# ASWSC Phase 3

Migration of the Automated Safety Warning System Controller to the Caltrans Advanced Transportation Controller Platform

## Phase 3 Development at USU (Part 4 of 6)

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# Phase 3 Development at USU

(Part 4 of 6)

# Phase 3

September 2018 – August 2020

Utah State University

# Phase 3

The ASWSC lab was moved from Montana to Utah thanks to Sean Campbell and Jeremiah Pearce.

Advice: keep a close eye on your movers …


2017/07/17 20:57:26 MON
Single Frame


2017/07/17 20:57:36 MON
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# Phase 3

A third phase of the ASWSC project has been conducted at Utah State University between September 2018 and August 2020.

While the Phase 2 ASWSC has been running well in the field since 2012 there were several major desired enhancements.

# Phase 3

It was desirable that the system be ported to the Caltrans' Linux-based Advanced Transportation Controller (ATC).

This device is available for purchase from several vendors and is standardized for Caltrans. As such, it is easy to procure and deploy by Caltrans.

# The 2070 LX, Linux-based ATC

The Safetran 2070 LX, Linux-based ATC.

This unit measures 19 x 10.25 x 7 inches and is also rack mountable.

Note the large display and additional keys.

Caltrans provided the project team with four 2070 LX ATCs for use on the project.


Safetran 2070 LX ATC, Used for Phase 3 ASWSC

# Phase 3

The ASWSC SOCCS interface was implemented using client-side Java via a Java applet

It was desirable to implement a new, HTML-based interface as Java applets are no longer widely used or supported.

# Phase 3

Another desired enhancement was to use a GPS to set the time on the ATC and circumvent problems with clock drift.

# Phase 3

The large time gap between the end of Phase 2 and the start of Phase 3 presented an opportunity to revisit and revise the system.

One change that occurred during this time is Caltrans' transition from the Model 170 CMS to the Model 2070 CMS, and the ASWSC would need to function with the new Model 2070.

# Phase 3 Accomplishments

Established a development environment for ASWSC software.

Tested controller software in the new lab.

Investigated alternatives for in-lab dialup networking – analog lines were becoming more and more difficult to obtain within the University setting.

Developed custom weather alert logic.

Developed RWISAgent, an RWIS emulator for use in the lab – replaced old proprietary software used for RWIS emulation.

# Phase 3 Accomplishments (continued)

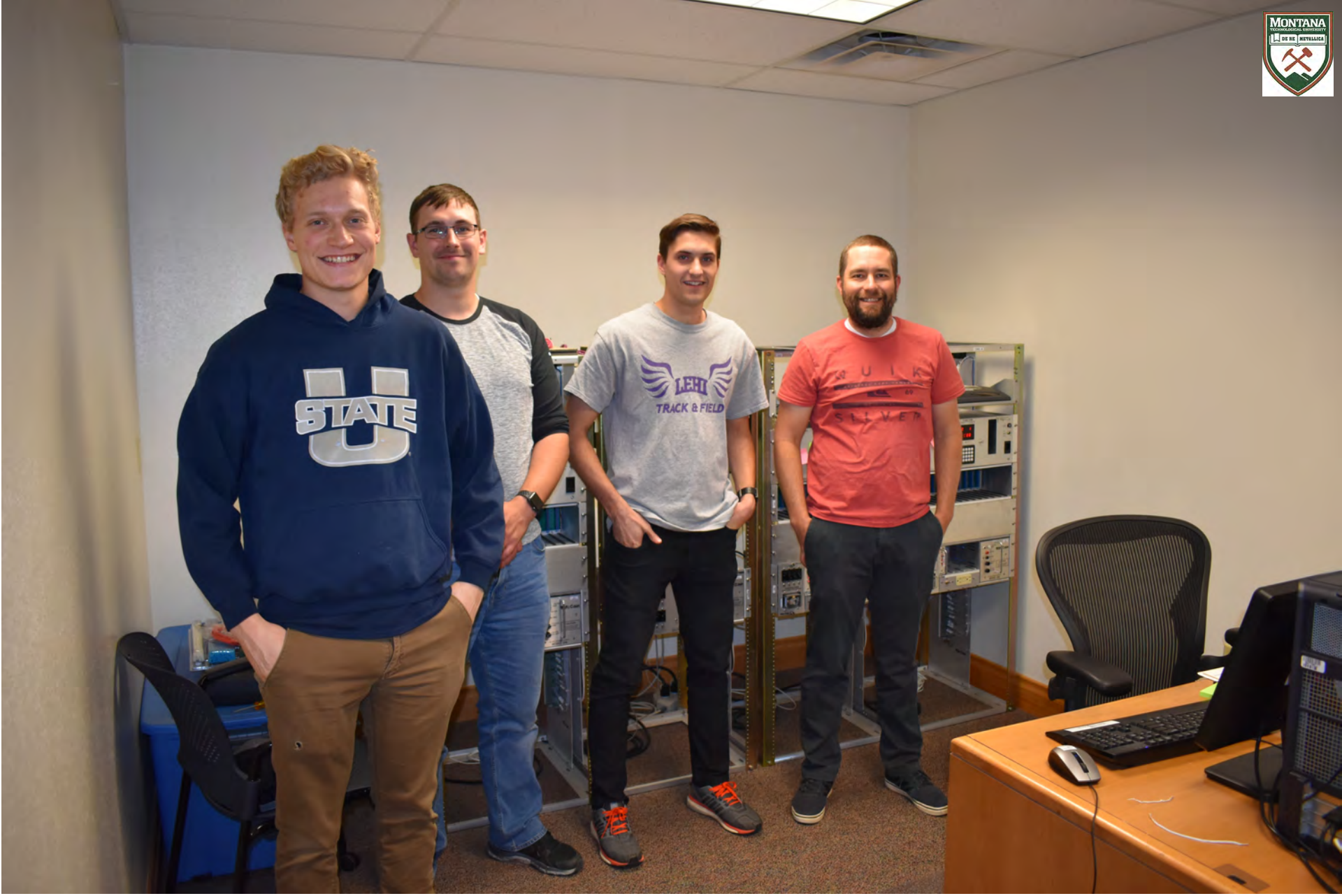
Cross-compiled Python for use on the ATC.

