California AHMCT Program
University of California at Davis
California Department of Transportation

REVIEW OF CALTRANS DISTRICT 10 TRANSPORTATION MANAGEMENT CENTER OPERATIONS AND EQUIPMENT*

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16. Abstract

This document describes Task 3, "Review of Caltrans District 10 Transportation Management Center Operations and Equipment," within the Open ATMS multi-year research project undertaken by the Advanced Highway Maintenance & Construction Technology (AHMCT) Research Center at the University of California, Davis. The Open ATMS project is implementing an open-source Advanced Traffic Management System (ATMS) within the California State Department of Transportation (Caltrans) District 10 (D10) Transportation Management Center (TMC). This document is a review of Caltrans D10 TMC operations and equipment. This includes D10 TMC software, hardware, communications, and operations.

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Abstract

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Table of Contents

List of Figures

List of Tables

Disclaimer/Disclosure

The research reported herein was performed as part of the Advanced Highway Maintenance and Construction Technology (AHMCT) Research Center, within the Department of Mechanical and Aeronautical Engineering at the University of California Davis, and the Division of Research and Innovation at the California Department of Transportation. It is evolutionary and voluntary. It is a cooperative venture of local, State and Federal governments and universities.

The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the State of California, the Federal Highway Administration, or the University of California. This report does not constitute a standard, specification, or regulation.

Acronyms and Abbreviations

Acronyms used within this document are defined below.

AHMCT	Advanced Highway Maintenance & Construction Technology
ATMS	Advanced Traffic/Transportation Management System
Caltrans	California State Department of Transportation
CAWS	California Automated Warning System
CCTV	Closed-Circuit Television
CHP	California Highway Patrol
CMS	Changeable Message Sign
CSU/DSU	Channel Service Unit/Data Service Unit
CTNet	Caltrans Central Signal Control System
D3	District 3
D10	District 10
DRI	Division of Research and Innovation
DSL	Digital Subscriber Line
EDGE	Enhanced Data Rates for GSM Evolution
EIA	Electronic Industries Alliance
FTP	File Transfer Protocol
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communications
HAR	Highway Advisory Radio

HTTP	HyperText Transfer Protocol
ILDA	Inductive Loop Detector Application
IP	Internet Protocol
IRIS	Intelligent Roadway Information System
ITS	Intelligent Transportation System
KML	Keyhole Markup Language
M170	Model 170
M2070	Model 2070
Mn/DOT	Minnesota Department of Transportation
NTCIP	National Transportation Communications for ITS Protocol
OSS	Open-Source Software
PeMS	Freeway Performance Measurement System
PTZ	Pan-Tilt-Zoom
RS-232	EIA serial communications standard
RTMS	Remote Traffic Microwave Sensor
SDRMS	San Diego Ramp Metering Software/System
SMS	Short Message Service
SOCCS	Satellite Operations Center Command System
TAG	Technical Advisory Group
TCP/IP	Transmission Control Protocol / Internet Protocol
TMC	Transportation Management Center
TMCAL	Traffic Management Center Activity Logging
TMCAD	Traffic Management Center Activity Database
UDP/IP	User Datagram Protocol / Internet Protocol
USGS	United States Geological Survey
VPN	Virtual Private Network
WAV	Waveform Audio
WGS-84	World Geodetic System 84

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Chapter 1

Introduction

1.1 Document Purpose

This document summarizes Caltrans District 10 (D10) Transportation Management Center (TMC) hardware, communications, software, and operations as they relate to the implementation of the Intelligent Roadway Information System (IRIS) ATMS for Caltrans D10. It also describes capabilities and features that D10 would like implemented in the future. These findings are the result of a single task within a multi-year research project undertaken by the Advanced Highway Maintenance & Construction Technology (AHMCT) Research Center at the University of California, Davis[1].

1.2 Project Background

In October 2005, AHMCT initiated a research project to study the potential benefits Open-Source Software (OSS) might provide for Caltrans in the ATMS and TMC domains. OSS can be used in two ways and provides correspondingly different potential benefits:

1. Transportation agencies may benefit from using OSS products such as Linux, MySQL[2], etc., as part of ongoing transportation projects. These transportation projects may be open or closed source projects.

2. Transportation agencies may benefit from creating open-source transportation projects that share software source code, data sets, test results, documentation, resources, etc., with a community of users and transportation agencies.

A number of completed and ongoing transportation projects are using OSS in both ways and have reported corresponding benefits [4]. The ongoing Open ATMS project is the 2nd

[1] For AHMCT see http://ahmct.ucdavis.edu

[2] All company and product names listed herein are the trademarks of their respective companies.

type–it is an OSS project using OSS software products, implementing the Minnesota Department of Transportation (Mn/DOT) IRIS open-source ATMS software, within Caltrans D10.

1.3 Caltrans District 10 Operations

Caltrans District 10 (D10) covers the geographic area shown in Figure 1.1 on the facing page. The District TMC is located in Stockton, California and is classified as an urban TMC by Caltrans. A high-level system topology diagram is shown in Figure 1.2 on page 4. The TMC is staffed 24x7 and is a real-time operations center responsible for:

- Monitoring the District's transportation system,
- Managing the District's transportation system,
- Emergency management [1].

