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

REVIEW OF MN/IRIS AND CALTRANS DISTRICT 10 TMC COMPATIBILITY AND FUNCTIONAL REQUIREMENTS FOR D10 IRIS DEMONSTRATION STUDY*

Michael T. Darter[1], Stephen M. Donecker[1],
Kin S. Yen[1], Bahram Ravani[1], &

Ty A. Lasky[1], Principal Investigator

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Affiliations:
1. AHMCT Research Center, Department of Mechanical & Aeronautical Engineering, University of California, Davis, CA 95616-5294

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16. Abstract

This document describes Task 4, "Review of Mn/IRIS and Caltrans District 10 TMC Compatibility and Functional Requirements for D10 IRIS Demonstration Study," 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 details general software and hardware requirements to be used in the subsequent design, implementation, and testing phases.

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Abstract

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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. Terms and definitions specific to the Open ATMS project are defined in the Definitions, Acronyms, and Abbreviations section (pg. 4).

AHMCT	Advanced Highway Maintenance & Construction Technology
ATMS	Advanced Transportation/Traffic Management System
Caltrans	California State Department of Transportation
CAWS	California Automated Warning System
CCTV	Closed-circuit Television Cameras
CHP	California Highway Patrol
CMS	Changeable Message Sign
CTNet	Caltrans Central Signal Control System
D3	District 3
D10	District 10
DOT	Department of Transportation
DRI	Division of Research and Innovation
DSL	Digital Subscriber Line
GPL	GNU's General Public License
HAR	Highway Advisory Radio
HTTP	HyperText Transfer Protocol
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol

IRIS	Intelligent Roadway Information System
IT	Information Technology
ITS-4	4th generation ITS technologies
ITS	Intelligent Transportation System
JPEG	Joint Photographic Experts Group
M-JPEG	Motion JPEG
M170	Model 170
Mn/DOT	Minnesota Department of Transportation
MPEG-4	Moving Picture Experts Group 4
NDA	Non-Disclosure Agreement
NTCIP	National Transportation Communications for ITS Protocol
PeMS	Freeway Performance Measurement System
PTZ	Pan-Tilt-Zoom
SDRMS	San Diego Ramp Metering Software/System
SOCCS	Satellite Operations Center Command System
SRS	Software Requirements Specification
TAG	Technical Advisory Group
TCP/IP	Transmission Control Protocol / Internet Protocol
TMC	Transportation Management Center
TMCAD	Traffic Management Center Activity Database
TMCAL	Traffic Management Center Activity Logging
UDP/IP	User Datagram Protocol / Internet Protocol
UI	User Interface
UTM	Universal Transverse Mercator
XML	eXtensible Markup Language

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Chapter 1

Introduction

Working with the advisory group, AHMCT has developed this interim report, which presents Caltrans D10 and IRIS compatibility, organized by functional areas (e.g. CCTV, CMS, etc.). In subsequent work, for each functional area, a general design and implementation approach will be specified to implement the open-source Mn/DOT IRIS within Caltrans D10. The overall goal is to maximize benefit for both D10 and the open-source IRIS project.

This document also provides the general requirements for the D10 IRIS demo. Results from Tasks 1, 2, 3, along with the Caltrans D10 and IRIS compatibility table (see Table 2.1 on page 8) presented herein, were used to develop these requirements. The functional requirements are based upon the prioritized functional areas (see Table 1.1 on page 6). Functional areas will be addressed according to the indicated priority levels (1 = highest).

This document also identifies which functional areas shall be included in the current D10 IRIS demo, and which will be marked for future work. Inclusion was based in part on priority, but also on external dependencies and resource availability (for example, telecommunications configuration and availability for CCTV control).

This document was reviewed (aside: draft submitted 10/1/2007) by the project Technical Advisory Group (TAG), and will guide the remaining project development.

This report discusses Open ATMS (a.k.a. the "System") requirements and goals. Requirements defined here are used in the subsequent design and implementation phases. In general, this report follows the Institute of Electrical and Electronics Engineers (IEEE) SRS standard 830-1998 [3].

1.1 Document Purpose

This document defines basic Open ATMS requirements which will be used in the subsequent design, implementation, and testing phases of the D10 IRIS Open-Source Demon-

stration Project. 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]. The intended audience includes: system developers, engineers, project management, the TAG, Caltrans management and engineers, and other Department of Transportation (DOT) personnel and management. For each functional area, this document provides a general design and implementation approach, basic requirements, reliability and fail-over requirements, a compatibility table (see Table 2.1 on page 8) and identification of which tasks will be included in the current D10 demo (see Section 2.6.1 on page 11).

1.2 Product Scope

Product Name

The software and hardware project under development is titled the *AHMCT/Caltrans D10 IRIS Demonstration* and is referred to here as 'Open ATMS' or the 'System'. IRIS is an open-source ATMS system developed and maintained by the Minnesota Department of Transportation (Mn/DOT).

