The Redding Responder Project: Computing and Communication in the Middle of No-Where

National Rural ITS Conference 2006 Big Sky Montana Wednesday, August 16th, 2006 8:30 am Session H2: Innovative Data Collection and Sharing

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Related Sessions:

<u>The Redding Responder Project: Mobile Data Communication Challenges</u> <u>in Remote Rural Areas</u> Session A4: Innovative Communication Solutions Monday, August 14th, 9:45 am

<u>The Application of Systems and Software Engineering Process Models for</u> <u>Development on Small to Moderate-Sized ITS Projects: WeatherShare and</u> <u>the Redding Responder Projects</u> Session G2: Using Existing Technology in New Ways Tuesday, August 15th, 2:45 pm



Abstract:

In cooperation with the California Department of Transportation, Montana State University's Western Transportation Institute has developed a "proof-of-concept" mobile data communication system for use on any roadway, particularly in remote rural locations with little or no communication infrastructure.

The system consists of an integrated Tablet PC, cellular modem, satellite modem, GPS, digital camera, and custom-developed software.

First responders can use the system to collect incident information such as digital photos of a rockslide, highlight the photos and maps of the area using a pen, and transmit incident information literally from the middle of nowhere.

This presentation will provide an overview of the system and the challenges faced in building it.



A "Responder" Problem Question:

"There's a rock in the road. How big is it?"

Problem:

How do you convey this information to someone who isn't there, looking at the rock alongside you?



"A Picture is Worth a Thousand Words" A Caltrans District 2 Rockslide SR-70 Butte County



Source: Caltrans District 2



Incident Background from Press Release

REDDING – The California Department of Transportation (Caltrans) will begin immediate emergency road work to remove <u>soil and rocks, some measuring</u> <u>more than 15 feet in diameter from State Route (SR) 70 in Butte County</u>.

The slide <u>occurred February 25, 2004 at approximately 7:40 p.m. near Lake</u> Oroville, 1.5 mile west of Pulga. The roadway is open to one-way traffic control and it is anticipated that it will reopen to normal traffic at 8 p.m., <u>Friday, February 27, 2004.</u>

The <u>slide includes more than 200 yards of material, much of which are large</u> <u>pieces of rock, some weighing well over 200 tons</u>. Explosive devices will be used in the slide removal, and <u>during the blasting operations, the roadway will</u> <u>be completely closed for up to 20-minute intervals</u>.

In order to complete the blasting process, more than 40 holes must be drilled into the rock. Drilling will begin this afternoon and continue through the night. Beginning Friday morning the slow process of blasting will be completed in small sections to limit the amount of rock that is dispersed. Extra precautions will be taken due to the location of a major electrical transmission line just below the blast area. Caltrans personnel are handling the removal process with the exception of the drilling. Certified Blaster, Mark Vukich, who is a Caltrans Maintenance Supervisor, will conduct the blasting and other Caltrans maintenance staff will remove the roadway debris.



Source: Caltrans District 2



Additional Information

- The road was cleared on Saturday, February 28th.
- Phone lines at Pulga, 1.5 mi east were out.
- It was estimated that each incident photo would have taken 15-20 minutes to transmit.
- Photos were not transmitted until the maintenance supervisor returned to Quincy, 55 miles to the east, on February 26th.



System Concept

The Responder System will consist of integrated hardware, software and data communication equipment capable of recording and transmitting incident information from the scene of incidents occurring anywhere (rural or urban) within the RIME (Northern California) region. It would also be capable of receiving information (data) from the outside, including the Redding TMC.























Information from Photos

"The first three photos show:

- The size of the slide
- Kind and type of rock
- Road blocked, but open to one way traffic control
- Rock too big to move with equipment, so we will need to blast
- Too many rock to drill by hand, so we will need to rent the track drill
- We will have to make a ramp for the track drill so it can drill the one large rock
- The person gives perspective to size of the rock
- The large rock is over 200 tons
- We will need to mobilize our blaster, air compressor and drill, long term traffic control, let PIO know what's happening, rent light plants and a track drill"



Information from Photos

"The last two photos show:

- Size of larger rock
- Pavement damage
- Progress of work"



Information from Photos

"Better (or additional) photos would have shown:

- The face of the hillside above the slide
- A better shot of the surrounding area
- Major power lines just below slide area, a concern when blasting
- A major railroad below the slide area, a concern when blasting"



(Technology) Solution: Build or Buy?

- Determine District 2's needs in regard to this problem.
- Conduct research of prospective technologies in an objective manner.
- Apply research to integrate technologies into a proof-of-concept system that addresses District 2's needs.