Adapted and installed ASWSC software on the ATC.

Installed ATC in the lab.

Supported Caltrans in installing the ATC in the D2 lab.

Prepared Caltrans for field testing.


STATE
LEHI
TRACK & FIELD


6
UNDERGRADUATE
AUTOMATED SAFETY WARNING CONTROLLER (PHASE 3)
Project Overview
Prior Work
Sample Alert Logic
Tasks Completed
3
UNDERGRADUATE
Nanoparticles in agriculture: copper oxide nanoparticles as altered by rooting zone processes in wheat

# ATC Hardware Installation

Originally this project was intended to be carried out at WTI and this task would have involved installing the ATC into the existing ASWSC lab at WTI. But the principal investigator left WTI and went to Utah State University, bringing the project and lab with him.

Sean Campbell and Jeremiah Pearce came to WTI to disassemble the lab in July 2017. Sean transported the lab to USU, and he and Jeremiah re-assembled the lab at USU.

# ATC Hardware Installation

Subsequently, Jeremiah shipped four ATC units to USU. Three of the units were used for development and the fourth was installed in the ASWSC lab for testing.

In conjunction with the project starting up at USU, the project team brought up a version control repository for project code. At WTI, an internal version control system had been used and was no longer available.

Jeremiah made a subsequent site visit to USU in June 2019.

# ATC Hardware Installation

Caltrans sent three Cisco 2509-ET routers with associated cables and shelves in July 2019 to replace three end of life Cisco 1600 series routers from the original lab configuration that were at end of life and were deemed unreliable.

These routers were installed in the associated field-element racks.

# ATC Hardware Installation

Near the end of the project, communication with both CMS nodes began failing.

It was suspected that the modems on those nodes needed to be replaced, but that was not done within this phase as the project was being wrapped up and the lab was to be transported to Montana with the principal investigator.

# ASWSC Development for the ATC

# Cross-Compilation: Python, Apache, etc.

The cross-compilation step was a critical path in porting the ASWSC to the ATC platform.

Since the ASWSC was written in Python, it was necessary to get Python running on the ATC.

The ATC runs a minimal Linux distribution, so it was necessary to cross-compile from source.

Apache was necessary for serving the revised SOCCS ASWSC interface, which previously functioned as a Java Applet.

