Automated Safety Warning Controller Phase 2

Review Summary and Recommendations

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REVISION HISTORY

Version	Date	Description	Description of Changes
1.0	02/16/2011	Baseline Summary and Recommendations	Preliminary Summary and Recommendations for Submission to Caltrans

INTRODUCTION

A major outcome of Phase 1 of the Automated Safety Warning Controller project was a pilot system running at the Caltrans District 2 Spring Garden site. The Moxa UC-7420 running the Controller application was installed at Spring Garden in mid-August 2009 and connected to an RWIS and two CMSs. This initial pilot test implemented an ice warning alert script that used the values from the pavement sensors to put a warning message on the CMSs if icy conditions were detected. The Controller has run with minimal supervision since it was installed and for the most part has performed as designed. Issues that were found during the extended testing were documented and will be addressed as part of Phase 2.

The first task in Phase 2 of the Automated Safety Warning Controller project will be to review the code developed during Phase 1 and make modifications where necessary to improve efficiency and fix issues found during pilot testing. Additional functionality will be identified and implemented with the intention to expand the pilot test to include additional sites and additional alert conditions.

This document outlines the recommendations for Phase 2 improvements and enhancements.

SYSTEM PILOT TEST EVALUATION

While for the most part the Spring Garden pilot test of the Phase 1 controller went well, a few issues arose that will need to be addressed as part of Phase 2. This section outlines some of the issues and requested enhancements that came out of the pilot test.

Auto archive problem

During testing, Ken Beals (Caltrans District 2 ITS Engineer) noticed that some of the data files (RWIS in particular) were growing very large and apparently not auto archiving correctly. This was causing the active file to grow excessively large and impacting system performance, particularly when the system restarts and attempts to read the active file into memory. The original intention of the auto archiving was to keep the "working" file small so that scripts that need historical data (for instance average of last hour's data) would be able to do so efficiently. Therefore the auto archiving would activate during file "reads" and archive according to a configurable limit. Since the pilot was only running an ice warning script that uses the current value it would only need to read the file upon program restart and archiving functionality would not be invoked. WTI will work with Caltrans to resolve this issue.

Data File Organization

An issue that Ken Beals identified during his in-lab testing in Phase 1 was the lack of readability of the data files. The arbitrary order of the fields in the data files made it more difficult to find the value of a particular field. To resolve this issue a configuration option will be added allowing the user to specify the order of the fields in each data file.

Improve Quality Control (QC)

The simple quality control implemented as part of Phase 1 allows a minimum and maximum value to be associated with a unit of measurement, such as degrees Fahrenheit, which can then be associated with a given sensor. If the sensor value falls outside the acceptable range the QC error is logged to the QC log file and the value is not used; a null value is stored. In the case where an alert script uses more than one sensor (e.g. the Spring Garden ice warning that uses readings from six surface sensors) the script will stop if one sensor is out of range and the null (or Python None) value isn't explicitly checked for in the script. WTI will work with Caltrans to review the current quality control capabilities and if necessary define and implement a more robust quality control model, including the capability for an alert script to ignore erroneous data but continue to run if there is valid data to use.

Improve front panel interface

The Moxa computer used to run Controller for the pilot test has a front panel interface using 5 push buttons and an 8 line by 16 character display. The front panel interface programmed into the Controller application tried to convey as much information as possible using the limited screen size. This interface was viewed as too cumbersome, especially for occasional use by maintenance personnel. The interface should be modified to be easier and faster for users who may be standing outside in cold or inclement weather and only need a brief summary of operating status.

Note that the rack mount version of the Moxa intended for subsequent deployment has only 4 buttons and a 2 line by 16 character display that will require an even more efficient user interface.

A test message function was added to the controller after it was installed at Spring Garden to allow an electrician or maintenance person to test the sign function via a command from the front panel. After selecting the sign test command the system notifies the user, via the front display, that the message will be put on the sign. The test message is added to the message queue for the sign with a high priority so that it should be placed on the sign at the next run interval for the CMS field element module. However there is no positive notification that it has been placed on the sign as desired. A response from the CMS module should be displayed on the LCD when a message is placed on a CMS. It was suggested that this functionality could be expanded to add additional options such as selecting the message to be displayed and the addition of a count-down timer to indicate how long the test message will be on the sign. This functionality was seen as necessary for the cases that require someone to drive to the sign to physically verify the message.

Ken Beals suggested that the "running since" portion of the default status display be modified to include the year. This will require reformatting to fit in the space available.

CMS Module Retries

Ken has noticed in lab tests that the CMS module will fail to connect to the CMS controller when more than one device is connecting to the CMS (the 170 controller only supports one connection at a time). The CMS module is designed to retry three times before failing, however it may be retrying too fast. A configurable number of retries and interval between retries will be added.

Rack Mount Moxa

A rack mountable version of the Controller hardware is desired for an installation that is consistent with other rack components of the Caltrans roadside cabinet. WTI will purchase Moxa DA-661-LX units and make any changes to the Controller application necessary for operation on both the DA-661 and the UC-7420 devices.

Software Evaluation

In addition to the changes dictated by the pilot test review, a review of all the code modules associated with Controller will take place and, where necessary, code will be re-factored. During this review, attention will be paid to how the application uses memory resources. Although no specific issues appeared during the pilot test that pointed to memory leak problems, it has been observed that the memory usage does grow prior to eventually leveling off. All modules will be evaluated and where possible changes will be made to assist the Python garbage collection in freeing up no longer used memory.

