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USDOT Integrated Corridor Management (ICM) Initiative

System Requirement Specification for the I-15 Integrated Corridor Management System (ICMS) in San Diego, California

March 31, 2008
FHWA-JPO-08-044
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Federal Highway Administration

San Diego I-15 Integrated Corridor Management (ICM) System

March 2008

FINAL
I-15 ICM System Requirements

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16. Abstract
This document presents a System Requirements Specification for an Integrated Corridor Management System (ICMS) in the I-15 Corridor in San Diego, California. The ICMS will consist of two major subsystems: the existing Intermodal Transportation Management Subsystem and a new, as-yet-undeveloped subsystem to be known as the Decision Support Subsystem. In addition, the ICMS will include organic functions such as Collect and Process Data, Access/Store Historical Data, System Management, and Lifecycle Support. Several existing and planned regional systems will be connected with the ICMS – some of these will be upgrades to Intermodal Transportation Management System (IMTMS), some will be new systems. Section 2 provides an overview description of the I-15 ICMS , which includes the ICMS Context, ICMS Description, ICMS User Characteristics, System Constraints and Assumptions, and Dependencies. Section 3 includes a requirements framework, definitions of the I-15 ICMS components and key terms, action verb description, user needs developed in the I-15 Concept of Operations, an overview “mind map” of the IMCS requirements, and an indexed listing of the system requirements organized according to the ICMS's 17 functional areas. Appendix A provides Definitions, Acronyms, and Abbreviations Appendix B provides Requirements Management Metadata (for future requirements management activity). Appendix C includes U.S. Department of Transportation Comments on the Draft System Requirements Specification for the San Diego ICM Pioneer Site with SANDAG Responses.

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ICM, Integrated Corridor Management, Requirements, I-15, San Diego, Freeway, Arterial, Transit, Intelligent Transportation Systems, ITS, HOT, Managed Lanes, 511, ATIS	

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1 INTRODUCTION

1.1 Integrated Corridor Management System (ICMS) Purpose

The ICMS will provide stakeholder agencies with an integrated, multi-modal system and the accompanying institutional agreements to implement the agreed upon ICM operational concept as described in the Interstate 15 (I-15) Integrated Corridor Management System Concept of Operations Document dated March 31, 2008.

The ICMS is currently under development by a team of San Diego area transportation agencies led by the San Diego Association of Governments (SANDAG). Team members include the following agencies:

- Federal Highway Administration (FHWA)
- Federal Transit Administration (FTA)
- U.S. Department of Homeland Security (DHS)
- San Diego Association of Governments (SANDAG)
- California Department of Transportation (Caltrans) District 11
- California Highway Patrol (CHP)
- City of Escondido (Traffic, Police, Fire)
- City of Poway (Traffic, Fire)
- City of San Diego (Traffic, Police, Fire)
- Metropolitan Transportation System (MTS)
- North County Transit District (NCTD)
- San Diego Sheriff's Department (SDSD - City of Poway contract PD, unincorporated areas in the corridor)
- San Diego County Office of Emergency Services (OES)

1.2 ICMS Scope

1.2.1 Needs and Issues

I-15 corridor stakeholders visualize current corridor operations through the individual networks and associated systems that comprise the I-15 corridor today. Using available technologies, these "stovepipes" can be effectively integrated to support a multi-modal management approach. The issues of congestion and capacity can be addressed through the planned Managed Lanes facility and associated bus rapid transit (BRT) stations and routes and coordination with arterial networks.

I-15 stakeholders in the San Diego region are focusing on the operational, institutional, and technical coordination of transportation networks and cross-network connections throughout the corridor. The ICMS concept will address the issues and needs identified by the stakeholders in Table 1-1.

Table 1-1. Issues and Needs Identified by I-15 Corridor Stakeholders

Issues and Needs
Congestion and Capacity—
Issue: Increasingly congested conditions on I-15
Issue: Increasingly congested conditions on corridor's arterial network
Issue: Park and Ride facilities are at, or near capacity
Transit—
Need: Improved transit reliability
Need: Real-time, comprehensive, accurate information to travelers
Need: Frequent service
Need: Competitive service
Transportation System Management—
Issue: Managing traffic flow between I-15 freeway ramps and adjacent arterials with ramp metering
Issue: Managing traffic flow on I-15 (general purpose/managed lanes)
Issue: Limited access to high occupancy vehicle/high occupancy toll (HOV/HOT) facilities
Issue: Coordination across multiple functional systems
Traveler Information Services—
Issue: Minimal Advanced Traveler Information System (ATIS) coverage of the corridor
Inter-organizational Coordination—
Need: Inter-jurisdictional and inter-organizational coordination and integration among corridor stakeholders
Need: Exchange and sharing of real-time data
Need: Improved response times to non-recurring incidents and ability to scale up for major disasters

1.2.2 Vision, Goals, and Objectives

The vision statement for the I-15 corridor was developed with the San Diego region stakeholders. This statement reflects current practices, planned improvements, and future scenarios.