Product Functions

The System provides a single user interface to TMC operators, integrating data from a number of sources (for an IRIS screen shot, see Figure 1.1 on the facing page). The following prioritized list of desired System functionality was previously developed by the project advisory group:

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

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

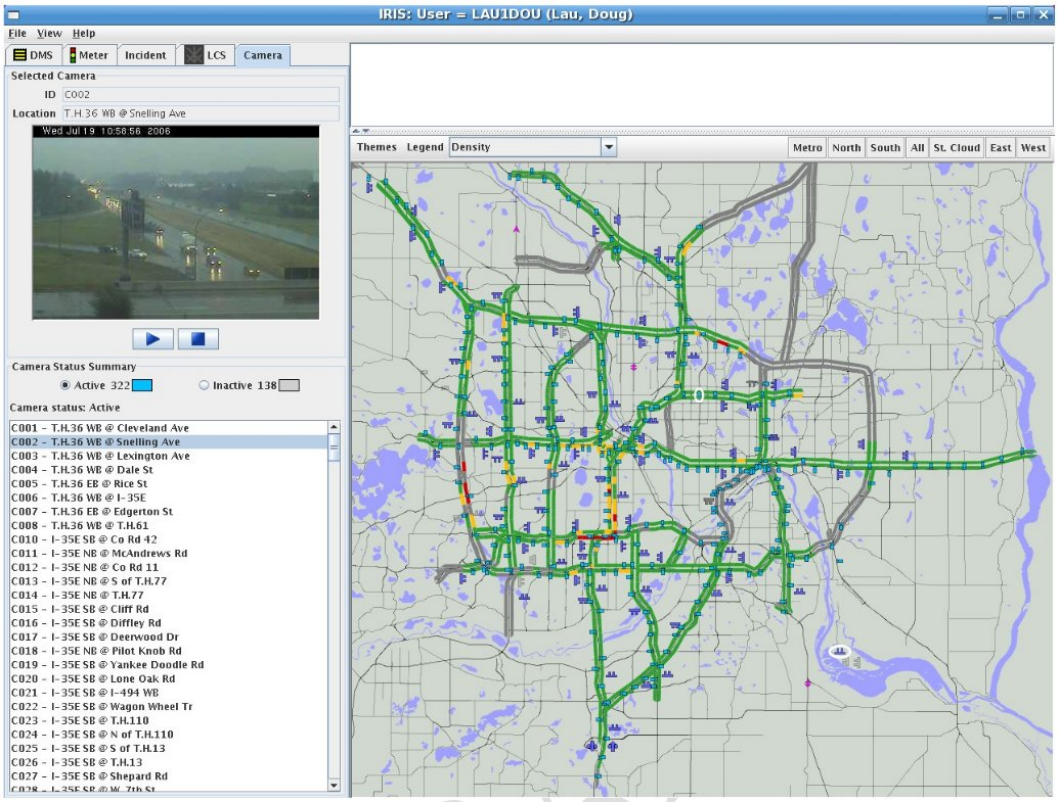

Figure 1.1: Mn/DOT IRIS ATMS screen shot with integrated mapping features [4]

Product Area

The ATMS field is a primary subfield within the Intelligent Transportation System (ITS) domain. The ATMS view is a top-down management perspective that integrates technology primarily to improve the flow of vehicle traffic and improve safety. Real-time traffic data from cameras, loop detectors, microwave detectors, and other sensors flows into the TMC where they are integrated and processed (e.g. for incident detection), and may result in actions taken (e.g. traffic routing, Changeable Message Sign (CMS) updates) with the goal of improving traffic flow. For more detailed information on ATMS and open-source ATMS, see an earlier project report [2]. The National ITS Architecture defines the following primary goals and metrics for ITS [7]:

- Increase transportation system efficiency,
- Enhance mobility,
- Improve safety,
- Reduce fuel consumption and environmental cost,
- Increase economic productivity, and
- Create an environment for an ITS market.

1.3 Definitions, Acronyms, and Abbreviations

See the acronyms and abbreviations section on page xvii.

- D10 Middleware: identifies the functionality provided by applications executing on TMC servers. These applications typically gather data from field sensors and applications, process it, and distribute or display the processed information.
- California Automated Warning System (CAWS): a portion of the D10 middleware functionality that provides automated CMS messages as a function of real-time weather and traffic.
- Satellite Operations Center Command System (SOCCS): a discrete system running within the TMC that currently provides CMS control and configuration.
- D10 IRIS: specifically identifies the software applications under development in this project–Mn/DOT's IRIS open-source ATMS package, customized and implemented for Caltrans D10. In addition, other applications and modules will be developed.
- The System: used interchangeably with D10 IRIS.

1.4 SRS References

For a list of references used in this document, see the bibliography on page 47. These references may also be useful for further background material. This report follows the recommended SRS document structure specified in IEEE Std 830-1998 (see below). Other related documents that may be useful are shown below:

- IEEE Recommended Practice for Software Requirements Specifications, IEEE Std 830-1998 [3].
- Implementing the IEEE Software Engineering Standards [5].
- Previous project reports:
  - Literature Review of National Developments in ATMS and Open-source Software [2]
  - Review of Caltrans District 10 Transportation Management Center Operations and Equipment [1]

1.5 Document Overview

SRS Organization

The remainder of this document provides an overall System description (Chapter 2), and individual chapters for specific D10 functional areas. Each functional area specifies essential background material, design and implementation constraints, and basic requirements. See the project Task 3 document for more complete background information [1]. Requirements are grouped by category and numbered for reference elsewhere in the document.

This report follows the recommended SRS document structure specified in IEEE Std 830-1998 [3], and therefore some document sections are left blank for conformance with standardized IEEE section numbering.

