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The goal of this research was to transition the prototype Responder system from the AHMCT Research Center to a third-party vendor for manufacturing purposes. This final report is a summary of the project deliverables. The primary project deliverables have been provided as separate, standalone documents. At the conclusion of this research, Caltrans had not contracted with a third-party vendor, due to unanticipated internal obstacles. Caltrans is considering establishing additional transition support using AHMCT's research capabilities. This report provides an overview of the current project, a summary of the separately provided deliverables, and brief conclusions and future research.

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# Advanced Highway Maintenance and Construction Technology Research Center

Department of Mechanical and Aerospace Engineering
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## Responder Study - Interim Phase I - Continued Support for Responder Transition

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Ty A. Lasky: Principal Investigator

Report Number: CA22-3756
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December 2, 2021

# California Department of Transportation

Division of Research, Innovation and System Information

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# List of Acronyms and Abbreviations

| Acronym | Definition |
|---|---|
| 3D | Three-Dimensional |
| AHMCT | Advanced Highway Maintenance and Construction Technology Research Center |
| Caltrans | California Department of Transportation |
| COTS | Commercial Off-The-Shelf |
| DGS | Department of General Services |
| DOE | Division of Equipment |
| DRISI | Division of Research, Innovation and System Information |
| IT | Information Technology |
| LPA | Leveraged Procurement Agreement |
| MSU | Montana State University |
| PRS | Portable Responder System |
| TMC | Transportation Management Center |
| VRS | Vehicular Responder System |
| WTI | Western Transportation Institute |

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# Chapter 1: Introduction

## Problem

The California Department of Transportation (Caltrans) maintenance staff is a first responder to incidents on the state roadways. They must collect information, determine the appropriate response, and access and manage resources at-scene. Caltrans currently does not have an efficient means to collect at-scene incident information and share this information with their Transportation Management Center (TMC) and other emergency responders. In most districts, emergency responders rely on voice communications to exchange information. However, Caltrans rural 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 appropriate decisions. These rural districts have areas with no communication availability including no two-way radio communication and/or cellular coverage.

## Objective

The primary task objective was to transition the prototype Responder system from the Advanced Highway Maintenance and Construction Technology (AHMCT) Research Center to a third-party vendor for manufacturing purposes. This effort is a follow-on to a prior transition task, and was needed as a third-party vendor could not be contracted by Caltrans during that prior effort.

## Background

Incident response is a critical function for Caltrans. It is important to provide relevant and timely information to responders, such as weather conditions. 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 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 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 AHMCT Research Center migrated the prototype Responder system to 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, the update of requirements, review of commercial systems, design and development of the Phase III Responder system, and testing and reporting. 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 not available.

Under a recent effort, AHMCT supported detailed field testing of the Responder system in four Caltrans districts, and initial testing in several others [3]. The goal of that research was to evaluate the Responder system by way of extensive field testing and to address identified issues to be addressed to assure compliance with the requirements of the previous research project.

The prior research yielded a working and deployable product. Specifically, the Responder system is through Stage 4 of Caltrans' Five Stages of Research Deployment,[1] specifically it is through "First Application (Contract) Field Pilot Stage." In some respects, the system has progressed partially into Stage 5, "Specification & Standards with Full Corporate Deployment Stage," under this current research task. It is partially into Stage 5 due to the nature of the recent field testing as well as the current task's system documentation, 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 the case in the field testing research task, except AHMCT installed the system in the Caltrans vehicles or provided the portable system for Caltrans to install. Herein, AHMCT provided the same service that a contractor or company would with regard to system installation should Caltrans require such installation in the future.
- "Deployment is without research supervision or direction." This was the case in the field testing research task, with the exception of initial

[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)

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 the field testing research task, wherein AHMCT was available for consultation and troubleshooting by email and/or phone during all field testing.
- "Assesses results." The field testing assessment is provided as a part of the final report for the field testing research task.

Hence, the Responder system is now in Stage 5. A previous transition effort [4] and the current research effort to transition design information to a third-party vendor to allow them to reproduce the system for Caltrans certainly puts the system in Stage 5, full corporate deployment, as Caltrans then has a clear route to provide each district with a fully functional Responder system.

Due to the nature of the Responder system design, it is now 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 included herein, 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 California Department of General Services (DGS). 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. This includes the right for a third party to incorporate AHMCT's software for Caltrans' use. If this overall approach is followed, as is supported by the current Responder transition research effort, system maintenance should be available from the third-party Responder system manufacturer.