Vision The San Diego I-15 ICMS transportation corridor will be managed collaboratively and cooperatively through ongoing partnerships among SANDAG, Caltrans, MTS, NCTD, CHP, and the Cities of San Diego, Poway, and Escondido.

Within approximately the next five years, the corridor will give travelers the opportunity to make seamless and convenient shifts among modes and among the corridor's networks to complete their trips. Enhanced mobility for people, goods, services, and information will be achieved by further enhancing current levels of existing interoperability between field elements and through continued collaboration and cooperation among the corridor's institutional partners and their native functional environments or systems. The ICMS is therefore focused on improving person- and vehicle-throughput, productivity, connectivity, safety, environmental compatibility, and enhancing accessibility to reach destination points in a reliable and timely manner.

Using this vision as a starting point and taking into account the I-15 corridor specifics, the stakeholders developed a list of goals and objectives detailed in Table 1-2. The stakeholders produced five goals and associated objectives covering the following primary topics. These take into account the traveler's experience on the corridor.

Table 1-2. I-15 ICMS Corridor Goals and Objectives

Goals	Objectives
1. The corridor's multi-modal and smart-growth approach shall improve accessibility to travel options and attain an enhanced level of mobility for corridor travelers.	▪ Reduce travel time for commuters within the corridor ▪ Increase transit ridership within the corridor ▪ Increase the use of HOVs (carpools and vanpools) for commuters ▪ Increase person and vehicle throughput within the corridor on general purpose and managed lanes ▪ Increase person and vehicle throughput on arterials ▪ Reduce delay time for corridor travel on the corridor's networks (e.g., I-15 and arterials) ▪ Increase percentage share of telecommuters from corridor commuter market ▪ Increase the use of established and effective Transportation Demand Management (TDM) programs ▪ Promote development to encourage the use of transit (especially BRT)
2. The corridor's safety record shall be enhanced through an integrated multi-modal approach.	▪ Reduce incident rate ▪ Reduce injury rate ▪ Reduce fatality rate ▪ Reduce roadway hazards
3. The corridor's travelers shall have the informational tools to make smart travel choices within the corridor.	▪ Improve collection and dissemination of arterial network information ▪ Collect and process data on the operational condition/status of all corridor networks, including ‣ Comparative travel times between major origins and destinations ‣ Construction, detours, and other planned road work ‣ Occurrence and location of incidents ‣ Expected delays ‣ Number of parking spaces available at Park and Ride lots/structures

Table 1-2. I-15 ICMS Corridor Goals and Objectives (cont'd)

Goals	Objectives
3. The corridor's travelers shall have the informational tools to make smart travel choices within the corridor. (cont'd)	▪ Disseminate, in a multi-lingual fashion, comprehensive, real-time, and accurate information to travelers within the corridor by means of multiple media (e.g., phone, computer, personal digital assistant ((PDA)/Blackberry, TV, changeable message signs (CMSs), 'Next Bus' informational signs) ▪ Make available archived historical data to travelers ▪ Achieve a high level of 511 call volume and Web use ▪ Achieve high overall satisfaction with 511 system
4. The corridor's institutional partners shall employ an integrated approach through a corridor-wide perspective to resolve problems.	▪ Improve level of institutional coordination among stakeholders by leveraging off of and modifying existing agreements among the partners to accommodate the needs of the I-15 corridor ▪ Strengthen existing communication linkages among all Corridor institutional stakeholders and establish new communication linkages where appropriate (e.g., business/ industrial parks along the corridor) ▪ Enhance the regional/joint operations concept throughout the corridor ▪ Balance the needs of through traffic and local communities by coordinating construction and overall mitigation management on I-15 and arterials
5. The corridor's networks shall be managed holistically under both normal operating and incident/event conditions in a collaborative and coordinated way.	▪ Establish/enhance joint agency action plans to respond to congestion especially at I-15/arterial network interfaces and at the Lake Hodges chokepoint ▪ Develop/improve methods for incident and event management (e.g., data-sharing) ▪ Reduce overall incident clearance time ▪ Identify means of enhancing corridor management across all networks (e.g., implement transit signal priority on selected components of arterial network)

1.3 Definitions, Acronyms, and Abbreviations

See Appendix A.

1.4 References

The following documents were used in developing the System Requirements Document for the I-15 Integrated Corridor Management project and are listed in alphabetical order.