Research Tasks and Progression

The Open ATMS project progressed as indicated below. Software development uses an evolutionary linear process model, which iteratively follows the typical sequence of requirements definition, design, development, and testing.

1. Formation of the advisory group
2. Literature review of National developments in ATMS and open-source software [2]
3. Review of current Caltrans D10 ATMS operations and equipment [1]
4. Development of demonstration open-source ATMS implementation requirements (this document).
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

Functional Area Priorities

The 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 (9). Table 1.1 shows function area priorities. Note that CMS and Incident Mapping both have the same priority level.

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

Overall System Description

2.1 Product Perspective

This chapter describes general factors that affect D10 IRIS and subsequent requirements. This section places D10 IRIS into perspective with adjacent and related products. At the highest level, D10 IRIS has three top-level system goals:

1. Implement Mn/DOT IRIS as is, within Caltrans D10, to the extent possible,
2. Meet District 10 needs,
3. Meet Caltrans-wide needs.

A number of information products and services are used by TMC personnel, including Freeway Performance Measurement System (PeMS), Traffic Management Center Activity Database (TMCAD), Traffic Management Center Activity Logging (TMCAL), Microsoft Access, Google Earth, etc. [1].

2.1.1 User Interface Constraints

User Interface (UI) constraints are primarily defined by the existing Mn/DOT IRIS product.

2.1.2 Software Interface Constraints

Defined somewhat by the existing Mn/DOT IRIS product.

2.1.3 Communications Interface Constraints

Primarily defined by the existing D10 communications hardware.

2.1.4 Site Adaptation Requirements

The following site adaptation requirements are anticipated:

- Installation of D10 IRIS server within the TMC.
- Installation of a terminal server for D10 IRIS CMS control.
- Configuration of the TMC router to forward traffic sensor User Datagram Protocol / Internet Protocol (UDP/IP) packets to the D10 IRIS server.
- Configuration of TMC workstations to execute the D10 IRIS client.
- Configuration related to enabling AHMCT remote access to the D10 network.

2.2 D10 IRIS Functions

D10 IRIS functionality is grouped and prioritized by functional area. See Table 2.1.

Table 2.1: IRIS and D10 compatibility summary

Priority	Functional Area	In IRIS	In D10	D10 IRIS Demo
1	Traffic Monitoring Stations	Yes	Yes	C, ES
2	CMS	Yes	Via SOCCS	C, EG, ES
2	Vehicle Incident Mapping	Yes	Via PeMS	C
3	Video Monitoring	Yes	Yes	C, EG, ES
4	Ramp Meters	Yes	Yes	C, ES
5	Weather Station Monitoring	No	Yes	EG or ES
6	Video Control	Yes	Yes	C, EG, ES
7	Event Logging	Yes	Yes	C
8	HAR and Extinguishable Message Signs	No	Yes	Future
9	Intersection Traffic Signals	Yes	Yes	Future
	Note: **C**: Currently supported in IRIS **EG**: Planned general IRIS enhancement **ES**: Planned D10 specific enhancement **Future**: Not implemented in current project			

2.3 User Characteristics

- D10 TMC Operators: Caltrans personnel working within the D10 TMC responsible for daily TMC traffic operations.
- D10 TMC Engineers: Caltrans personnel working within the D10 TMC responsible for daily Information Technology (IT) and systems engineering operations.
- AHMCT Researchers: personnel developing and implementing D10 IRIS for Caltrans.
- Future actors: are anticipated to be consultants, researchers, Caltrans personnel, and others who will interact with D10 IRIS.

2.4 Constraints

To the extent possible, the software system shall be implemented to be portable across operating system platforms. This may not always be possible due to performance and cost trade-offs.

2.5 Assumptions and Dependencies

- The general implementation approach is to initially implement minimal functionality in each functional area, and subsequently iterate through remaining requirements across all functional areas as prioritized by D10 staff, Caltrans, budget constraints, time constraints, ease of implementation, etc. Determination of priorities within functional areas is therefore anticipated to be dynamic. The priorities of different functional areas may also change as determined by the TAG.
- Development will use an evolutionary linear process model, which iteratively follows the waterfall sequence of requirements definition, design, development, and testing.
- Testing is anticipated to take approximately one third of development time.
- The System will be implemented using higher level languages, as determined by performance, reliability, and functional requirements.
- System and functional area documentation will be developed for new functionality and existing functionality, to the extent possible and as appropriate, balanced with development needs.

- Trend: communications between sensors and the TMC are migrating towards Internet Protocol (IP)-based communication. This is directly relevant for ongoing Mn/DOT IRIS development, and D10 IRIS design decisions and implementation.
- Trend: there is a movement over time within ITS towards distributed sensors, processing, communication, and decision making[1].
- Implemented D10 IRIS functional areas will operate in parallel with existing D10 systems, to the extent possible.
- The System shall be implemented in English.

2.5.1 Project-wide Machine Logistics

1. AHMCT will perform development work in Davis, California.
2. The production D10 IRIS server will be located in the D10 server room.
3. The production D10 IRIS server will be administered remotely by AHMCT and locally by D10 staff.
4. Some D10 IRIS functionality may require an additional server for execution. For example, the TRAFDAT application (see Section 3 on page 13).
5. AHMCT will be connected to the D10 network.
6. Workstations within the D10 TMC will execute the D10 IRIS client on their machines, loaded from the D10 IRIS server.
7. A second Open ATMS server may be located in an undetermined location, and may provide backup services and manual fail-over functionality for the primary D10 IRIS server, as determined by project needs and budget constraints.