# Cross-Compilation: Python, Apache, etc.

The main software cross-compiled and added to the ATC included:

- python-2.7.3
- httpd-2.2.2
- zlib-1.2.5
- php-5.1.4
- openssl-1.0.2r
- libxml2-2.6.16

# New version of SOCCS

It was necessary to develop a new version of ASWSC SOCCS because the prior version had been written as a Java Applet, and Java Applets are no longer widely supported in browsers.

It was important to make the interface lightweight so that it would perform well on slow, high latency networks such as the POTS network still used by Caltrans D2 in the field and in the ASWSC lab and D2 test lab.

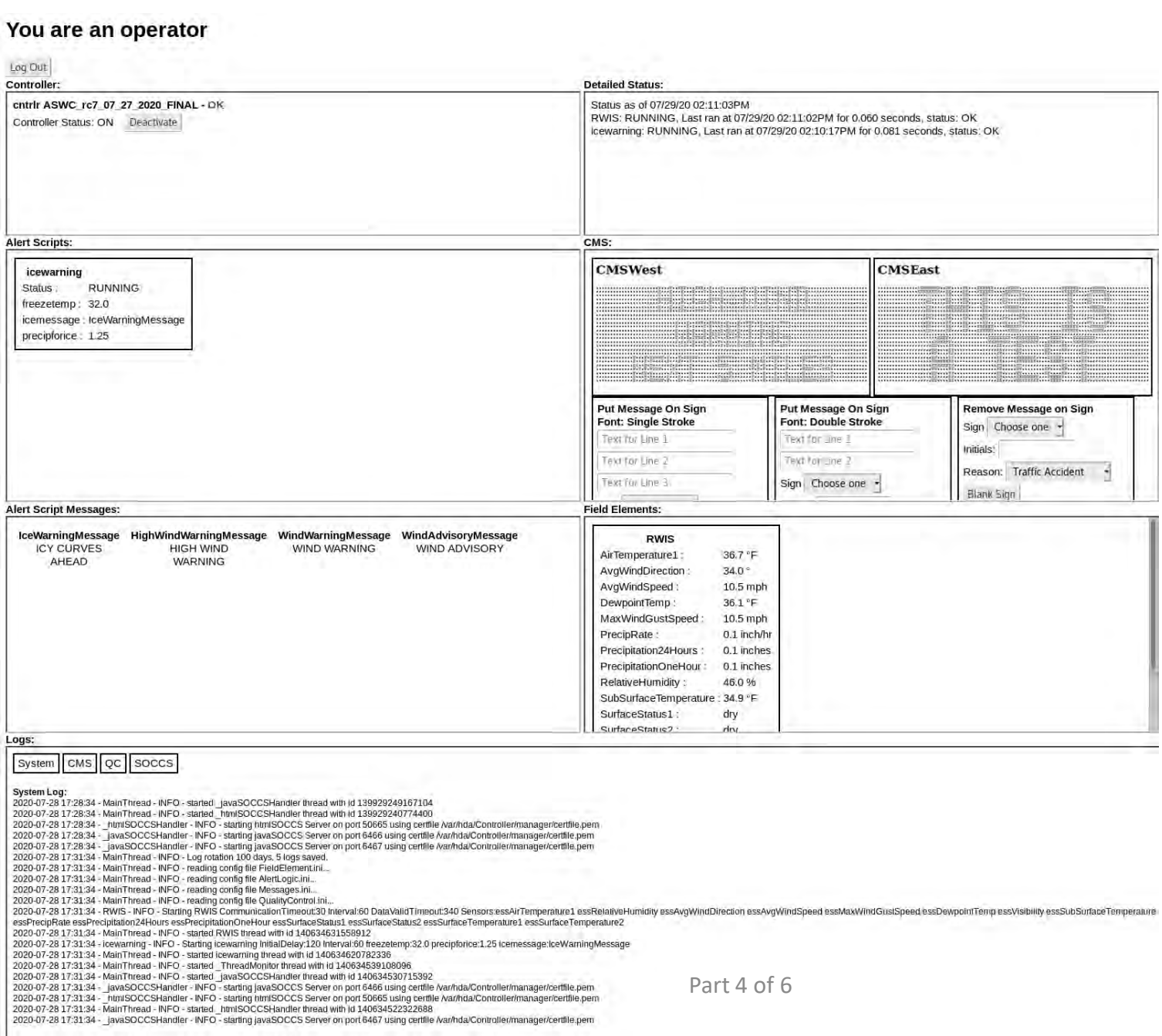
HTML and PHP were used to implement the interface, Python scripts were called via PHP to interface with ASWSC functionality on the server-side.