1.3.1 TMC Information Sources

The Stockton TMC receives information from a variety of information sources:

- Traffic monitoring stations (real-time),
- Existing messages from Changeable Message Signs (CMSs), real-time, via the software system known as Satellite Operations Center Command System (SOCCS),
- California Highway Patrol (CHP) incidents, from colocated TMC CHP personnel (present during commute hours 5-9 am and 4-6 pm) and from the CHP dispatch center,
- 911 incidents, from the CHP,
- Video from traffic cameras (City of Stockton, D10, real-time),
- City of Stockton,
- Caltrans highway crews,
- Earthquake monitors (real-time) from the United States Geological Survey (USGS),
- Traffic information (speed, occupancy, diagnostics), CHP incidents, real-time, from Freeway Performance Measurement System (PeMS)[3]. PeMS incident data originates with the CHP web site,
- Ramp meters (in the future), will eventually be connected real-time,

[3]For PeMS see https://pems.eecs.berkeley.edu/.

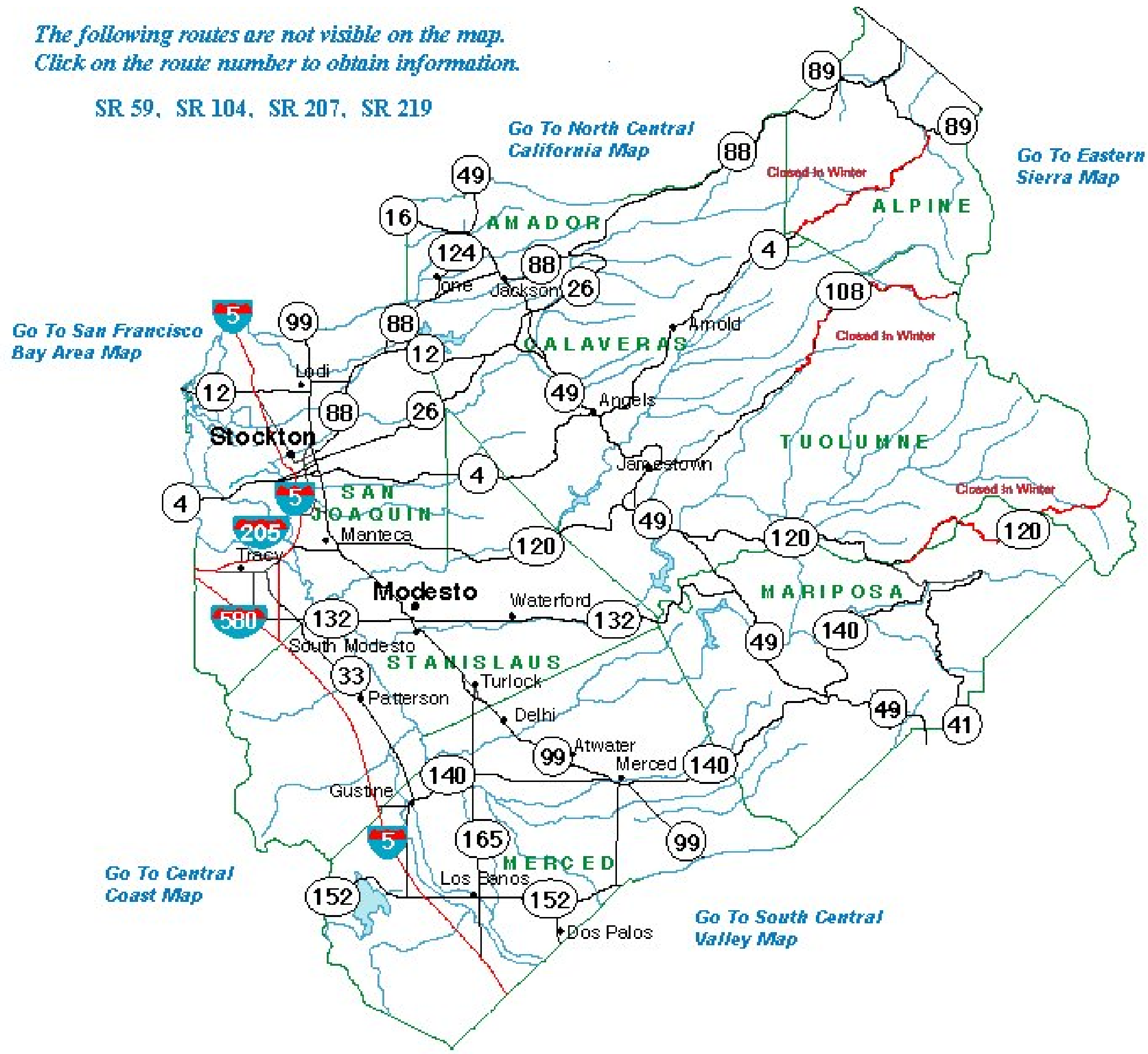

Figure 1.1: Caltrans D10 map [2]

1.3.2 TMC Information Outputs

The Stockton TMC manages District-wide transportation using:

- Changeable Message Sign (CMS), with automated and manual messages,
- Incident management, coordinated with CHP,
- Highway Advisory Radio (HAR) and extinguishable message signs,
- Ramp meter timing, real-time (future capability).

1.4 High-Level Caltrans District 10 Topology

For the D10 topology diagram, please contact the document authors.

Figure 1.2: Caltrans D10 topology diagram placeholder

1.5 D10 Middleware System

The term *middleware* is used to identify functionality provided by applications executing on D10 TMC servers. All middleware applications are written in Java. Provided functionality includes:

- Retrieval, storage, and interaction with traffic detection stations, weather stations, and Closed-Circuit Television (CCTV),
- CAWS automated CMS messaging system (see Section 3.1.1 on page 12),
- Support for the display of real-time Statewide CMS messages via Google Earth (see Section 3.1.2 on page 13),
- Support for the statewide centralized ScanWeb program (see Section 7 on page 23).