2.6 Apportioning of Requirements

This section distinguishes between requirements that will be implemented in the existing project time frame, requirements that are optional within the existing project time frame, and requirements that may be implemented in the future.

Two functional areas (Highway Advisory Radio (HAR) and traffic signals) have been identified by the TAG as deferred for future work and will not be performed in the existing project. All requirements in those sections have been tagged as deferred and are for informational use only.

[1] See the Open ATMS Task 2 Report, pg. 37, and also ongoing Caltrans DRI research projects (Sean Campbell). This trend is also visible in next-generation Caltrans CMS specifications that assume an intelligent built-in CMS controller. This trend is also known as 4th generation ITS technologies (ITS-4) [6].

2.6.1 Types of Requirements

This document identifies different types of requirements for each functional area:

- Normal Requirements: these requirements will be implemented within the ongoing project. These requirements have a higher priority than optional requirements.
- Optional Requirements: these requirements may be implemented in the ongoing project, depending on budget and schedule constraints and their priority relative to other requirements and testing work. Optional requirements are tagged as '(optional)' and are specified with an *italic* font.
- Deferred Requirements: these requirements will not be implemented in this project. They are included here for informational use. The TAG has identified the functionality associated with these requirements as desirable and this information may be used in future projects. Deferred requirements are tagged as '(deferred)' and are specified with an *italic* font.

Chapter 3

Traffic Monitoring Stations

3.1 Background

Traffic monitoring has been identified as priority 1 for D10. The IRIS client displays traffic volume and occupancy on a map (see Figure 1.1 on page 3). It is anticipated that real-time traffic data will be received from the D10 loop and microwave detectors via a D10 router. D10 traffic monitoring functionality is expected to use IRIS functionality as is. In addition, D10 is highly interested in the IRIS TRAFDAT application, which archives traffic data and provides web-based applications for data extraction and traffic plots.

3.2 Functional Area Requirements

3.2.1 External Interface Requirements

User Interface Requirements

Requirement 1: Traffic-related functionality will be used as-is within the IRIS client.

Requirement 2: The IRIS client will display a D10 map.

Hardware Interface Requirements

Requirement 3: D10 IRIS will receive UDP/IP packets from a D10 router, containing real-time traffic data from inductive loop and microwave traffic detectors.

Software Interface Requirements

Requirement 4: D10 IRIS will format real-time traffic data received from a D10 router for input into IRIS.

Communications Interface Requirements

See R3 and R4.

3.2.2 Functional Requirements

IRIS-Related Requirements

Requirement 5: IRIS traffic-related functionality shall operate as-is.

Requirement 6: Real-time traffic data from microwave and inductive loop detectors will be used by IRIS.

Requirement 7: *(optional) The IRIS TRAFDAT applications will be implemented.*

Requirement 8: If implemented, the IRIS TRAFDAT applications will operate as-is.

Non-IRIS-Related Requirements

Requirement 9: If TRAFDAT is implemented, D10 IRIS-specific TRAFDAT reports and plots are anticipated, depending on subtask priority. For example, TRAFDAT reports specific to CAWS.

3.2.3 Performance Requirements

Requirement 10: D10 IRIS is not anticipated to impact existing D10 hardware or software performance.

3.2.4 Logical Database Requirements

Requirement 11: D10 IRIS will use the existing IRIS database schema as-is.

3.2.5 Design and Implementation Constraints

- D10 IRIS will use the existing IRIS design as-is.
- The D10 TMC router receives 30-second traffic data from microwave and inductive loop detectors, forwarded by in-field Wizards.
- The D10 TMC router will forward 30-second traffic data to a traffic monitoring process executing on the IRIS server.
- The IRIS TRAFDAT application will receive daily traffic data from the IRIS server.
- If implemented, the IRIS TRAFDAT applications and database will execute on a separate machine from the IRIS server.
- The timeliness of D10 IRIS traffic data depends on the timeliness of real-time data received from the D10 router and field hardware.

Standards Compliance

Requirement 12: D10 IRIS will use existing IRIS data formats wherever possible.

3.2.6 Software System Attributes

Reliability

Requirement 13: Developed traffic functionality will use existing IRIS features to monitor reliable operation (e.g. the event log database).

Requirement 14: AHMCT and D10 will test developed functionality both in the laboratory and in the field.

Availability

Requirement 15: D10 IRIS traffic functionality will operate in parallel with existing D10 middleware.

Requirement 16: D10 IRIS and existing D10 TMC functionality are not interdependent in any way.

Security

Requirement 17: D10 IRIS will use, and be dependent on existing IRIS and D10 security features.

Maintainability

Requirement 18: Software source code will be maintained in a source control repository to support ongoing and future software maintenance.