Correspondence to Caltrans' Stages of Research Deployment



slide18

Need / (Initial) Concept 1 [Concept Stage]

Original Concept:

To enhance the collection and delivery of 'real-time' incident information, a study will be conducted to investigate, analyze and make recommendations on an electronic data collection and communications system for Redding District maintenance personnel. <u>The concept is</u> <u>that the maintenance personnel would use the system to</u> <u>provide information to the traffic management center, track</u> <u>and inventory at-scene equipment and materials provided</u> <u>and serve as a record for post incident analysis.</u>



October 2003 Kickoff Meeting

D2 Director:	" <u>Responder should consider EMS, fire department, and other needs, but at this stage</u> should focus on collecting incident information needed by Caltrans"
D2 Maintenance Manager:	"What is the incentive for the at-scene responder to input all the incident information to a device? <u>Time is precious</u> . So maybe <u>the at-scene data collection device should be</u> <u>automated.</u> "
D2 Maintenance Manager:	"Possible Use: There's <u>a rock in the road</u> . How big is it?"
D2 ITS Engineer:	"Build a <u>mobile data terminal for use in rural areas</u> . Incorporate 802.11 for local area communication." <u>Communications is KEY in the District 2</u> area and the most reliable coverage (for <u>external communication) might be the satellite phone system</u> . Cellular phone coverage is neither 24/7 nor available anywhere in the area (<u>due to mountainous geographical</u> <u>characteristics</u>)
DRI Project Manager:	"Make it of <u>use in urban areas</u> as well."
D2 Maintenance Manager:	" <u>Information should flow both ways</u> between the at-scene personnel and TMC."
TI Research Team:	"A <u>Tablet PC</u> and <u>Digital Camera</u> could be used to incorporate <u>Digital Photos and</u> <u>other data</u> ."
D2 Director:	<i>"Responder project should have a research component. (What can be learned from the project? What results can be applied elsewhere?)"</i>



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(Refined) Concept 2 [Concept Stage]

Refined Concept:

The Responder System will consist of integrated hardware, software and data communication equipment capable of recording and transmitting incident information from the scene of incidents occurring anywhere (rural or urban) within the RIME region. It would also be capable of receiving information (data) from the outside, including the Redding TMC.



High-Level Requirements

- A system shall be implemented to collect incident information.
- The system shall be used by Caltrans' staff, but shall be of potential for use by EMS, fire and other agencies.
- The system shall be deployed within Caltrans' vehicles in the field.
- The system shall be operational within and in the vicinity of Caltrans' vehicles in the field.
- The system shall be easy to use.
- The system shall automate the collection of incident information.
- The system shall minimize the amount of time required for use.
- The system shall transmit information to the TMC and other outside agencies.
- The system shall receive information from the TMC and other outside sources.
- The system shall have data communications capability in all areas of District 2.
 - The system shall be operable in rural areas including mountainous areas.
 - The system shall be operable in urban areas.



Preliminary Design / Specification

- The system shall use a Tablet PC as a mobile data terminal to collect and record incident information.
- The system shall use a digital camera to collect digital photographs of incidents.
- The system shall use satellite communication to provide data communication capability in mountainous areas.
- The system shall use cellular data communication to provide data communication capability in urban and other areas where cellular communication is available.
- The system shall use IEEE 802.11 –based (Wi-Fi) wireless technology to implement un-tethered use in the proximity of parked Department vehicles in the field.



Rough Prototype

A rough prototype was presented to demonstrate a prospective user interface and information flow.

Authorization was given to proceed.



(Refined) Concept 3 [Concept Stage]

Revised (Final) Concept:

A system integrating hardware, software and communications shall be developed to give responders the ability to download and use pertinent and available electronic data including maps and aerial photographs as well as weather conditions. The system will also allow for the collection and transmission of at-scene information that is difficult to convey via voice communications. Photos can be taken at the scene, associated with data such as time and GPS location, and organized to provide a more complete picture of the scene. Photos can be enhanced with hand-drawn diagrams outlining the situation and plans in much the same way a football coach might outline a formation or play on a chalkboard. Forms can be included and tailored to a situation or by responsibility, facilitating more accurate and timely recording of information as well as future evaluation and analysis.



May 2004 Survey

Participants:

- Caltrans D2 Communications Center staff (2)
- Caltrans Supervisor
- Caltrans Redding Maintenance Area Superintendent
- Caltrans, District 2 Area Supt, Specialist, Hazmat Manager
- Caltrans Maintenance staff (1)
- Caltrans Acting Supervisor



Conclusions from Survey

- Communication is a challenge. There are areas with no service and crews are equipped with a number of systems (radio, cellular and satellite).
- The more data transmitted from the incident scene, the better. But, data must be prioritized due to communication challenges.
- Incident photos, aerial photos and maps may help responders.
- The system must be of benefit to responders.
- The system must be user-friendly and efficient.



Prototype 1 [Laboratory Prototype Stage]

A functional prototype was developed consisting of OTC hardware, software and communication components and services.