- 2030 San Diego Regional Transportation Plan Final, November 2007
- Advanced Transportation Management System 2005 (ATMS 2005): Architecture Document, Delcan Corporation, Version 4.1 June 27, 2006
- Common Alerting Protocol v1.1 (OASIS Standard CAP-V1.1, October 2005)
- I-15 Managed Lanes Operations and Traffic Incident Management Plans, HNTB, July 2006
- I-15 Managed Lanes Task 3.1 Electronic Toll Collection System (ETC) – Concept of Operations, HNTB, September 2006.
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- I-15 Managed Lanes Toll System – Draft System Requirements, Wilbur Smith Associates, October 2002
- I-15 Managed Lanes Value Pricing Project Planning Study – Volume 1 Traffic, Revenue, and Toll Operations Concept Plan, Wilbur Smith Associates, February 2002
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- IEEE Guide for Developing System Requirements Specifications, IEEE Std. 1233, The Institute of Electrical and Electronics Engineers, Inc., 1998 Edition
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- Integrated Corridor Management: The Transition from a Concept of Operations to Requirements, Mixon-Hill, Version 1.6 August 2007
- Intermodal Transportation Management Systems (IMTMS) Integration Guidebook, Delcan Corporation, Version 1.0, April 2007
- San Diego I-15 Integrated Corridor Management System - Final Concept of Operations, San Diego Association of Governments, August 2007
- San Diego Interstate 15 Managed Lanes Value Pricing Project Final Traffic Operations Plan, June 2002
- San Diego Region Intermodal Transportation Management System – San Diego 511 System Requirements Document (Final Version 3.0), National Engineering Technology Corporation, July 2006
- San Diego Regional Transit Management System Radio Communications/CAD/AVL Conformed Technical Specification, May 2003
- Software Detailed Design Document: San Diego Intermodal Transportation Management System, Delcan Corporation, March 2006
- Systems Engineering for Intelligent Transportation Systems: An Introduction for Transportation Professionals, U.S. Department of Transportation, January 2007
- Systems Engineering Guidebook for ITS, California Department of Transportation, Division of Research and Innovation, Version 1.1, February 14, 2005

1.5 Document Overview

The remainder of this document is divided into the following sections:

- Section 2 – Overview description of the I-15 ICMS, which includes the ICMS Context, ICMS Description, ICMS User Characteristics, System Constraints and Assumptions, and Dependencies.
- Section 3 – Requirements framework, definitions of the I-15 ICMS components and key terms, action verb description, user needs developed in the I-15 Concept of Operations, an overview "mind map" of the IMCS requirements, and an indexed listing of the system requirements organized according to the ICMS' 17 functional areas
- Appendix A – Definitions, Acronyms, and Abbreviations
- Appendix B – Requirements Management Metadata (for future requirements management activity)
- Appendix C – U.S. Department of Transportation Comments on the Draft System Requirements Specification for the San Diego ICM Pioneer Site with SANDAG Responses

2 INTEGRATED CORRIDOR MANAGEMENT SYSTEM (ICMS) – OVERALL DESCRIPTION

2.1 ICMS Context

The ICMS will consist of two major subsystems: the existing Intermodal Transportation Management Subsystem and a new, as-yet-undeveloped subsystem to be known as the Decision Support Subsystem. In addition, the ICMS will include organic functions such as Collect and Process Data, Access/Store Historical Data, System Management, and Lifecycle Support. Several existing and planned regional systems will be connected with the ICMS – some of these will be upgrades to Intermodal Transportation Management System (IMTMS), some will be new systems.

Figure 2-1 shows the ICMS, its subsystems, and the systems to which it will be connected. These systems are listed in Table 2-1 with the owning agency and in Table 2-2 with the major data elements being exchanged. Table 2-2 shows the high-level data flows in and out of ICMS – no entry in the table signifies that no data is assumed to flow in that direction.

Table 2-1. ICMS Interfacing Systems and Owner Agencies

Existing or Planned System	Owning Agency
Advanced Transportation Management System (ATMS 2005)	Caltrans District 11
Reversible [Managed] Lanes Control System (R[M]LCS)	Caltrans District 11 (RLCS becomes MLCS)
Ramp Meter Information System (RMIS)	Caltrans District 11
Lane Closure System (LCS)	Caltrans District 11
Regional Transit Management System (RTMS)	SANDAG (MTS and NCTD are system operators)
Modeling System (TransModeler)	SANDAG
Regional Arterial Management System (RAMS)	SANDAG (local agencies are system operators)
Regional Event Management System (REMS)	California Highway Patrol ((CHP) in future, other public safety agencies will be included)
Multi-Agency Collaboratno (3Cs - Command, Control, and Communications Network)	Regional Technology Partnership
Advanced Transportation Information Management System (ATIMS or 511)	SANDAG
Smart Parking System (SPS)	SANDAG (Planned)
Congestion Pricing System (CPS)	SANDAG (FasTrak®)

2.2 ICMS Description

The ICMS will be a system that consists of three major subsystems:

- System Services, consisting of systemwide functions of Data Management, System Management, and Life Cycle Support;
- IMTMS, an existing data acquisition and dissemination network within the San Diego region; and
- Decision Support System (DSS), a new capability that provides the integration of event management, multi-agency collaboration tools, multi-modal response plans, and impact assessment (modeling) to the existing IMTMS network.

The IMTMS subsystem is, in turn, connected to a number of existing and planned external systems in the region (shown in Figure 2-1) that provide static and dynamic data on the condition of the region's transportation networks. The IMTMS system also provides a degree of shared changeable message signs (CMSs) and closed circuit television (CCTV) control, data processing, and information display capabilities that will be enhanced by the ICMS development process.