Portability

3.2.7 Other Requirements

Chapter 4

Changeable Message Signs

4.1 Background

The CMS functional area has been identified as priority 2 for D10. The relationship between the existing D10 SOCCS system and IRIS is discussed in section 4.2.5 on page 19. Caltrans is presently developing a CMS specification to supersede existing specifications. The future CMS specification stipulates the use of the National Transportation Communications for ITS Protocol (NTCIP) protocol and CMS with built-in, intelligent controllers. IRIS and Mn/DOT use NTCIP to communicate with their CMS. Caltrans predominately uses the SignView protocol. Some D10 CMS are connected to the TMC through dial-up lines and some are connected with wireless devices [1].

CMS messages originate from these sources:

- CAWS: automatically generated as a function of sensor inputs,
- TMC operators: either manually entered or selected from a message library,
- IRIS-generated: travel-time related messages.

With existing IRIS CMS functionality, operators can:

- View, create, edit, and activate CMS messages,
- Send Amber Alert messages to all CMS,
- Travel-time messages are displayed on CMS.

4.2 Functional Area Requirements

4.2.1 External Interface Requirements

User Interface Requirements

Requirement 19: *(optional) D10 IRIS will indicate to TMC operators the origin of CMS messages (see the background section for potential message origin).*

Hardware Interface Requirements

Requirement 20: D10 IRIS shall use existing IRIS functionality, such as support for the NTCIP protocol.

Requirement 21: D10 IRIS shall support CMS on dial-up lines.

Requirement 22: D10 IRIS shall support CMS connected to the TMC via D10's InfoTek Wizards.

Requirement 23: D10 IRIS will not use existing IRIS serial tunneling functionality.

Software Interface Requirements

Requirement 24: D10 IRIS shall implement the SignView protocol in an application separate from IRIS.

Communications Interface Requirements

Requirement 25: D10 IRIS shall support CMS that use the SignView protocol.

Requirement 26: D10 IRIS shall interface with CMS on dial-up lines through a terminal server, as in the existing D10 SOCCS system.

4.2.2 Functional Requirements

IRIS Related Requirements

Requirement 27: The D10 IRIS UI shall function as is (see the Background section above).

Non-IRIS Related Requirements

Requirement 28: D10 IRIS shall receive and process D10 middleware generated messages (CAWS) and display them on the CMS.

4.2.3 Performance Requirements

4.2.4 Logical Database Requirements

4.2.5 Design and Implementation Constraints

The D10 IRIS design seeks to anticipate future CMS trends to the extent possible, by providing:

- Support for multiple protocols,
- Support for locating CMS processing intelligence within the TMC or in the field (see Section 2.5 on page 9),
- Support for Caltrans' Field Element Protocol to the extent possible (currently in development by Caltrans), in concept, design, or within the implementation.

The existing D10 SOCCS system and IRIS CMS functionality will exist and operate 1) independently of each other and 2) in parallel. Individual CMS will be controlled either with the existing D10 system (SOCCS) or D10 IRIS, but not both at the same time. Therefore, development, testing, and validation will be performed incrementally. CMS will individually be moved over to IRIS control at D10's discretion, using their existing CMS validation procedures. D10 IRIS-controlled CMS may revert back to SOCCS control as necessary. The existing D10 SOCCS system will act as a backup CMS control system. Moving CMS between D10 IRIS and SOCCS control is anticipated to only require software configuration changes within the TMC (to SOCCS and D10 IRIS).

Anticipated Logistics Steps:

1. D10 IRIS and new SignView functionality will initially be laboratory-tested at AHMCT and possibly in the Caltrans Sacramento CMS test facility.
2. D10 IRIS CMS functionality will subsequently be tested on a single in-field CMS, connected through a Wizard, that is not part of the CAWS system.
3. Additional non-CAWS CMS will be controlled with IRIS at D10's discretion.
4. CAWS-controlled CMS will be added to IRIS control at D10's discretion.

Standards Compliance

Requirement 29: Developed SignView applications and functionality shall comply with the existing protocol, to the extent possible.

Requirement 30: Developed NTCIP applications and functionality shall comply with the existing protocol, to the extent possible.

Requirement 31: Developed SignView functionality will support a subset of the full SignView protocol.

4.2.6 Software System Attributes

Reliability

Requirement 32: Developed CMS functionality will use existing IRIS features to monitor reliable operation (e.g. the event log database).

Requirement 33: AHMCT will test developed functionality both in the laboratory and in the field.

Requirement 34: AHMCT will develop a formal internal SignView protocol document using information from 1) verbal communication with Caltrans engineers, 2) from viewing previously developed SOCCS source code, 3) from internal Caltrans documentation, and 4) from testing of AHMCT-developed code.

Availability

Requirement 35: Existing D10 middleware and CAWS applications are not expected to change.

Requirement 36: Existing D10 CMS control (the SOCCS system) will act as a backup CMS control system.

Security

Requirement 37: Existing SignView code will not be shared outside of AHMCT or Caltrans.

Requirement 38: The SignView protocol will not be shared outside of AHMCT or Caltrans.

Maintainability

Requirement 39: Software source code will be maintained in a source control repository to support ongoing and future software maintenance.

Portability

4.2.7 Other Requirements

Requirement 40: Existing SignView code is copyrighted by Caltrans.

Requirement 41: Existing SignView code is not subject to the GNU's General Public License (GPL) copyright.

Requirement 42: Newly-developed code that uses the SignView protocol will not be released outside of AHMCT or Caltrans.

Requirement 43: Newly-developed code that uses the SignView protocol shall not be copyrighted with the GPL.