Middleware processes running on server A (see Figure 1.2) include:

1. Traffic application: receives 30-second traffic data from Wizards connected to inductive loops and microwave detectors in the field.
2. Traffic application: retrieves 15-minute traffic data from wizards connected to inductive loops.
3. Weather Station application: retrieves 60-second data from workstation B via the EIA serial communications standard (RS-232) connection.
4. CAWS decision-making process that creates a file containing recommended CAWS CMS messages.

5. Web Server: providing HyperText Transfer Protocol (HTTP) access to a file on server A, containing recommended CAWS CMS messages. A process running on SOCCS server E reads the file every 30 seconds using HTTP.

1.6 Research Tasks

The Open ATMS project tasks are shown below. Here, software development will use an evolutionary linear process model, which iteratively follows the waterfall sequence of requirements definition, design, development, and testing. The project tasks are:

1. Formation of the advisory group,
2. Literature Review of National Developments in ATMS and Open Source Software [4],
3. Review of current Caltrans D10 ATMS operations and equipment,
4. Development of demonstration open-source ATMS implementation requirements [3],
5. Review of Mn/DOT IRIS source code and documentation,
6. D10 IRIS design,
7. D10 IRIS implementation,
8. Test plan development,
9. Lab testing, field testing, and system demonstration,
10. Documentation.

1.7 Functional Area Priorities

The Technical Advisory Group (TAG) identified D10 functional area priorities at a June 13th, 2007 meeting in Stockton, CA. At a September 13th, 2007 TAG meeting, it was determined that the Intersection Monitoring and Control functional area should be moved to the lowest priority. Table 1.1 on the following page shows function area priorities. Note that CMS and Incident Mapping both have the same priority level.

1.8 Document Scope

This document was developed by the researchers using project documentation, research reports, software and hardware specifications, software development documentation, field and laboratory data, and guidance and information gained through collaboration with the project TAG and D10 engineers and staff.

1.9 Summary of Report

The following chapters discuss existing Caltrans D10 ATMS functional areas. Chapter order corresponds to functional area implementation priority for D10, shown below. Each chapter covers background, operations, hardware, software, and communications.

1. Traffic Monitoring Stations,
2. Changeable Message Signs and Incident Mapping,
3. Video Monitoring and Control,
4. Ramp Meters,
5. Weather Stations,
6. Event Logging,
7. Highway Advisory Radio and Extinguishable Message Signs,
8. Intersection Traffic Signals.

Table 1.1: Caltrans D10 IRIS Demo Study prioritized functional areas

Priority	D10 Functional Area
1	Traffic Monitoring Stations
2	CMS
2	Vehicle Incident Mapping
3	Video Monitoring
4	Ramp Meters
5	Weather Station Monitoring
6	Video Control
7	Event Logging
8	HAR and Extinguishable Message Signs
9	Intersection Traffic Signal Monitoring

Chapter 2

Traffic Monitoring Stations

2.1 Background

Traffic monitoring has been identified as priority 1 for D10. D10 uses inductive loop and microwave traffic sensors. Single and double inductive loop configurations are used (see Figure 2.1 on the next page). Speed data from double loops are used as inputs into the CAWS middleware system (see Section 1.5 on page 4) for automated CMS message generation. Wizard wireless modems[1] connect all traffic detectors with the TMC. Geographic loop position data is available via PeMS in World Geodetic System 84 (WGS-84).

2.2 Operations

Traffic data is collected on these intervals:

1. 30 seconds: speed, flow, and occupancy, broadcast (via User Datagram Protocol / Internet Protocol (UDP/IP)) to the TMC by each Wizard executing the Inductive Loop Detector Application (ILDA). Microwave detectors also broadcast their data to the TMC.

2. 15 minutes: accumulated speed, flow, and occupancy, pulled from the Wizard by a middleware application. Microwave traffic detectors do not have the ability to store accumulated data.

3. 8-10 hours: speed, flow, occupancy, pulled from the Wizards every 8-10 hours by a middleware application.

[1] The Wizard was jointly developed by D10 and InfoTek Inc. See appendix A on page 37 for more information.

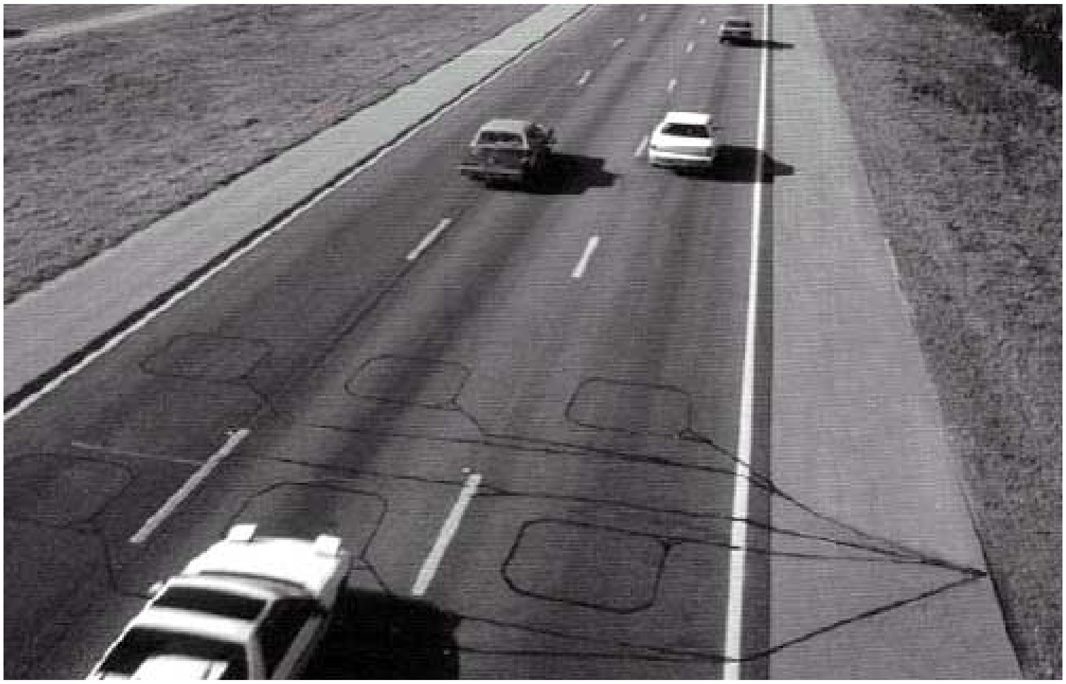

Figure 2.1: Traffic detector, double inductive loop [5]