I-15 ICMS functions will be developed for extensibility and adaptability to other corridors in the San Diego region. Source:SANDAG
Figure 2-2 provides a preliminary architectural view of ICMS and its component subsystems.

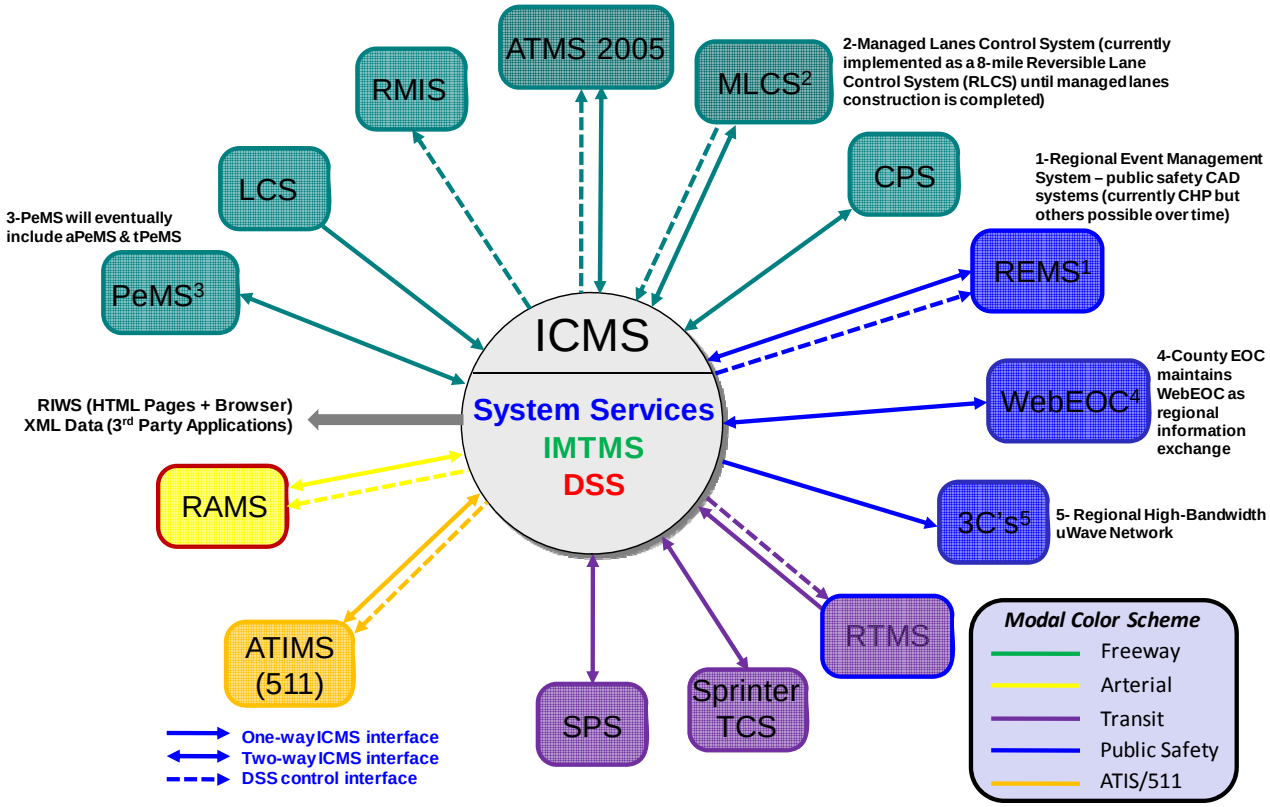
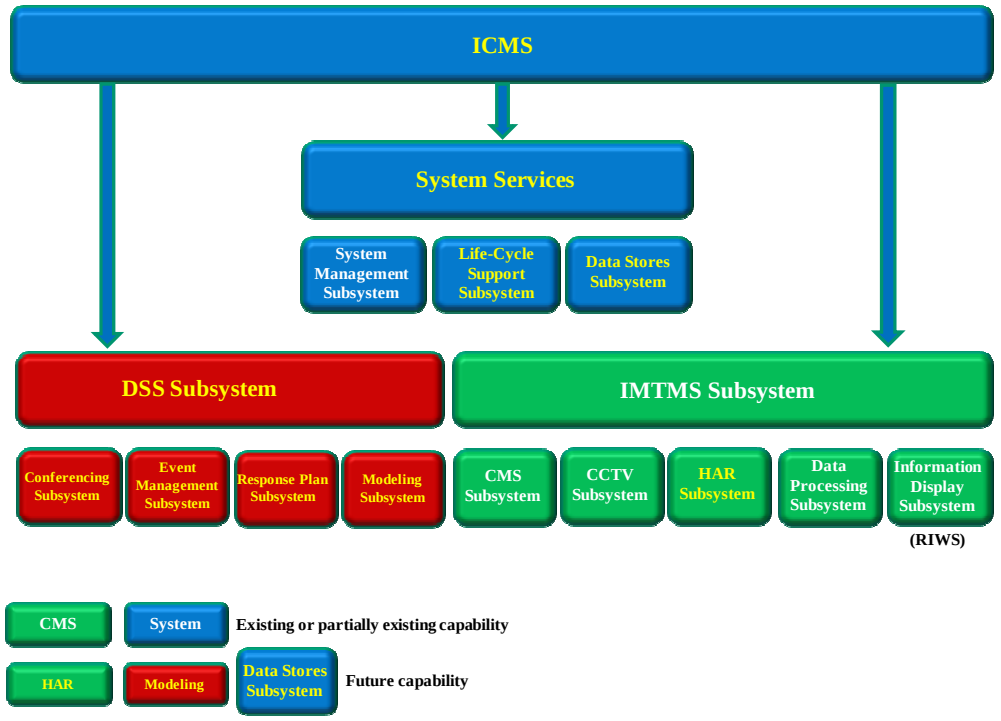