Chapter 5

Vehicle Incident Mapping

5.1 Background

Vehicle incident mapping capabilities have been identified as priority 2 for D10. IRIS contains incident mapping functionality, and uses ESRI's ArcView mapping files. IRIS locates incidents on the system map. Incidents are clickable, which shows CMS in close proximity. IRIS displays incident details on the left side of the screen.

5.2 Functional Area Requirements

5.2.1 External Interface Requirements

User Interface Requirements

Requirement 44: D10 IRIS shall use existing IRIS mapping UI functionality.

Hardware Interface Requirements

Software Interface Requirements

Requirement 45: D10 IRIS shall convert the California Highway Patrol (CHP) eXtensible Markup Language (XML) file into a data format supported by IRIS.

Communications Interface Requirements

Requirement 46: D10 IRIS shall periodically read real-time CHP incident data.

Requirement 47: CHP incident data will be read from a web server as an XML file via HyperText Transfer Protocol (HTTP).

5.2.2 Functional Requirements

IRIS Related Requirements

Requirement 48: D10 IRIS incident mapping functionality shall operate as-is.

D10 IRIS Specific Requirements

Requirement 49: D10 IRIS will perform geographic coordinate translation between supplied CHP mapping coordinate system (Thomas Brothers XY) and the coordinate system used by IRIS (Universal Transverse Mercator (UTM)).

5.2.3 Performance Requirements

5.2.4 Logical Database Requirements

5.2.5 Design and Implementation Constraints

Standards Compliance

5.2.6 Software System Attributes

Reliability

Requirement 50: Developed incident mapping functionality will use existing IRIS features to monitor reliable operation (e.g. the event log database).

Availability

Requirement 51: IRIS incident mapping is independent of any existing D10 systems and operations.

Security

Maintainability

Requirement 52: Software source code will be maintained in a source control repository to support ongoing and future software maintenance.

Portability

5.2.7 Other Requirements

Chapter 6

Video Monitoring and Control

6.1 Background

This chapter covers both video monitoring (priority 3) and control (priority 6). Video monitoring consists of viewing video camera images. Video control involves manipulating camera Pan-Tilt-Zoom (PTZ). IRIS uses a joystick attached to each workstation executing the IRIS client, to provide PTZ camera control. IRIS supports Motion JPEG (M-JPEG) video compression.

D10 uses two separate camera systems:

1. The D10 System: presently being constructed, IP-based, and may be connected to the TMC through Digital Subscriber Line (DSL) or wireless,
2. The City of Stockton System: analog, provides PTZ, transitioning to IP based system, is presently supplied to the TMC with fiber.

6.2 Functional Area Requirements

6.2.1 External Interface Requirements

User Interface Requirements

Requirement 53: The IRIS user interface will be used as is.

Hardware Interface Requirements

Software Interface Requirements

Communications Interface Requirements

6.2.2 Functional Requirements

IRIS Related Requirements

Requirement 54: D10 IRIS shall support video monitoring of D10 IP-based cameras.

Requirement 55: D10 IRIS shall support TMC-based camera control of D10 IP-based cameras that support motion control.

Requirement 56: *(optional) D10 IRIS shall support video monitoring of the existing D10 4 channel City of Stockton analog system.*

D10 IRIS Specific Requirements

Requirement 57: *(optional) D10 IRIS may support Moving Picture Experts Group 4 (MPEG-4) encoding, pending other priorities.*

6.2.3 Performance Requirements

6.2.4 Logical Database Requirements

6.2.5 Design and Implementation Constraints

To the extent possible, the D10 camera system will use open-source software and commodity hardware. For example, analog cameras with PTZ capabilities, interfaced to Linux-based machines with video cards, running an open-source PTZ package, and open-source operating system. This approach is consistent with the original intent and spirit of the Open ATMS project. Communication with in-field cameras will be by DSL, cable, or wireless.

The D10 IRIS interface with the City of Stockton analog camera system may be through a video server, providing analog-to-digital video conversion, for example to M-JPEG or MPEG-4 encoded video stream.

Standards Compliance

Requirement 58: D10 IRIS shall use primarily M-JPEG or MPEG-4 for digital video encoding.

6.2.6 Software System Attributes

Reliability

Requirement 59: Developed video functionality will use existing IRIS features to monitor reliable operation (e.g. the event log database).

Requirement 60: AHMCT will test developed functionality both in the laboratory and in the field.

Availability

Requirement 61: Any developed D10 IRIS video monitoring functionality providing City of Stockton video monitoring is anticipated to operate in parallel with existing D10 City of Stockton systems.

Requirement 62: Any developed D10 IRIS video control functionality providing control of existing City of Stockton cameras is anticipated to operate in parallel with existing D10 City of Stockton systems.

Security

Maintainability

Requirement 63: Software source code will be maintained in a source control repository to support ongoing and future software maintenance.

Portability

6.2.7 Other Requirements

Chapter 7

Ramp Meters

7.1 Background

Ramp meter functionality has been identified as priority 4 for D10. IRIS uses a custom-developed ramp meter protocol with Model 170 (M170) controllers. D10 ramp meters are not connected to the TMC at the time of this report.

7.2 Functional Area Requirements

7.2.1 External Interface Requirements

Ramp meters are expected to be connected to the TMC wirelessly using Wizards, using Transmission Control Protocol / Internet Protocol (TCP/IP) and San Diego Ramp Metering Software/System (SDRMS).