2.3 Hardware

D10 has approximately 151 inductive loop installations, with 96 more to be installed by the end of 2007. The following hardware is used:

- Wizard wireless modems (see appendix A on page 37). Both microwave and inductive loop detectors communicate with the TMC using Wizards.
- Dual inductive loop detectors, 53% of sites (80 detectors),
- Single inductive loop detectors, 31% of sites (47 detectors),
- Microwave detectors, 16% of sites (24 detectors), two manufacturers are used:
  - EIS Remote Traffic Microwave Sensor (RTMS) microwave traffic monitoring sensors[2],
  - Wavetronix microwave traffic monitoring sensors[3].

[2]For EIS see http://www.rtms-by-eis.com/
[3]For Wavetronix see http://www.wavetronix.com/

2.4 Software

Software applications execute on the Wizards and in the middleware layer. For more details on the middleware system, see section 1.5 on page 4. Traffic specific software includes:

- InfoTek ILDA, a software application executing on the Wizards, connected to the inductive loops. ILDA calculates speed, occupancy, flow, and is written in Java. Speed estimates from single loops are not considered accurate enough for input into the CAWS system.
- InfoTek Data Collector, is considered part of the middleware system and executes on server A. This application receives UDP/IP packets broadcast from each Wizard and inserts complete records into the D10 Oracle database every 30 seconds. The application is written in Java.
- Processes running on server A within the middleware system, including: the Oracle database server, processes running on time-intervals which retrieve data from the Wizards connected to loop detectors.
- A database is under development which will store traffic data for archival purposes. It is being developed internally by D10 in Microsoft Access.

2.5 Communications

Microwave and inductive loop amplifiers are connected to Wizards. Wizards forward UDP/IP packets over the Cingular wireless Virtual Private Network (VPN) to a TMC router. From the router, packets are forwarded to PeMS and to server A where it is received by InfoTek Data Collector software and inserted into a database.

Chapter 3

Changeable Message Signs

3.1 Background

The CMS functional area has been identified as priority 2 for D10. CMS are non-portable, fixed location signs that can present changeable illuminated messages visible to drivers. CMS contain arrays of lamps that use block characters to form simple messages (see Figure 3.1 on the following page). TMC operators send new text messages to the CMS and retrieve existing messages for validation purposes. Sign messages are either one or two pages in length. CMS messages originate from three sources:

- TMC operator, manually specified,
- TMC operator, selected from a library of existing messages,
- The CAWS middleware system, auto-generated as a function of real-time weather and traffic conditions (see below). Auto-generated messages can be overridden by operators.

The primary means of CMS control is through the SOCCS system (see Section 3.1.3 below). SignView is used within the TMC as a backup CMS control application. Some CMS are part of the CAWS system and others are independent of CAWS (respectively call-outs F and Q, Figure 1.2 on page 4). Caltrans sign standards are: Model 500, 510, 520[1]. These models have different physical sizes. The 500 and 510s have the same resolution. The 520s have lower resolution. Some CMS geographic positions are available; others need to be collected.

[1]For CMS types see http://www.dot.ca.gov/hq/traffops/elecsys/teeschap8/

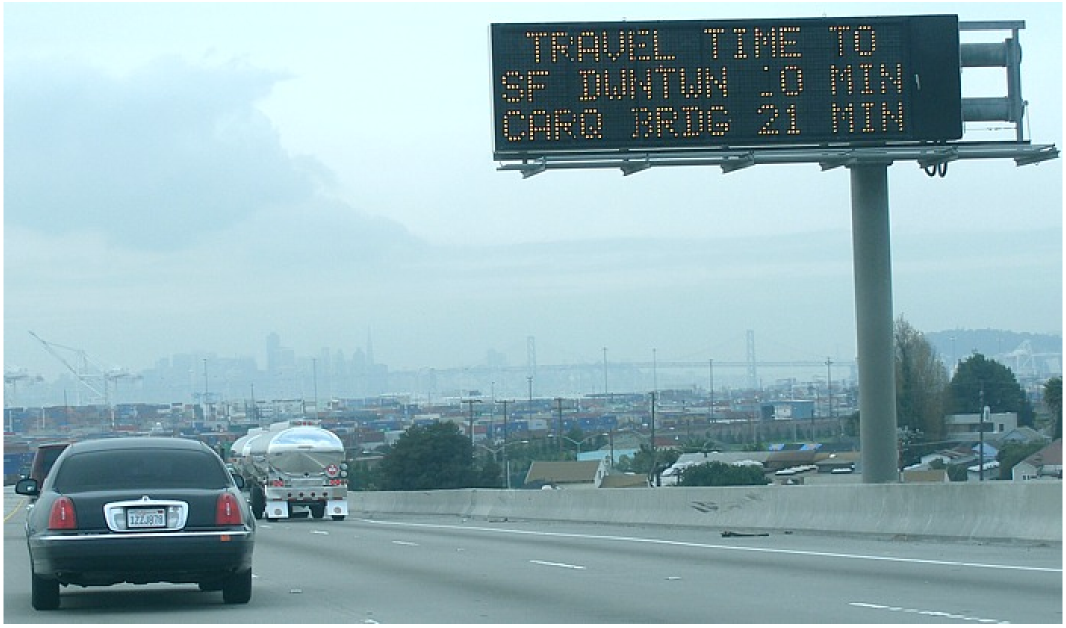

Figure 3.1: Caltrans CMS with travel times [8]