Figure 2-1. ICMS Context Diagram

Source:SANDAG

Table 2-2. Context Diagram High-Level Data Flows

ICMS Subsystem	Data FROM the System TO ICMS	Data FROM ICMS TO the System (Control Interface)
ATMS 2005	Freeway congestion, freeway incidents, travel times, planned events, CMS status and current messages, and CCTV imagery	CMS plans
RMIS	Current metering plan and stored metering plans	Ramp meter plans
LCS	Construction and maintenance status	N/A
MLCS	ML traffic, ML status, and mainline traffic	ML configuration request
CPS	Current dynamic pricing	General Purpose Lane congestion
Model	Model outputs in 2D and 3D	Input data sets
RAMS	Arterial congestion, intersection status, system alarms, local traffic advisories, CMS status, and CCTV imagery	Signal timing plans, EV preemption, transit priority; and CMS plans
ATIMS (511)	Future	Filtered IMTMS data (e.g., RTMS data and toll road data do not go to 511)
RTMS	Transit incidents, bus automatic vehicle location, schedule adherence, selected stop/route data, panic alarms, and security video	Service change request
SPS	Facility identification and free spaces	N/A
REMS	Incident detection, incident details, and response status	N/A
Conferencing	N/A	Conference request, participating agencies, and call-in data



Source:SANDAG

Figure 2-2. ICMS System-Subsystem Architecture

As shown in Figure 2-1, the ICMS will interface to a number of existing and planned *modal management systems* in the San Diego region. A *modal management system* is a legacy (i.e. existing) system that is designed to manage the operations of a single transportation mode – freeway, transit, arterial, etc. Freeway, reversible lane, transit and limited public safety systems currently exist. Arterial, additional public safety, lane closure and smart parking management systems are planned. The I-15 Managed Lanes will have a control system when the first (middle) phase is completed in 2008. The following sections will provide a high-level overview of the ICMS subsystems shown in Figure 2-2.

2.2.1 ICMS Services Description

The ICMS will encompass three basic subsystems that apply to both IMTMS and DSS. These are the System Management Subsystem, the Data Management Subsystem, and the Life Cycle Support Subsystem.

2.2.1.1 System Management Subsystem

The System Management Subsystem encompasses system security, backup, and archival functions.

2.2.1.2 Data Stores Subsystem

The Data Stores Subsystem encompasses the creation, management, and reporting of configuration and historical data stores needed for ICMS functions. This function also incorporates the functions needed to access existing modal databases in ATMS 2005, RTMS, and RAMS. The data in these databases will not be replicated in ICMS.

2.2.1.3 Lifecycle Support Subsystem

The Lifecycle Support Subsystem encompasses training, documentation, and maintenance for the ICMS, including online help, online training, and system maintenance functions.