User Interface Requirements

Hardware Interface Requirements

Software Interface Requirements

Requirement 64: D10 IRIS enhancements to IRIS supporting multiple ramp meter protocols will be modular to the extent possible, anticipating the addition of future ramp meter protocols to the IRIS project.

Communications Interface Requirements

7.2.2 Functional Requirements

IRIS Related Requirements

Requirement 65: D10 IRIS shall use IRIS ramp metering functionality as is, with the exception of the communications protocol.

Requirement 66: D10 IRIS may support a subset of IRIS ramp metering functionality, depending on the priority of other requirements.

D10 IRIS Specific Requirements

Requirement 67: D10 IRIS shall use the SDRMS protocol.

7.2.3 Performance Requirements

7.2.4 Logical Database Requirements

7.2.5 Design and Implementation Constraints

D10 IRIS will implement an SDRMS module, and communicate with an in-field ramp meter controller. The SDRMS protocol or documentation is not covered by a Non-Disclosure Agreement (NDA).

Development and testing is expected to following these steps:

1. Initial D10 IRIS laboratory development and testing will be performed.
2. In-field testing will be performed with the controller and ramp meter.
3. Testing with D10 IRIS in the TMC and the ramp meter will follow.

Standards Compliance

Requirement 68: The in-field controller shall support and conform to the SDRMS protocol.

Requirement 69: Implemented modules or applications within D10 IRIS shall support and conform to the SDRMS protocol.

Requirement 70: Developed ramp meter functionality will support a subset of the full SDRMS protocol.

7.2.6 Software System Attributes

Reliability

Requirement 71: Developed ramp meter functionality will use existing IRIS features to monitor reliable operation (e.g. the event log database).

Requirement 72: AHMCT will test developed functionality both in the laboratory and in the field.

Availability

Requirement 73: D10 IRIS ramp meter testing will involve lab testing, field testing, and TMC testing.

Security

Maintainability

Requirement 74: Software source code will be maintained in a source control repository to support ongoing and future software maintenance.

Portability

7.2.7 Other Requirements

Chapter 8

Weather Stations and Sensors

8.1 Background

Weather station monitoring functionality has been identified as priority 5 for D10. IRIS does not use weather station data. The primary motivation for adding weather station functionality to D10 IRIS is that TMC operators need to know the reason a particular CMS message is being displayed, its source, and verification of sensor inputs for automated CAWS message generation. The TAG has identified weather station functionality as a valuable generalized enhancement to IRIS. D10 has two types of weather stations: Qualimetrics and SSI. They are connected to the TMC via dial-up lines and wireless Wizards [1].

8.2 Functional Area Requirements

8.2.1 External Interface Requirements

User Interface Requirements

Requirement 75: D10 IRIS UI enhancements to IRIS will be consistent with the existing UI.

Hardware Interface Requirements

Software Interface Requirements

Requirement 76: D10 IRIS will receive weather station data from an existing D10 middleware server.

Communications Interface Requirements

8.2.2 Functional Requirements

IRIS Related Requirements

D10 IRIS Specific Requirements

Requirement 77: D10 IRIS shall display the locations of weather stations on the System map.

Requirement 78: The D10 IRIS map shall indicate current wind speed and visibility measurements.

8.2.3 Performance Requirements

8.2.4 Logical Database Requirements

8.2.5 Design and Implementation Constraints

D10 IRIS will read real-time weather station information from a D10 middleware server. This may require minor enhancements to the existing D10 middleware. D10 IRIS will initially use data from the Qualimetrics weather stations. D10 middleware will eventually support receiving data from the SSI weather stations, which would be read by the D10 IRIS implementation, using the same data format. Weather station data may alternatively be read from the existing District 3 (D3) server, as determined by functional area priorities during implementation.

Standards Compliance

8.2.6 Software System Attributes

Reliability

Requirement 79: Developed weather station functionality will use existing IRIS features to monitor reliable operation (e.g. the event log database).

Requirement 80: AHMCT will test developed functionality both in the laboratory and in the field.

Availability

Requirement 81: Existing D10 weather station functionality will not be dependent on D10 IRIS.

Security

Maintainability

Requirement 82: Software source code will be maintained in a source control repository to support ongoing and future software maintenance.

Portability

8.2.7 Other Requirements

Chapter 9

Event Logging

9.1 Background

Event logging has been identified as priority 7 for D10. Two logging packages are presently in use within D10: TMCAD and TMCAL. D10 is transitioning to TMCAL. D10 has no need to log incidents with IRIS. IRIS event logging supports the addition of new events and devices.

9.2 Functional Area Requirements

9.2.1 External Interface Requirements

User Interface Requirements

Requirement 83: D10 IRIS logging shall be consistent with the existing UI.

Hardware Interface Requirements

Software Interface Requirements

Communications Interface Requirements

9.2.2 Functional Requirements

IRIS Related Requirements

Requirement 84: D10 IRIS shall log trigger-based weather station events, e.g., visibility and wind speed reaching trigger values.

Requirement 85: D10 IRIS shall log other sensor events that are relevant to D10, according to their relative subtask priority.