3.1.1 CAWS System

The CAWS functional area is part of the D10 middleware layer and generates CMS messages as a function of real-time traffic and weather conditions. CAWS was developed in 1996 [7]. Figure 3.2 on the facing page shows the original system configuration. Message generation is based on prioritized sensor data:

1. Stopped traffic, from double inductive loops and microwave traffic sensors, data every 30 seconds,
2. Slow traffic, from double inductive loops and microwave traffic sensors, data every 30 seconds,
3. Visibility, from weather stations, data every 60 seconds,
4. Wind speed, from weather stations, data every 60 seconds.

CAWS relies on the SOCCS system to display the message on the CMS (see Section 3.1.3 below). The automated system requires a certain level of accuracy for vehicle speeds, which are subsequently used as inputs in the automated decision making process. Vehicle speeds estimated from single loop detectors are not deemed accurate enough for automated messaging and are not used by the CAWS system. Vehicle speeds from double loop and microwave detectors are used exclusively by CAWS. The capability of displaying travel times on CMS is presently under development.

Configuration files are used to specify:

- Internet Protocol (IP) addresses associated with each sign (Wizard or via SOCCS),
- Which CMS are available for automated control,
- Sign messages for various sensor detected conditions such as high winds, low visibility, stopped or slow traffic,
- Message decision making thresholds related to wind speeds, visibility.

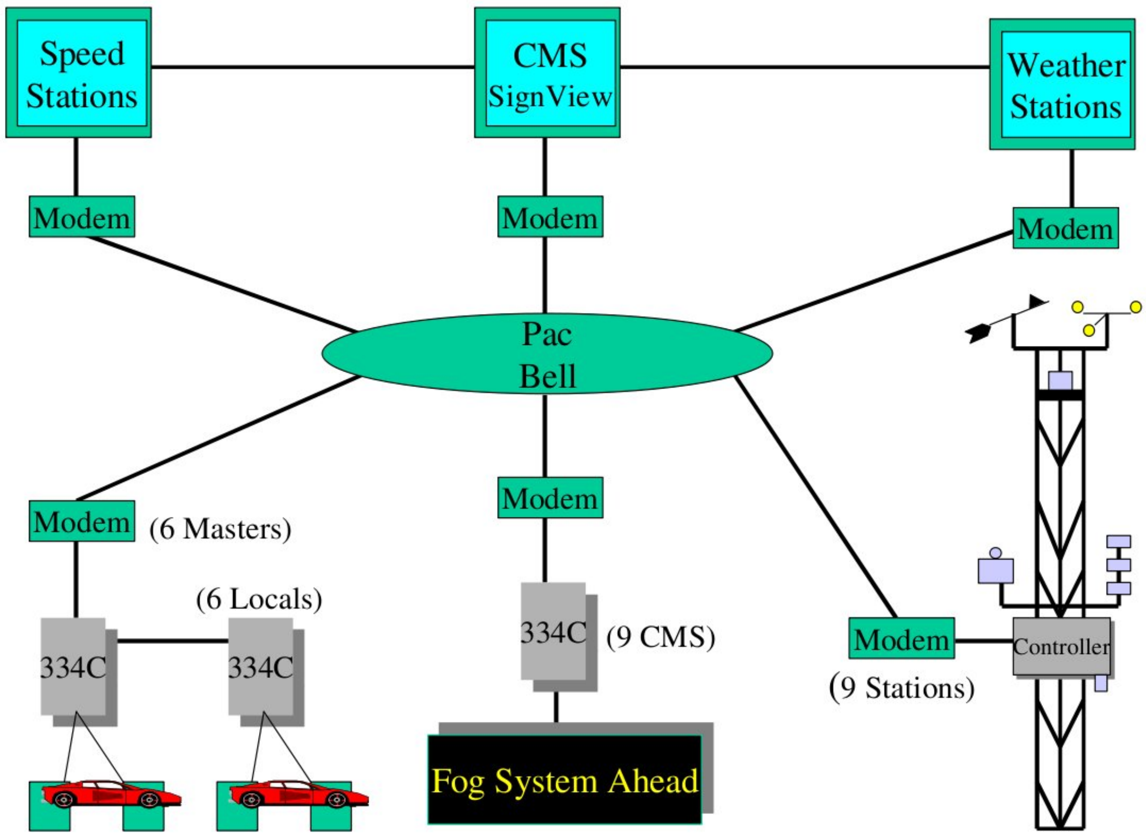

Figure 3.2: Original 1999 Caltrans CAWS key components [7]

3.1.2 Statewide Google Earth CMS System

The middleware system supports the statewide Google Earth CMS system, by performing the following:

1. A middleware application retrieves the CMS history file (via File Transfer Protocol (FTP)) from the SOCCS server,

2. The middleware application then copies this file to a centralized server in Sacramento, CA,

3. The server located in Sacramento then executes a script to create a static Keyhole Markup Language (KML) file, accessible via a web server to Caltrans users running the Google Earth client.