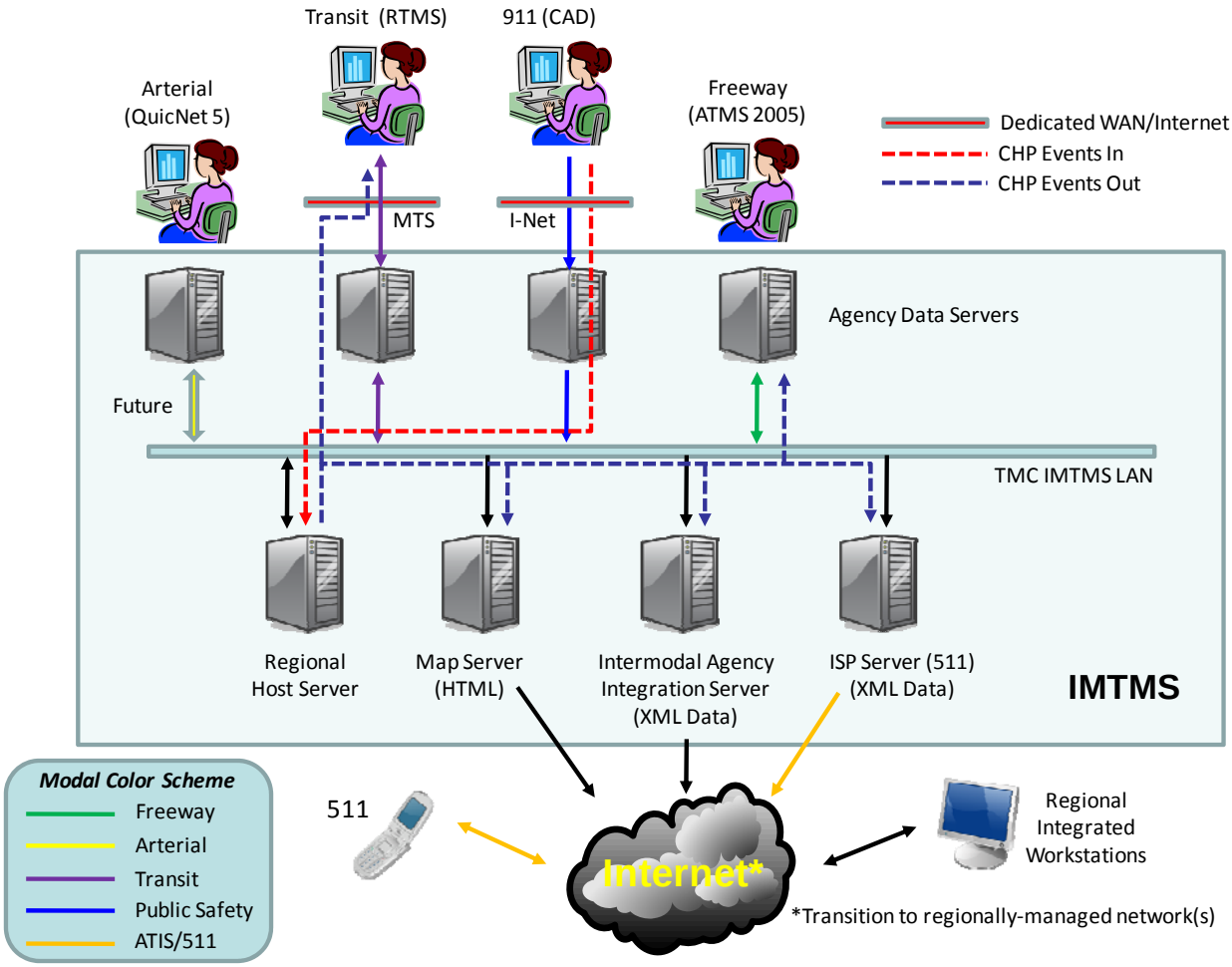
2.2.2 IMTMS Description

The IMTMS architecture is shown in Source:SANDAG
Figure 2-3. IMTMS is implemented as a distributed Service-Oriented Architecture (SOA) using off-the-shelf Web service development technologies. Most IMTMS servers shown in the figure are located in the Caltrans/CHP Transportation Management Center (TMC), but that location is a convenience, not a necessity. The IMTMS architecture facilitates scalability and redundancy to handle a variety of anticipated operational environments. New data suppliers can be added by adding a new Agency Data Server (ADS) to the IMTMS network and defining new eXtensible Markup Language (XML) schemas as needed for new data elements.

For example, adding the county's Emergency Communications Center (ECC - San Diego Sheriff Dispatch) or a new Smart Parking System (SPS) would be handled in this manner. Using a variety of distribution servers, IMTMS takes data received from participating agencies and provides fused data to participating agencies as either Hypertext Transfer Protocol (HTTP) Web pages or XML data feeds and to the general public through the regional 511 system. Subject to regional agreements, IMTMS allows the shared control of agency CCTV cameras and CMSs. IMTMS provides a dynamic, Web-based Graphical User Interface (GUI) to selected agencies for the monitoring and control of regional field devices.

Source:SANDAG

Figure 2-3 also shows a typical IMTMS interaction for CHP events (freeway incidents). The [CHP Computer-Aided Dispatch (CAD)] system initiates a new incident record in response to a Mobile 911 call. The initial data is extracted by IMTMS via the CHP Agency Data Server (ADS). The ADS converts the CHP data format into XML and sends the XML data to the Regional Host Server (RHS). The RHS acts as a "traffic cop" for IMTMS data and sends the CHP incident information to the Map Server (for Hypertext Markup Language (HTML) formatting and HTTP distribution) to the Intermodal Agency Integration (IAI) server for XML data distribution for third-party applications and to the Internet Service Providor (ISP) server for the regional 511 program. The incident data also is sent to the ATMS 2005 subsystem to automatically create an UNCONFIRMED incident in the ATMS system. Updates from the CHP dispatcher are distributed as free text in the same manner until the TMC ATMS operator changes the incident to a CONFIRMED status. At this time, the automatic updates from CHP cease. Data from transit, arterial, and other subsystems are (or will be for planned systems) distributed in a similar manner.