D10 IRIS Specific Requirements

9.2.3 Performance Requirements

9.2.4 Logical Database Requirements

Requirement 86: D10 IRIS shall use the existing IRIS log database schema.

Requirement 87: D10 IRIS shall add additional events and devices specific to D10 as needed.

9.2.5 Design and Implementation Constraints

Standards Compliance

9.2.6 Software System Attributes

Reliability

Requirement 88: Logging functionality will use existing IRIS features to monitor reliable operation (e.g. assertion reporting, the event log database).

Requirement 89: Logging functionality is used in most functional areas and will therefore be tested across those functional areas, both in the laboratory and in the field where appropriate.

Availability

Security

Maintainability

Requirement 90: Software source code will be maintained in a source control repository to support ongoing and future software maintenance.

Portability

9.2.7 Other Requirements

Chapter 10

Highway Advisory Radio and Extinguishable Message Signs

10.1 Background

The addition of HAR functionality to D10 IRIS has been deferred to a future project and will not be performed in the existing project. All requirements in this section are for informational use only and have been marked as deferred.

HAR and extinguishable message signs have been identified as priority 8 for D10. Quixotes DR2000 software is used to control HAR and the associated proprietary hardware. A dedicated TMC workstation is used by TMC operators to perform this task. The workstation also contains the proprietary Quixote hardware that interfaces with the HAR system.

10.2 Functional Area Requirements

10.2.1 External Interface Requirements

User Interface Requirements

Requirement 91: *(deferred) D10 IRIS UI enhancements to IRIS will be consistent with the existing UI.*

Hardware Interface Requirements

Software Interface Requirements

Requirement 92: *(deferred) D10 IRIS shall interface to the Quixote DR2000 SIM module.*

Communications Interface Requirements

Requirement 93: *(deferred) D10 IRIS shall interface to the Quixote DR2000 SIM module over the TMC local area network.*

10.2.2 Functional Requirements

IRIS Related Requirements

D10 IRIS Specific Requirements

Requirement 94: *(deferred) D10 IRIS shall display HAR and extinguishable message sign locations on the IRIS system map.*

Requirement 95: *(deferred) D10 IRIS shall display current HAR messages for each HAR unit. The message display may be symbolic or literal. For example "WAV Msg 14" or "Slow Speed Ahead".*

10.2.3 Performance Requirements

10.2.4 Logical Database Requirements

10.2.5 Design and Implementation Constraints

When HAR functionality is added to D10 IRIS, it is anticipated that it will integrate with Quixote's software module that provides 3rd party application access to proprietary Quixote hardware and software. If this technical approach is used, the purchase of this Quixote software module would be required for HAR development and integration with D10 IRIS. Other technical approaches may be considered.

Standards Compliance

10.2.6 Software System Attributes

Reliability

Availability

Security

Maintainability

Requirement 96: Software source code will be maintained in a source control repository to support ongoing and future software maintenance.

Portability

10.2.7 Other Requirements

Chapter 11

Intersection Traffic Signals

11.1 Background

The addition of intersection traffic signal functionality to D10 IRIS has been deferred to a future project and will not be performed in the existing project. All requirements in this section are for informational use only and have been marked as deferred.

Intersection traffic signal monitoring has been identified as priority 9 for D10. Approximately six signals are connected with dial-up lines to the TMC, but are not used. D10 has long term plans to connect traffic signals to the TMC, possibly using Wizards. IRIS reads signal-generated data files daily, but otherwise does not control signals. Most traffic signal controllers are M170s, with a smaller number of M2070s [1].

11.2 Functional Area Requirements

11.2.1 External Interface Requirements

User Interface Requirements

Hardware Interface Requirements

Software Interface Requirements

Communications Interface Requirements

11.2.2 Functional Requirements

IRIS Related Requirements

Requirement 97: *(deferred) D10 IRIS shall support non-realtime monitoring of traffic signals using the Caltrans Central Signal Control System (CTNet) protocol.*

D10 IRIS Specific Requirements

Requirement 98: *(deferred) D10 IRIS shall support real-time monitoring of traffic signals using the CTNet protocol.*

Requirement 99: *(deferred) D10 IRIS shall support real-time control of traffic signals using the CTNet protocol.*

11.2.3 Performance Requirements

11.2.4 Logical Database Requirements

11.2.5 Design and Implementation Constraints

When traffic signal support is added to D10 IRIS, it is anticipated that the CTNet protocol will be used.

Standards Compliance

11.2.6 Software System Attributes

Reliability

Availability

Security

Maintainability

Requirement 100: Software source code will be maintained in a source control repository to support ongoing and future software maintenance.

Portability

11.2.7 Other Requirements

Chapter 12

Conclusion

12.1 Conclusion and Future Work

This report provides a review of the functional requirements for D10 IRIS Open-Source Demonstration Project. This document was reviewed by the project TAG. These requirements will drive the subsequent design, implementation, and testing phases of the project.

This document also identifies which functional areas shall be included in the current D10 IRIS demo, and which will be marked for future work. Inclusion was based in part on priority, but also on external dependencies and resource availability (for example, telecommunications configuration and availability for Closed-circuit Television Cameras (CCTV) control).

12.2 Future Work

This report identifies three types of requirements within each functional area: normal, optional, and deferred (see Section 2.6.1 on page 11 for details). In addition, all requirements within the HAR and traffic signal areas are deferred.

References

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