3.1.3 SOCCS

Satellite Operations Center Command System (SOCCS) is a software and hardware system used by TMC operators to display messages on D10 CMS (see call-out E in Figure 1.2 on page 4). Messages are selected from an existing message library or manually specified. Sign messages specified by operators override CAWS recommended messages. SOCCS server E reads (via HTTP) a file containing CAWS recommended messages from middleware server A every 30 seconds. The SOCCS system maintains a history of CMS message changes, which are downloaded from SOCCS server E daily. TMC operators and administrators use a web interface to interact with the SOCCS server E. SOCCS server E runs a web server and custom developed applications. These applications interface with the Lantronix[2] terminal server, which interfaces with the Model 170 (M170)s controlling the CMS (see Figure 1.2 on page 4). The SOCCS system supports the following functionality:

- Provides a web interface for TMC operators to manually specify CMS messages.

- Provides a web interface for administrators to perform system maintenance and configuration.

- Provides a 24-hour message history file via HTTP for external systems. This includes sign on/off times and message text.

3.2 Operations

For message verification, the M170 controllers are queried, which return the last message that was sent to the sign. The ability to query the sign is a desirable feature, but is presently not performed. All signs are controlled using SOCCS except for Model 520 signs. SignView is used as a backup method of controlling signs. This involves dialup software and modems. For field diagnostics, the keypad on the M170 is used to control the sign directly.

[2]For Lantronix see http://www.lantronix.com/

3.3 Hardware

D10 is using three types of signs, all manufactured by Ledstar[3]. D10 has a combined total of 30 model 500s and 510s, and 14 model 520s.

- Caltrans Model 500,
- Caltrans Model 510, smaller than the Model 500, functionally identical to the Model 500,
- Caltrans Model 520, smaller than the Model 510, used in rural areas, not controlled using SOCCS.

In addition, other hardware includes:

- Wizards: used only as modems to connect to the M170 via the Wizard's RS-232,
- Caltrans M170, which is used to control all signs, and contains SV170 firmware,
- Dialup modems: used to connect to CMS over analog telephone lines in remote locations.

3.4 Software

The following software is used for CMS operations:

- SOCCS: see Section 1.5 on page 4.
- Middleware/CAWS: see Section 3.1.3 on the facing page.
- SignView: software developed by Caltrans to control CMS. Runs on workstations within the TMC. Used as a backup control software.
- SV170: firmware running on M170 CMS controllers.

3.5 Communications

Communications and control of signs is performed as indicated below. Also see the D10 topology Figure 1.2 on page 4. M170 controllers are used to control all signs:

- Model 500: Wizard, Cingular VPN.

[3]For LedStar see http://www.ledstar.com

- Model 510: Wizard, Cingular VPN.
- Model 520: Dialup modem, analog phone line, SignView running in the TMC.

Chapter 4

Vehicle Incident Mapping

4.1 Background

Vehicle incident mapping capabilities have been identified as priority 2 for D10. An incident map is an on-screen map used by TMC operators that contains annotated traffic incident locations (see Figure 4.1 on the following page). The D10 TMC presently does not have incident mapping capabilities and does not use incident mapping provided by PeMS.

4.2 Operations

The D10 TMC presently logs incidents that require a TMC response to a spreadsheet file. Incident information originates with the CHP dispatch center and colocated CHP personnel.

4.3 Hardware

TMC personal computers are used for logging incidents.

4.4 Software

A spreadsheet is presently used for incident logging. Logging to a database is being considered.

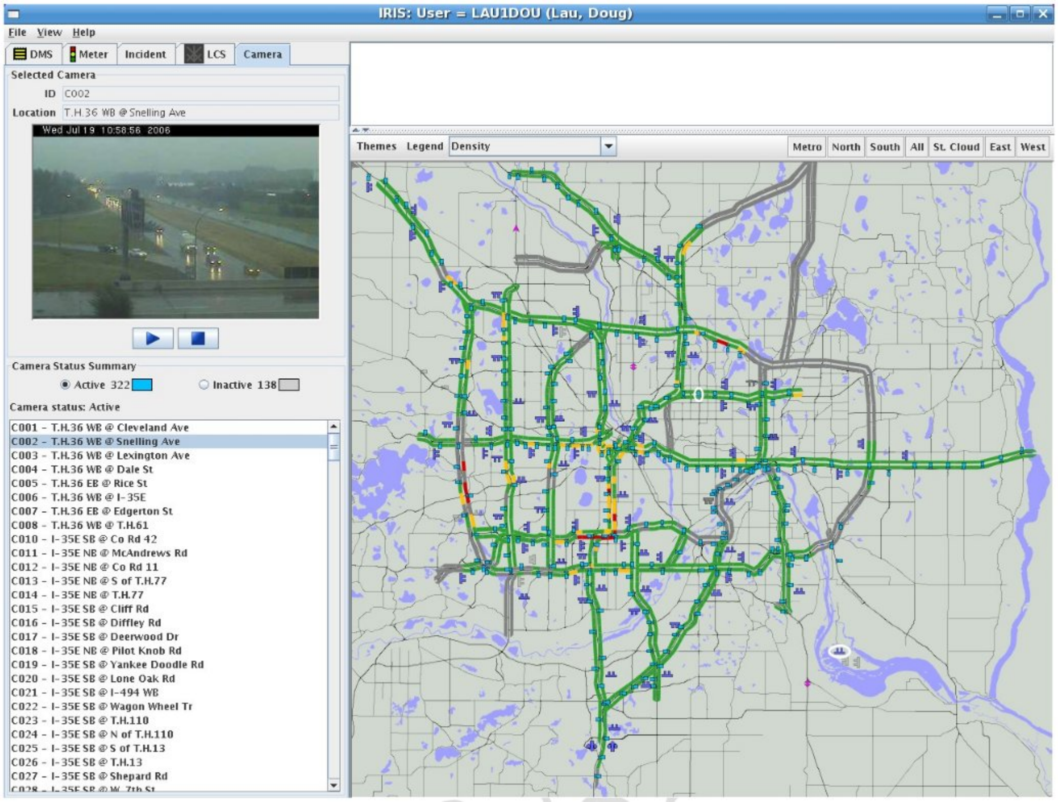

Figure 4.1: Mn/DOT IRIS ATMS screen shot with integrated mapping features [6]

4.5 Communications

Voice communications with CHP.