Splash Screen





Incident Organizer

Redding Responder Incident Organizer

Summary Photos Mapping Sketches Forms Manuals Internet Communications Help

Responder Summary:

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Description:																			
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Photos and Sketches

Redding Responder Incident Organizer Summary Photos Mapping Sketches Forms Manuals Internet Communications Help Add Blank Sketch Remove Sketch sketch 1 Description One lane Exit



Forms

Redding Responder Incident Organizer

Summary Photos Mapping Sketches Forms Manuals Internet Communications Help

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Manuals

Redding Responder Incident Organizer

Summary Photos Mapping Sketches Forms Manuals Internet Communications Help

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Weather

Redding Responder Incident Organizer

Summary Photos Mapping Sketches Forms Manuals Internet Communications Help GetWebPage Remove Web Page web 1 WWW.fW/S.noba.074 Prototype SEARCH Enter Search Here HOME NEWS ORGANIZATION Current Hazards Watches/Warnings **NWS Digital Forecast Data** Local Outlook (39.78 N and 121.45 W at 1938 feet above sea-level) National Outlooks current Conditions Date: Sep 23 Sep 24 Sep 25 Observations Radar Imagory Hour: SPM EPM 11PM 2AM SAM BAM 11AM 2PM SPM EPM 11PM 2AM SAM BAM 11AM 2PM Satelite knagery 81 Max Temp (*F): 88 Soundings Mn Temp ("F) -000 50 Rome Levels Temp ("F): 81 64 56 54 55 53 72 79 79 63 55 63 79 53 62 71 Precipitation **Buoy Reports** Dewpoint (*F): 38 30 33 31 32 32 32 30 31 33 38 **Road Conditions** Humidzy (%): 21 42 42 42 45 23 OTHERE IS NO. Local Forecasts Cloudiness (%) n ñ Assation Wind Speed (mph): Fire Weather Wind Dir, SW SW NE ME Hydrology. Marine Chance of Precip (%): D 0 0 0 0 iπ. 0 n in the n **Computer Models** Weather **Limate** Many CONTROL TION ON A CONTROL TO A CONTROL OF A CONTROL Exit



Device Monitoring

Redding Responder Incident Organizer

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Incident Email

Redding Responder Incident Organizer

Summary Photos Mapping Sketches Forms Manuals Internet Communications Help

Satellite Phone Cell Phone Email

Create Email Send Email Rebesh

Responder Summary:

Email Generated:	9/24/2004	11:38:58 AM
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Location:

Latitude: 39.77616 Longitude: -121.45572 Road / Address: SR-70, Oroville, CA 95965 City: County: Butte Calfornia State:

Description:

A rock slide on SR-70, approximately 25 miles northeast of Groville, has blocked one lane of traffic. See attached ph

Organization: Calvans Date: 9/24/2004 District: 2 Date: 8:26 AM Observer: Joe Smith

Photos:





Hardware in the Vehicle





Evaluation Survey – October 2004

- The Incident Organizer and general functionality were well-received.
- Specific comments were made to improve utility and usability.
- Hardware was understood to be only for testing and demonstration



Evaluation Survey – October 2004

- Additional fields (Organization and District) should autopopulate.
- Post Mile and Direction fields should be included.
- Use of Date/Time field should be clarified.
- An easier means for adding photos should be implemented.
- Management of photos on the camera is important.
- It is not practical to download maps and photos. It takes too much time.
- Caltrans maps and aerials should be included.



Evaluation Survey – October 2004

- Forms were well-received, but technical issues exist.
- Manuals were well-received, but technical and content issues exist.
- Weather information was useful, but slow to download. Need to automate this process.
- Diagnostic displays for devices may or may be useful.
- Email is an acceptable means of transmitting incident information, but further work needs to be done to streamline this process.

Mountains & Minds

slide40

• A help section may not be necessary.



Prototype 2 [Controlled Field Demonstration Stage]

A second functional prototype was developed consisting of OTC hardware, software and communication components and services.

This prototype was fully-functional and fieldusable, but not field hardened.



Software

- Application made more robust to handle device malfunctions, loss of communication, etc.
- Ability to save and re-open incident records added. (Saved in XML format.)
- Export to MS-Word, HTML also added.



Incident Organizer - Reorganized

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Maps – Preloaded



ENGINEERING

Photos – Improved Preview and Selection





Weather – "Get Weather"

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Incident Information via Microsoft Word Attachment to Email





Hardware

- Wireless capability added to make the system self-contained and portable.
- Tablet PC can be used un-tethered.



The Responder "Briefcase"





Inside the Responder "Briefcase"





Evaluation: Survey, Demonstrations, Discussions and Field Testing

Maintenance Staff:

- "It looks like it's really user friendly. I think with a minimal amount of training I could walk outside and do it right now."
- "(It) looks almost fool-proof, there's only one way to go ..."



Evaluation: Survey, Demonstrations, Discussions and Field Testing Reality Check:

- "The key for the next phase is just as hard as this, if not harder. That's coming up with a slick, clean, reliable design that will work in the field that's easy enough to use that field guys will use it and that it will be a benefit to them."
- "He's right. Especially with my folks. Reliability is everything. You fail once, especially in the beginning, it'll sit and collect dust."



Evaluation: Survey, Demonstrations, Discussions and Field Testing

After limited Caltrans' field testing:

I had couple moments when it was flaky but the way I look at it (is that) in a couple places I was standing in the middle of nowhere (with) no other form of communication. ... it was still pretty neat to actually get out and pass on some information from the middle of nowhere.



Logical Hardware and Communication Framework





College of ENGINEERING

Preliminary to Phase 2 Pilot 1 [First Application (Contract) Field Pilot Stage

We have:

- A working, proof-of-concept system.
- Detailed requirements.
- An evaluation of communication alternatives.



Acknowledgements

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