 (4) 5 (Easy)

   6 (No opinion)

6. **Were you able to document incidents with photos?**

   ☒ Yes ☐ No ☐ No opinion

7. **How helpful did you feel the roadway information provided by Responder was?**

   (Not helpful) 1 2 3 4 (5) (Very helpful)

   6 (No opinion)

8. **How helpful did you feel the weather information provided by Responder was?**

   (Not helpful) 1 2 3 4 5 (Very helpful)

   (6) (No opinion)

9. **Were you able to fill out a complete incident report and send the corresponding email?**

   ☒ Yes ☐ No ☐ No opinion

10. **How much do you feel the Responder system improves your ability to respond to incidents?**

    (No improvement) 1 2 3 4 (5) (Significant improvement)

    6 (No opinion)

11. **Does the Responder system improve your ability to communicate incidents to the TMC?**

    ☒ Yes ☐ No ☐ No opinion

12. **Would you be interested in having a Responder system available in your district?**

    ☒ Yes ☐ No ☐ No opinion

13. **Would you be interested in having a Responder system available in your maintenance area?**

    ☒ Yes ☐ No ☐ No opinion

You can e-mail additional comments to Ty Lasky at [illegible]

2

Responder Field Testing Questionnaire

14. How often in a typical year does your maintenance area respond to incidents?

Less than two times 2-4 4-6 6-8 8-10 (Greater than 10 times)

15. For the times your maintenance area responds to incidents, roughly what percentage of the time do you think you would use a Responder system?

☐ 100% ☒ 50% ☐ Never

☐ 75% ☐ 25%

16. What other types of maintenance work would you use the Responder system?

PUBLIC SERVICE REQUESTS TO SHOW WHEN THEY ARE COMPLETED.

17. Do you have any suggestions that could improve the effectiveness and ease of use of the Responder system for Caltrans incident response?

HAVE AT THIS TIME, ONCE YOU GET THE HANG OF IT IT'S PRETTY SIMPLE.

18. Do you have any suggestions for additional features or capabilities for the Responder system?

RECEIVE RESPONSE BACK FROM E MAIL

19. Do you have any other comments about the Responder system or your experience with it?

IF IT IS IMPLEMENTED, I BELIEVE IT'S A GOOD SYSTEM.

You can e-mail additional comments to Cy Lasky at lasky@pbworldwest.com

APPENDIX B:
RESPONDER SYSTEM USER'S GUIDE

APPENDIX C:
RESPONDER SYSTEM QUICK REFERENCE GUIDE