Chapter 5

Video Monitoring and Control

5.1 Background

Video monitoring has been identified as priority 3 for D10. Video control is priority 6. Some geographic camera position data is presently available; other camera locations need to be collected. The D10 TMC is presently using cameras on two networks (see the topology diagram on pg. 4):

- City of Stockton: call-outs K and L, analog CCTV. The Stockton system is presently converting to an IP based system and is therefore in flux.
- D10 cameras: call-outs N and O, analog CCTV connected to in-field computers with encoders. Cameras and communications are presently being defined, the system is in flux.

5.2 Operations

- City of Stockton cameras: the D10 TMC has Pan-Tilt-Zoom (PTZ) control of these cameras. TMC operators can view four different video streams from the existing 260 cameras. Operators use a control box to select from the 260 available channels.
- D10 cameras: system is presently being defined.

5.3 Hardware

- City of Stockton cameras: CCTV, 260 cameras in the field. Analog video streams arrive in the TMC via a fiber link. A Grass Valley Group TenX production video switcher is used to split off 4 selectable channels, which are viewed on multiple monitors within the TMC. PTZ control is through a joystick in the TMC, which is plugged into the Grass Valley Group video switcher.

- D10 cameras: some units are Cohu model 3960s[1]. All Cohu 3960 cameras are CCTV analog models. Eighteen units will be installed over time. Presently, two units are installed on Digital Subscriber Line (DSL) lines. The Cohu 3960 is National Transportation Communications for ITS Protocol (NTCIP) compatible. In-field computers, operating system, PTZ control, and encoders are presently being defined.

5.4 Software

None.

5.5 Communications

- City of Stockton cameras: connected to the TMC with fiber. Server K encodes the analog video for display on TMC workstations (H).
- D10 cameras: the system is presently being defined. The use of DSL, cable, or wireless is possible.

[1]For the Cohu 3960 see http://www.cohu-cameras.com/products/vidcams/3960.html

Chapter 6

Ramp Meters

6.1 Background

Ramp meter functionality has been identified as priority 4 for D10. D10 has two ramp meters and no mainline metering or freeway connector metering. The ramp meters are installed but not currently connected to the TMC. They are located on the on-ramp from Tracy Ave to Highway 205. Ramp meter geographic position can be collected.

6.2 Operations

The ramp meters are presently off and unused. No data is being received from the meters.

6.3 Hardware

The ramp meters will be controlled by an M170, connected to Wizards.

6.4 Software

The M170 controllers will run the San Diego Ramp Metering Software/System (SDRMS) firmware.

6.5 Communications

The TMC will communicate with the ramp meters using the wireless VPN.

Chapter 7

Weather Station Monitoring

7.1 Background

Weather station monitoring functionality has been identified as priority 5 for D10. D10 uses weather stations and sensors to monitor real-time weather conditions and trigger automatic system responses. The original CAWS system diagram is in Figure 3.2 on page 13. Geographic positions for weather stations are available or can be collected. For weather stations, see Figure 1.2 on page 4. Weather stations fall into two categories:

- Type 1: see call-outs B and C. These stations provide sensor data for the CAWS system to trigger automatic CMS messages. D10 has explored using Wizards to wirelessly connect these stations to the network.
- Type 2: see call-outs P and M. Data from these stations is not used by D10 and is forwarded to District 3 (D3) in Sacramento, CA, as part of the Statewide ScanWeb program[1]. D10 would like to connect these stations to the CAWS system, but this is presently precluded by data licensing issues.

7.2 Operations

Weather station data is used by D10 personnel and applications:

- Type 1: sensor data triggers automatic CMS messages using wind speed and visibility. TMC staff use a workstation to monitor weather conditions (see call-out B in Figure 1.2 on page 4).
- Type 2: weather station data is not used by any D10 application or personnel. The data is forwarded to Sacramento (D3) every 15 minutes.

[1] For SSI Inc. see http://www.qttinc.com.

7.3 Hardware

D10 has 17 weather stations installed and operational:

- Type 1: Qualimetrics (AllWeather Inc.[2]). These nine units are part of the CAWS system and include sensors for: wind speed, visibility, wind direction, among others.
- Type 2: SSI (Quixote Transportation Technologies Inc.[3]) Eight units are installed. A Linux box (call-out P, Figure 1.2 on page 4) serves as the weather station controller and interfaces with the weather station hardware. It is not internally accessible to D10 staff.

7.4 Software

None.

7.5 Communications

Both types of weather stations communicate with the TMC. See the D10 topology diagram (page 4) for components:

- Type 1: Qualimetrics weather stations, connected to a leased digital line via a Channel Service Unit/Data Service Unit (CSU/DSU).
- Type 2: SSI weather stations, connected to SSI Inc. Linux box, then to Wizards and the Cingular wireless service, and thus to the TMC. The Wizards serve only as modems and are not executing custom applications.

[2]See http://www.allweatherinc.com
[3]See http://www.qttinc.com/

Chapter 8

Event Logging

8.1 Background

Event logging has been identified as priority 7 for D10.

8.2 Operations

D10 presently logs CHP incidents that require TMC action in a spreadsheet. D10 is in the process of switching from the Traffic Management Center Activity Database (TMCAD) logging system to the Traffic Management Center Activity Logging (TMCAL) logging system. CMS event history is presently downloaded manually from the SOCCS system and stored locally. This is performed daily.