The controller data module, used by all modules to access storage files, will be reviewed and reworked to improve efficiency. As part of Phase 1, a comparison was made between the flat (CSV) file structure currently used and implementing a database structure (SQLite). The conclusion of this testing was that the flat file structure, when implemented with buffering, is just as fast and efficient as a database, with the additional advantage of being human readable. Note that the flat file structure was selected in the original specification for the sake of simplicity and

anticipated efficiency. A potential drawback of this format is that efficient access required careful implementation by the project team so-as to avoid file contention and locking issues as well as other problems. Additional evaluation and development will be done to gain more speed improvements.

ITEMS INCOMPLETE FROM PHASE 1

Some items from Phase 1 were deferred to Phase 2. The following items, deferred from Phase 1 will be completed as part of Phase 2.

SOCCS style interface

An interface similar to the Satellite Operations Center Command System (SOCCS) used by Caltrans Traffic Management Centers (TMC) to control changeable message signs will be created to allow TMC operators to interact with the controller(s). This was deferred from Phase 1 but important for the ultimate integration of the Controller into the TMC operations. Meetings will be held to further clarify the design and operation of this interface. Items brought up during testing were:

- Coordinating SOCCS with Controller so that Controller has a record of all messages placed on the CMS regardless of whether it was from SOCCS or an Alert script.
- Handling low priority messages from the TMC. Allow Controller to override low priority messages such as “Click it or Ticket” messages.

Loop detector

A module for handling the Loop Detector protocol (on the 170 controller) was developed during Phase 1, but it was never fully tested, and associated, realistic alert scripts were not developed. Part of Phase 2 will include further testing of the Loop Detector module, both in-lab and at a real site. WTI recommends the following steps:

- Have Controller monitor and store live traffic loop data. This data can then be analyzed and alert scripts tested against it.
- After appropriate Alert scripts have been written, run Controller receiving live traffic loop data with alert script running in test mode with no messages written to the CMS(s).
- Analyze data and logs from previous step to ensure that Controller is operating as intended.
- Run pilot tests with full Controller functionality.

Flashing Beacon, Extinguishable Message Sign (EMS)

A protocol module was written to interact with a flashing beacon or EMS using a WebRelay™ device. A WebRelay™ device was not purchased under Phase 1 so this functionality was not fully tested. The hardware to fully test and implement the flashing Beacon and EMS modules will be purchased and tested. This functionality will then be available for field testing.

Microwave Vehicle Detection System (MVDS)

Some preliminary work was done to handle the EIS X3 RTMS protocol, however full implementation was deferred until a suitable test site/application is found.

WTI recommends the following steps:

- Have Controller monitor and store live MVDS data from a Caltrans selected site. This data can then be analyzed with alert scripts tested against it.
- After appropriate alert scripts have been written, run Controller receiving live MVDS data with alert script running in test mode with no messages written to the CMS(s).
- Analyze data and logs from previous step to ensure that Controller is operating as intended.
- Run pilot tests with full Controller functionality.

Highway Advisory radio (HAR) – text to voice, etc…

This was deferred until a suitable test site and application is found.

OTHER ITEMS

Reevaluate the user interface

The Controller Phase 1 Concept and Requirements document defines four levels of security for the Controller system: Operator, Supervisor, Technician, and System Administrator. The current Controller application implements a command line interface accessible through an SSH client that includes Operator and Supervisor levels of access. Technician and System Administrator users can access the system using separate Linux logins. Under the current Controller implementation the Technician access is not a limited account as specified in the original requirements. The original concept called for the primary Operator and Supervisor access to the system to be made via the SOCCS style interface. The SOCCS style interface will be developed as part of the current Phase of Controller (see above) and WTI will work with Caltrans to reevaluate the requirements for all levels of access. The command line interface will be redesigned and developed according to these requirements.

Identify new applications

The Automated Safety Warning Controller is intended to be a multipurpose device for use with a variety of applications. For the Phase 1 pilot test the Controller was shipped with alert scripts for wind warning and ice warning. Only the ice warning script was implemented at the Spring Garden test site. WTI will work with Caltrans to identify additional applications and test sites where the Automated Safety Warning Controller can be used. Applications that have been discussed previously have been: high wind warning, cross wind warning, and congestion warning using a loop detector. Each of these can present their own challenges to the Automated Safety Warning Controller system, including timing and communications issues associated with the greater distance between the controller and the field elements and the near real time requirements of the congestion warning alerts.

Improve/expand documentation

The Controller documentation will be reviewed and revised to reflect changes made during the current phase of the project. The documentation should include more complete information about variables, system errors, and log messages**.**

Automated installation

Installation of Controller on a device will be automated as much as possible so that an administrator need only run a single installation script.

TIMELINE

We propose the following rough time line outlining the implementation order of our recommendations.

- During the fourth quarter of 2010 start work reviewing and reworking existing Controller code.
- In December 2010, purchase 2 Moxa DA-661 rack mount computers and start Controller code modifications to be compatible with DA-661.
- End of January 2011, purchase 2 Moxa DA-661 rack mount computers to be sent to Caltrans District 2 for lab testing and subsequent deployment at a pilot site of Caltrans' choosing.
- February 2011 meet with Caltrans to identify requirements for the SOCCS interface and start implementation.
- April 2011 work with Caltrans to identify next application and test site(s) and start working on code additions/modifications as needed to implement. Recommendations include:
    - Loop detector analysis, testing, and implementation.
    - Prepare for next bad weather season by identifying appropriate test sites and applications to be ready by November 2011.

(Note again that by the time this document is finalized, many if not most of these improvements and enhancements will have already been implemented. Most of the wording in this document regarding improvements and enhancements is left in the future tense.)