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16. ABSTRACT

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. This report provides an overview of the project, a summary of the separately provided deliverables, and brief conclusions and future research

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Responder Study Phase 4: Transition Phase - Research and Development in Support of the Implementation of the Responder System into Caltrans Operations

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Ty A. Lasky: Principal Investigator

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California Department of Transportation

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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	Caltrans Division of Research, Innovation and System Information
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 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.

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 [3]. 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. 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. This effort is now complete.

The prior research has yielded a working product that is now deployable. More 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 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

[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)

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. 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, per the initial 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 supported by the current Responder transition research effort, system maintenance should be available from the third-party Responder system manufacturer.

Key Deliverables

- List of vendor required capabilities and responsibilities
- Mechanical documentation for the Responder system
- Assembly video for the portable Responder system and the in-vehicle electronics box
- Electrical wiring documentation for the Responder system
- Source code including comments
- High-level block diagram

- Hierarchical listing of source code files
- Instructions for installation of the executable software
- Instructions on system configuration
- Test and verification procedure
- Software revision history
- Export of the issue tracker
- Updated Responder Instruction Manual
- Updated User's Guide
- Updated project datasheet
- One-day training session to be held at AHMCT
- Training material from the training session
- Summary Final Report

Report Overview

This final report is a summary of the project deliverables. The primary project deliverables have been provided as separate, standalone documents. 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. Table 2.1 provides a listing of the primary deliverables, the delivery date, and, if needed, a brief explanatory note. Two proposed deliverables 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.

Table 2.1: Summary of project deliverables

Task	Deliverable	Notes
2	List of vendor required capabilities and responsibilities	Interim deliverable, file vendorCapabilities.pdf
3	Mechanical documentation	Interim report, file responder_mechanical.pdf
3	Assembly video for the portable Responder system and the in-vehicle electronics box	
4	Electrical wiring documentation	
5	Source code including comments	
5	High-level block diagram	
5	Hierarchical listing of source code files	
5	Instructions for installation of the executable software	
5	Instructions on system configuration	
5	Test and verification procedure	For validation of newly manufactured Responder systems
5	Software revision history	
5	Export of the issue tracker	

Task	Deliverable	Notes
6	Updated Responder Instruction Manual	
6	Updated User's Guide	
6	Updated project datasheet	
7	One-day training session to be held at AHMCT	Deferred as Caltrans has not selected vendor
7	Training material from the training session	Deferred as Caltrans has not selected vendor
8	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 extensive Caltrans use of the Portable Responder System (PRS) in District 4, as well as in strenuous testing on the Vincent Thomas Bridge in Los Angeles Harbor, and in extremely remote sections of the High Sierras.
- Additional testing in other participating Caltrans districts.
- Development of vendor requirements in support of Caltrans' bid process.
- Complete system software documentation.
- Complete system electrical documentation.
- Complete system mechanical documentation.
- High-level block diagram.
- Instructions for installation of the executable software.
- Instructions on system configuration.
- Test and verification procedure.
- Software revision history.
- Export of the issue tracker.
- Updated Responder Instruction Manual.
- Updated 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, 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, 2018.