Source:SANDAG

Figure 2-3. Intermodal Transportation Management Subsystem Architecture

2.2.2.1 Advanced Traffic Management System (ATMS) 2005

ATMS 2005 is the latest generation of Caltrans freeway management systems, deployed in Districts 11 in San Diego and 7 in Los Angeles. ATMS 2005 uses an SOA, PC hardware components, and a browser-based user interface to reduce acquisition and operating costs. ATMS 2005 functions are nearly identical to those of the previous generation, UNIX-based ATMS 2.0, but with enhanced device control features. ATMS 2005 provides the following major functions:

- Real-time vehicle occupancy and count data collection every 30 seconds from embedded inductor loops and non-intrusive radar detectors on freeway mainlines and on-ramps
- Processing of the real-time data to provide the most accurate incident detection algorithms and reporting functions
- Automatic Incident Detection (AID)
- Automatic response plan generation using an expert system
- Event management for incidents, special events and emergency closures
- Device status monitoring and control for loops, CMSs, and CCTV cameras
- Display of real-time data for freeway mainlines, (HOV lanes, on-ramps, and off-ramps)
- Display of device locations and status
- Display of streaming video imagery from CCTV sites
- Report generation
- ATMS configuration database editing

2.2.2.2 Managed Lanes Control System (MLCS)

The ML facility is currently under construction from SR 52 to SR 78 and is divided into three segments as noted in Source:SANDAG and Caltrans District 11
Figure 2-4. Two types of access will be provided for ingress and egress to and from the ML facility: Intermediate Access Points (IAP) and Direct Access Ramps (DAR). The fully-operational ML facility will have seven northbound and six southbound IAPs. IAPs are at-grade transitions to allow vehicular traffic to safely enter and exit the ML facility. DARs are grade-separated interchanges leading from a Bus Rapid Transit (BRT) station to the ML facility as depicted in
Source:SANDAG and Caltrans District 11
Figure 2-5. DARs will be located at the following points along the fully constructed ML facility:

- Mira Mesa/Miramar College
- Sabre Springs/Peñasquitos
- Rancho Bernardo
- Del Lago
- Escondido Transit Center

Source:SANDAG and Caltrans District 11

Figure 2-4. Managed Lanes Segments

Source:SANDAG and Caltrans District 11

Figure 2-5. DAR Depiction for Rancho Bernardo

The Managed Lanes will be partitioned from the main lanes by fixed barriers. Within the fixed barriers, lane reconfiguration will be accomplished using movable barriers and a Barrier Transfer Machine (BTM). Except in the northern segment through Escondido, managed lanes can be configured as 3N/1S, 2N/2S, or 3S/1N. The northern segment will be fixed at 2N/2S.

The southern segment is currently a reversible lane facility with two segregated lanes that are fixed at 2N or 2S. This facility is controlled by a recently upgraded Reversible Lane Control System (RLCS) for an eight-mile segment of I-15. The RLCS consists of gates, pop-up barriers, CMSs and CCTV cameras to control the flow of traffic in one direction during scheduled peak hours. The MLCS will differ in that it will control the two-way flow of traffic using a variable number of lanes in each direction with multiple ingress and egress points. ATMS 2005 will be modified to show the lane configuration status of the Managed Lanes. Sensors in the managed lanes will be incorporated as part of the ATMS 2005 configuration database schema. As part of the IMTMS architecture, the MLCS will have an Agency Data Server to provide data on status to IMTMS.

2.2.2.3 Congestion Pricing System (CPS)

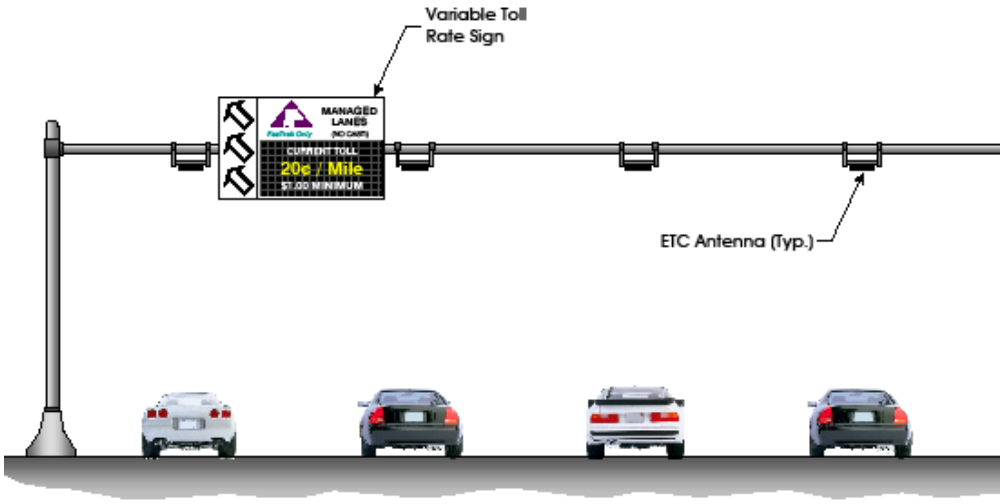
The CPS is the system through which appropriate tolls are charged to single occupancy vehicle (SOV) users of the Managed Lanes facility who are enrolled with FasTrak®[1]. The CPS is a form of electronic toll

[1] FasTrak® is California's electronic toll collection system used on tollways in the state that allow drivers to drive through designated "FasTrak® Only" lanes without stopping. The toll is automatically deducted from a prepaid account.

collection that is based on radio frequency identification (RFID) technology and uses transponders and antennas mounted over traveled lanes to communicate and process high-speed, open road toll transactions in real-time.