# New version of SOCCS (A comment from Jeff …)

*The old implementation of SOCCS required a separate MOXA controller (in our Basement Equipment Room) with the installed SOCCS application for the ASWSC. This would require the network to connect to the Spring Garden Site to get the status. We still need to establish that connection to the site, obviously, but the Apache server is running on the same hardware now and requires no additional embedded server to operate.*

*-Jeff Worthington*

# New (HTML) version of SOCCS ASWSC



# GPS and Clock

Because of significant clock-drift on the prior Moxa platforms and potential for similar clock drive on the ATC, it was desirable to use GPS to set the ATC clock on the regular (e.g., daily) basis.

Caltrans provided GPS modules for the ATC to the project team for this purpose.

# GPS and Clock

While the GPS modules functioned as expected, there were some oddities the Linux commands that set time on the ATC and the mechanism described in the ATC Linux support guide for setting time did not work.

The project team determined that setting the time via the Linux *date* command using UTC time would set both the hardware and system clock and would respect the local time set by the selected time zone for the zone.

This is non-standard behavior, but it worked, and the GPS module could be used to set the ATC clock.

# Model 170 CMS -> Model 2070

The large time gap between the end of Phase 2 and the start of Phase 3 presented an opportunity to revisit and revise the system.

One change that occurred during this time is Caltrans' transition from the Model 170 CMS to the Model 2070 CMS, and the ASWSC would need to function with the new Model 2070.

The Model 2070 is backward compatible with the Model 170, so the initial thought was that no new development would be required.

Unfortunately, that was not true.

# Model 170 CMS -> Model 2070

The Model 170 CMS was used in prior phases. An ASWSC field element module was written for the Model 170 CMS. This worked well and was used in the pilot deployment at Spring Garden.

The project team did not have access to a Model 2070 CMS controller. Caltrans would have provided this, but it was decided that testing could occur in the Caltrans D2 lab.

Ideally the prior field element module for the Model 170 CMS would have worked and nothing more would need to be done.

But it did not.

# Model 170 CMS -> Model 2070

After some back and forth, investigation of network traffic and comparison against other software that controls both the Model 170 and Model 2070, modifications were made to the CMS field element module that made it compatible with both the Model 170 and the Model 2070.

Informal discussion occurred about whether the situation merited separate field element modules for the two models, but it was decided that the differences between them and the changes needed to give compatibility for both were minimal, so a single field element module was used.

This could be revisited in the future.

# Field Testing

Field testing of the new system was not conducted in Phase 3.

Due to the project end in August 2020, field testing by Caltrans would occur during the bad weather season that followed the conclusion of Phase 3.

(See subsequent presentation from Jeff Worthington regarding this.)

# Lab Testing

Extensive lab testing was conducted over 10 months between October 2019 and July 2020.

The project team produced 12 versions of the system before concluding the project.

Each version built on the prior by adding functionality and/or addressing issues raised by District 2 staff.

# Lab Testing

Testing and interaction with Caltrans were critical to development of the system and assurance that it would ultimately be ready for field testing.

This iterative approach worked well and is recommended for future work as it introduced hands-on feedback from Caltrans throughout the process.

# Lab Testing

Following is a chronology of the ASWSC packages and feedback received from Caltrans.

# Lab Testing

October 11, 2019

The project team sent an installation package to Caltrans D2 via FedEx. Included were SD cards, a thumb drive with installation files, documentation, etc.

During the initial attempt to install the ATC, D2 ended up with a “bricked” ATC. The sequence of applying updates and the timing of removing a USB drive caused problems.

# Lab Testing

October 11, 2019 (continued)

The project team revised the documentation to make things clearer, particularly for new users and an initial installation.

Caltrans D2 worked with Caltrans HQ and Econolite to obtain a recovery process.

The recovery process worked and turned out to be valuable for development purposes as it allowed the ATC to be reset to its “out of the box” state. This allowed the project team to test the installation of the system against a “new” ATC.

# Lab Testing

October 25, 2019

Caltrans D2 was able to attempt the install again after recovering the “bricked” ATC.

D2 recognized changes from prior (Phase 2) version of ASWSC.

The project team noted that the old Java SOCCS applet would work with the system while the new HTML-based SOCCS was still in development.