8.3 Hardware

None.

8.4 Software

None.

8.5 Communications

None.

Chapter 9

Highway Advisory Radio and Extinguishable Message Signs

9.1 Background

HAR and extinguishable message signs have been identified as priority 8 for D10. Fixed location HAR and extinguishable message signs are installed and used within D10 (see Figure 9.1 and Figure 9.2 on the following page). HAR, extinguishable message signs, and flashing beacons work together to provide information to drivers via recorded messages. Flashing beacons on the extinguishable message sign alert drivers of active HAR messages. HAR sign and antenna geographic locations are available or can be collected.

Figure 9.1: HAR sign and flashing beacons

Figure 9.2: HAR antenna (Quixote Inc.)

9.2 Operations

To specify a new HAR radio message, TMC operators use workstation I (see Figure 1.2 on page 4) to upload Waveform Audio (WAV) files to the HAR units. Flashing beacons on the signs are automatically activated via touch-tone sounds within the HAR messages.

9.3 Hardware

Quixote HAR systems are used by D10[1]. Some mobile HAR signs and antennas are used within D10 but are not a subject of this report. Workstation I contains a proprietary Quixote board used to interface with HAR hardware in the field.

9.4 Software

Quixote's DR2000 software is used by TMC operators on workstation I to control the HAR system. Operators use workstation I to record messages and activate various HAR units. Quixote offers an optional DR2000 software module (for a fee) that enables third-party software to interface with the HAR system.

[1]For Quixote see http://www.qttinc.com/pages/hisproducts.html

9.5 Communications

See Figure 1.2 on page 4.

Chapter 10

Intersection Traffic Signal Monitoring

10.1 Background

Intersection traffic signal monitoring has been identified as priority 9 for D10. Presently D10 has no real-time control or communications with traffic signals. D10 anticipates that Caltrans Central Signal Control System (CTNet) may be used at some point in the future to control and monitor traffic signals. The Wizards have been experimentally interfaced with the M170s to act as traffic signal controllers. D10 has also used CTNet with installed Model 2070 (M2070) and reports compatibility problems.

10.2 Operations

Presently, traffic signal timing is changed manually at the traffic signal.

10.3 Hardware

Most traffic signal controllers are M170s, however a number of M2070s are also in the field. D10 has 234 traffic signals.

10.4 Software

None.

10.5 Communications

A small number of dial-up lines (less than 6) with modems are installed but are not used.

Chapter 11

Summary

11.1 Summary

This document has summarized Caltrans District 10 TMC hardware, communications, software, and operations for ten functional areas, as it relates to the subsequent design and implementation of the IRIS ATMS within the District 10 TMC. Functional areas are: traffic monitoring stations, CMS, incident mapping, video monitoring, ramp meters, weather station monitoring, video control, event logging, HAR and extinguishable message signs, and intersection traffic signal monitoring. Functional area prioritized order is shown in Table 1.1 on page 6.

11.2 Future Work

The information in this document will be used in subsequent project tasks: D10 IRIS requirements definition [3], design, implementation, and testing.

References

[1] California Department of Transportation, "California ITS Architecture and System Plan," California Department of Transportation, Tech. Rep., Oct 2004. [Online]. Available: http://www.dot.ca.gov/hq/tpp/offices/opar/CAarchitecture/

[2] Caltrans, "Caltrans web site," July 2007. [Online]. Available: http://www.dot.ca.gov/

[3] M. Darter, S. M. Donecker, K. Yen, B. Ravani, and T. Lasky, "Review of Mn/IRIS and Caltrans District 10 TMC compatibility and functional requirements for D10 IRIS Demonstration Study, Tech. Rep. UCD-ARR-07-09-30-02, Sept. 2007.

[4] M. Darter, K. Yen, B. Ravani, and T. Lasky, "Literature review of national developments in ATMS and open source software, Tech. Rep. UCD-ARR-06-12-08-01, Dec. 2006.

[5] Federal Highway Administration, "Freeway Management and Operations Handbook," Federal Highway Administration, Tech. Rep. FHWA-OP-04-003, June 2006. [Online]. Available: http://ops.fhwa.dot.gov/freewaymgmt/publications/frwy_mgmt_handbook/

[6] Minnesota Department of Transportation, "Intelligent Roadway Information System (IRIS) As Built System Design Document," Minnesota Department of Transportation, Tech. Rep., June 2007.

[7] Transportation Electronics Laboratory, Dept. of Electrical Engineering California Polytechnic State University, "Evaluation of Caltrans District 10 Automated Warning System, Year Two Progress Report," California Partners for Advanced Transit and Highways, Tech. Rep. TEL591699, June 1999. [Online]. Available: http://www.path.berkeley.edu/PATH/Publications/PDF/PRR/99/PRR-99-28.pdf

[8] Wikipedia, "Wikipedia Variable Message Sign," July 2007. [Online]. Available: http://en.wikipedia.org/wiki/Variable-message_sign

Appendix A

District 10 InfoTek Wizard GSM Modem

The Wizard is a wireless modem jointly developed by D10 and InfoTek Inc. (CommTech Systems)[1]. The Wizard is a Global System for Mobile Communications (GSM) based General Packet Radio Service (GPRS)/Enhanced Data Rates for GSM Evolution (EDGE) modem. It has 32 digital inputs, 8 digital outputs, and an RS-232 port. It has an embedded Java runtime that supports the Transmission Control Protocol / Internet Protocol (TCP/IP) stack. The Java development environment also supports Short Message Service (SMS) for remote command and alert and HTTP. Each modem has an associated phone number and one or two IP addresses.

[1]For more detailed Wizard information, see http://commtechsystems.com/wizard.htm.