# Key Deliverables

- Satellite, cellular, and email services for the two systems
- Updated hardware/electrical documentation as needed
- Updated assembly video for the portable Responder system as needed

- Source code including comments
- Software revision history
- Documentation of all non-Caltrans data feed addresses, and assistance in setting up Caltrans accounts for these data feeds where needed
- Updated Responder Instruction Manual as needed
- Updated User's Guide as needed
- Updated project datasheet
- One-day training session to be held at AHMCT (omitted, as Caltrans has not contracted a third-party vendor)
- Training material from the training session(omitted, as Caltrans has not contracted a third-party vendor)
- Follow-up technical support to the vendor related to issues of clarity associated with material presented in the training session(omitted, as Caltrans has not contracted a third-party vendor)
- Summary Final Report (current document)

# Report Overview

This final report is a summary of the project deliverables. The primary project deliverables have been provided as separate, standalone documents or files. This report provides an overview of the project in Chapter 1, a summary of the separately provided deliverables in Chapter 2, and brief conclusions and future research in Chapter 3.

# Chapter 2:
# Project Deliverables Summary

As noted in Chapter 1, the primary project deliverables have been provided as separate, standalone documents or files. Table 2.1 provides a listing of the primary deliverables and, if needed, a brief explanatory note. The three proposed deliverables under Task 5 requiring availability of a vendor were not completed, as Caltrans has not yet identified a vendor, which was a prerequisite for these deliverables. This is noted in Table 2.1.

In addition to the proposed deliverables, AHMCT provided an interim report documenting the Responder database data fields definition [5].

**Table 2.1: Summary of project deliverables**

| Task | Deliverable | Notes |
|---|---|---|
| **1** | Satellite, cellular, and email services for the two systems | Satellite service to be procured for two systems in December, 2021 from California Department of Technology Leveraged Procurement Agreement (LPA) listed vendor. Cellular procured monthly through project. Email service procured annually throughout project. |
| **2** | Updated hardware/electrical documentation as needed | No update needed, refer to deliverable of Task 3098 |
| **2** | Updated assembly video for the portable Responder system as needed | No update needed, refer to deliverable of Task 3098 |
| **3** | Updated source code | Provided in separate repository for each module |

| Task | Deliverable | Notes |
|---|---|---|
| **3** | Software revision history for the task period as a Git repository | Provided separately as text file for each module |
| **3** | Documentation of all non-Caltrans data feed addresses, and assistance in setting up Caltrans accounts for these data feeds where needed | Interim deliverable, file *responderFeedsummary 20210908.xlsx* (or later) |
| **N/A** | Responder database data fields definition | Provided at the request of Caltrans IT, see Interim report [5] |
| **4** | Updated Responder Instruction Manual as needed | No update needed, refer to deliverable of Task 3098 |
| **4** | Updated User's Guide as needed | No update needed, refer to deliverable of Task 3098 |
| **4** | Updated project datasheet | Will be updated at close of project in coordination with project manager |
| **5** | One-day training session to be held at AHMCT | Omitted, no third-party vendor in project |
| **5** | Training material from the training session | Omitted, no third-party vendor in project |
| **5** | Follow-up technical support to the vendor related to issues of clarity associated with material presented in the training session | Omitted, no third-party vendor in project |
| **6** | Summary final report | This document |

# Chapter 3:
# Conclusions and Future Research

Key contributions of this research project included:

- Continued support for Caltrans use of the Vehicular Responder System (VRS) in District 2.
- Continued support for the Portable Responder System (PRS).
- Update of the PRS and VRS modem to dual service (Verizon and AT&T) modem, including hardware support for FirstNet/Band 14.
- Additional testing in Caltrans District 2.
- Continued support of Caltrans' bid process.
- Continued support of Caltrans IT requests.
- Updated system software documentation.
- Updated software revision history.
- System electrical documentation.
- System mechanical documentation.
- Responder Instruction Manual.
- User's Guide.

Future work includes continued support for Caltrans field use of the two existing Responder systems. The VRS is anticipated to be used in District 2. The PRS will be used on an as-needed basis throughout Caltrans. In addition, upon completion of the contract for a third-party vendor, AHMCT expects to provide in-person training to the selected vendor, and support for the vendor while they establish or modify their software development tool chain, install the Responder code base, and confirm that they are able to build the Responder software system.

# References


[1] D. Richter, K. Bateman, and D. Galarus, "Responder Phase 2 Final Report," *Western Transportation Institute*, 2009.

[2] S. Donecker, T. Swanston, K. Yen, B. Ravani, and T. Lasky, "Development and testing of Responder Phase III," AHMCT Research Center, UCD-ARR-15-09-30-05, Jun. 2017.

[3] S. Donecker, K. Yen, T. Swanston, B. Ravani, and T. Lasky, "Responder Study Phase 3: Testing and support," AHMCT Research Center, UCD-ARR-18-06-30-02, Jun. 2018.

[4] S. Donecker, T. Swanston, K. Yen, and T. Lasky, "Responder study Phase 4: Transition phase - Research and development in support of the implementation of the Responder system into Caltrans operations," AHMCT Research Center, UCD-ARR-19-09-30-02, 2019.

[5] T. Lasky, S. M. Donecker, and T. Swanston, "Responder Study - Interim Phase - Continued Support for Responder Transition: Data fields description," AHMCT Research Center, Interim report UCD-ARR-21-04-22-01, Apr. 2021.