# Lab Testing

October 28, 2019

The project team recommended the use of Win32DiskImager to write images of the SD card.

Rather than send new physical SD cards and thumb drives for every update, the project team decided to electronically send image files for the SD card. This would dramatically improve turn-around time for fixes versus shipment of physical media.

# Lab Testing

November 14, 2019

Caltrans sent a feedback package to the project team. Feedback was mostly positive.

There was a problem communicating with their RWIS that was related to use of SNMP 1 vs SNMP 2. The Phase 2 version of ASWSC experienced a similar problem, and the firmware on the RWIS was reverted to a prior version to resolve that problem in the field. Subsequent WireShark network traffic samples and log files were critical to addressing issues like this and became a regular part of the feedback packages.

# Lab Testing

November 22, 2019

Caltrans sent a feedback package to the project team.
A wind warning problem was documented. The feedback package included data and log files.

November 13, 2019

Caltrans sent a feedback package to the project team.
This feedback package included further data, log files, etc. regarding the wind warning problem.

# Lab Testing

January 13, 2020

A Box share was set up for sharing revisions of the system. A new image, updated documentation, and a response to prior comments were sent.

The Box share worked for the remainder of the project. Images were created for the SD card and shared via Box so D2 could then use Win32DiskImager to write the images to their SD card.

# Lab Testing

January 27, 2020

Brief feedback was received from Caltrans confirming resolution of several issues.

February 29, 2020

New image, updated documentation, and response to prior comments were posted on Box. This image included the new HTML SOCCS interface.

March 6, 2020

Caltrans sent a feedback package to the project team. This feedback package showed the results of detailed SOCCS testing.

# Lab Testing

March 6, 2020

Caltrans sent a feedback package to the project team. This feedback package showed the results of detailed SOCCS testing.

March 12, 2020

Caltrans sent a feedback package to the project team. This feedback package pointed out a CMS checksum issue.

# Lab Testing

March 19, 2020

New image, updated documentation, and response to prior comments were posted on Box. The new image included a fully functional version of new HTML-based SOCCS ASWSC.

The project team made Caltrans aware that a Covid-19 campus shutdown was in effect. Classes at USU were shifted to online and students were encouraged to leave campus and go home. As such, the principal investigator was concerned that access to the ASWSC lab on campus could be limited, so work accelerated as best possible. Subsequently, student research assistants were allowed to take ATCs and development laptops home to work on so they could continue work remotely. They continued to use the lab for testing but were able to reduce the amount of time spent on campus.

# Lab Testing

April 1, 2020

Caltrans sent a feedback package to the project team. This feedback package indicated that major issues had been addressed.

Improvements were suggested for the SOCCS interface. The feedback package also discussed compatibility issues with Model 2070 CMS.

# Lab Testing

April 15, 2020

New image, updated documentation, and response to prior comments were posted on Box. This update addressed interface issues with SOCCS. New functionality included GPS.

# Lab Testing

April 16, 2020

Feedback was received from Caltrans regarding the Model 2070 CMS issue.

Feedback was sent from Sean Campbell regarding handling of packets by the Model 2070 CMS. Sean proposed a possible fix. Unfortunately, this fix did not resolve the problem.

April 27, 2020

Feedback was received from Caltrans regarding the Model 2070 CMS issue.

Feedback was received regarding the GPS and the Model 2070 CMS issue. The GPS worked as expected but communication with the Model 2070 was still not working.

# Lab Testing

April 30, 2020
Feedback was received from Caltrans regarding the Model 2070 CMS issue.
Continuing problems with the Model 2070 CMS were described.

May 5, 2020
Feedback was received from Caltrans regarding the Model 2070 CMS issue.
More feedback was given regarding the Model 2070 CMS issue.

May 7, 2020
Feedback was received from Caltrans regarding the Model 2070 CMS issue.
More observations and feedback regarding the Model 2070 CMS were presented.

# Lab Testing

May 14, 2020

New image, updated documentation, and response to prior comments were posted on Box.

This update was related to time issue on ATC, provided a fix for 2070 CMS controller, and implemented a conversion dictionary.

# Lab Testing

May 22, 2020

A feedback package was received from Caltrans. Suggestions were made for installation and documentation clarification, clock testing, etc. The package confirmed that the Model 2070 CMS issue was fixed.

May 27, 2020

A feedback package was received from Caltrans. ASWSC was not handling NULL values from RWIS correctly.

May 29, 2020

A feedback package was received from Caltrans. RWIS variables and the associated NTCIP standard were provided relative to RWIS variable data size discussion and clarification.

# Lab Testing

June 11, 2020

New image, updated documentation, and response to prior comments were posted on Box.

This was referred to as Release Candidate 1 and implemented a better naming scheme to indicate the version of the ASWSC system.

The project team needed clarification on data sizes for RWIS data considered and attempted to clear some socket errors that were logged.

# Lab Testing

June 25, 2020

Feedback was received from Caltrans. Some RWIS values for surface condition were not being handled.

June 29, 2020

New image, updated documentation, and response to prior comments were posted on Box. This was referred to as Release Candidate 2 and it addressed prior issues. It also included a revised ice warning script that implemented better error handling.

July 1, 2020

Feedback was received from Caltrans. Comments were given on documentation and the revised ice warning script.

# Lab Testing

July 3, 2020

New image, updated documentation, and response to prior comments were posted on Box. This was called Release Candidate 3. This release included inline code documentation and updates to stand-alone documentation.

July 13, 2020

Feedback was received from Caltrans. Comments were made on documentation and a problem that occurred during installation. The problem was not related to problems with the code or installer.

# Lab Testing

July 16, 2020

The ASWSC Lab was dismantled and removed from USU.

From this point forward it was no longer possible to test against the ASWSC lab at USU.

New code and images could still be generated.

# Lab Testing

July 18, 2020

New image, updated documentation, and response to prior comments were posted on Box. This was called Release Candidate 4. It included some updates to documentation and quality control handling.

July 21, 2020

New image, updated documentation, and response to prior comments were posted on Box. This was called Release Candidate 5. It made further updates to documentation and quality control handling.

# Lab Testing

July 22, 2020

Feedback was received from Caltrans. Several conversion issues were mentioned. One required a change in the conversion dictionary and Caltrans provided a file with that change. Another conversion issue was outside the ASWSC.

July 22, 2020

New image, updated documentation, and response to prior comments were posted on Box. This was Release Candidate 6. It included resolution to the conversion issue and several other minor fixes.

# Lab Testing

July 24, 2020

Feedback was received from Caltrans. It was noticed that several directories were empty after installation, and that the version number displayed on the ATC was not correct.

July 25, 2020

New image, updated documentation, and response to prior comments were posted on Box. This was Release Candidate 7. It included resolution to prior issues and was intended to be the final version.

# Lab Testing

July 31, 2020

Feedback was received from Caltrans.

It was noted that there is inconsistent use of “ASWC” versus “ASWSC” and requested that we use one of these consistently. The D2 preference was “ASWC”, but the project team chose to use “ASWSC” for consistency with the Phase 3 project proposal and with original naming of the system by the original project champion.

This version ran in the D2 test lab for a week and did not produce any errors.

# Lab Testing

August 4, 2020

New image, updated documentation, and response to prior comments were posted on Box.

This was Release Candidate 8. It included renaming of several items from “ASWC” to “ASWSC” for consistency.

This was the final version from Phase 3.

# Other Deliverables

A number of deliverables were produced during the course of the project effort, including:

- Final Report
- Quarterly Reports
- System Management and Maintenance Guide
- User Guide

# Phase 3 Conclusion

The Phase 1 ASWSC ran reliably and autonomously at Caltrans Spring Garden site for over three years.

The Phase 2 ASWSC ran at the Spring Garden site for nearly nine years and continued to run at the time Phase 3 concluded.

The Phase 3 ASWSC ran for 10 months in the Caltrans District 2 lab, while the USU Project Team worked to prepare the system for field testing.

It was anticipated that the system would be deployed at the Spring Garden site during the 2020-2021 bad weather season.  It was.

# Phase 3 Conclusion

Phase 3 enhancements included bringing the system up on the Model 2070 LX ATC, using the ATC GPS addon card to obtain date/time for the system, implementing a new, HTML-based version of SOCCS ASWSC, and updating the CMS field element module to communicate both with the Model 170 CMS controller and the Model 2070 CMS controller.

# Next Steps

Next steps would include collecting feedback from Caltrans after 2020-2021 field testing, and further updating and enhancing the system accordingly.

# Phase 3 Testing and Evaluation at D2

See Jeff's presentation for more detail on Phase 3 Testing and Evaluation at D2 …