A legacy CPS installed in 1997 is being replaced in 2008. The new CPS is under development now in parallel with the construction of the Managed Lanes facility on I-15. Tolls rates will be computed using a dynamic variable pricing algorithm, and transactions will be based on the rate per mile at the time of travel multiplied by the distance of travel (i.e., a distance-based fare). The toll rate algorithm will have two primary formulas: the first will base the price on the value of travel time (VOTT) saved for a user of the Managed Lanes in relation to the adjacent free lanes; the second calculation will operate in the background and is set to maintain a minimum level of service (LOS) rating of "C" at all times in conformance with the congestion pricing enabling legislation.

Just like HOVs, including buses, authorized FasTrak® users will physically gain access to or leave the managed lanes through two means: (1) a series of IAPs spaced roughly every two miles, which include a combination of General Purpose-Managed Lanes weave zones, essentially a break in the barrier that separates those lanes; and (2) from a number of DARs that connect the Managed Lanes to BRT centers near the freeway's edge. It is also noted that to help maintain free-flow conditions on the Managed Lanes, traffic also will be managed by re-configurable barriers in the Managed Lanes that separate northbound from southbound traffic. This movable barrier will allow for two lanes to operate in both directions, or for three lanes to operate in the peak direction with a single lane in the off-peak direction. Thus, both strategies will help to ensure an efficient allocation of scarce resources (i.e., road capacity). Each time the toll rate is recomputed, the CPS will compose and disseminate a message to the appropriate sign controller(s) instructing the sign controller(s) to update the toll rate and travel time information on the variable toll message signs (VTMS) that will be installed at each entry location. A typical VTMS is shown in Source: SANDAG and Caltrans District 11
Figure 2-6.



Source: SANDAG and Caltrans District 11

Figure 2-6. Typical Installation of a VTMS

Further, for the I-15 Managed Lanes, a series of overhead lasers will be installed as part of the CPS in order to associate transponder reads to vehicles. The lasers will be a new source of traffic vehicle detection stations (VDS) that can provide detailed traffic speed, occupancy, and possibly vehicle classification data to the regional IMTMS network. Additionally, historic average toll rate data or "current" toll rate data will be available from the CPS in a configurable (e.g., six-minute) interval for all Managed

Lane entrance locations. This data also will be made available to IMTMS for broadcast via 511. Additionally, based on the average vehicle speeds as determined by the lasers, as well as supplemental travel time data derived from the sampled transponders themselves, the I-15 Managed Lane FasTrak® system will broadcast estimated travel times within the Managed Lane facility at the same configurable interval (e.g., six-minute), and this data will be made available to IMTMS for broadcast via 511.

To support the dynamic pricing algorithm, the CPS data management system will obtain real-time traffic sensor data from the regional sensor network for the I-15 corridor. This includes all general purpose and Managed Lane sensors in the default network, but excludes the internal FasTrak® lasers. This data will be used by the dynamic pricing algorithm to determine the VOTT factor for each segment. The algorithm support need will be met by a new data feed based on National Transportation Communicatinos ITS Protocol (NTCIP) protocols (2304 for message encoding and Traffic Management Data Dictionary (TMDD) v2.1 for data structure) specified in the I-15 Managed Lanes Toll Collection System request for proposal.

Finally, the CPS has its own maintenance online management system (MOMS) that will monitor all CPS field element health (e.g., power, data connectivity, heartbeats, etc.). The CPS also has a violation enforcement subsystem that includes enforcement cameras, automatic license plate recognition (ALPR) technology, and a full violation noticing system. The CPS also has an account management system for direct customer Web account management and customer service representative account-handling features. A variety of other subsystems and interfaces exist within the CPS framework. Access will be granted to the FasTrak® maintenance contractor to obtain real-time CCTV feeds from the Caltrans' CCTV network via the Regional Integrated Workstation (RIWS) with appropriate login/password credentials. This would allow the FasTrak® operator to monitor field element status beyond what is provided by the MOMS in addition to monitoring overall traffic flow and providing superior customer service on traffic conditions.

2.2.2.4 Lane Closure System (LCS)

The LCS collects and manages information that is related to construction projects that deal with the time, location, and impact associated with a specific construction or maintenance project. Construction staff sends closure requests to the district traffic manager who reviews these and approves or disapproves based on potential conflicts, such as with special events, etc. Approved planned closures are entered into the LCS Web application and ATMS 2005. When closures actually occur, construction staff notifies the TMC with start and end times and locations and the number of lanes being closed (impact).

2.2.2.5 Ramp Meter Information System (RMIS)

The RMIS is an existing system that performs congestion management by limiting access to freeways at over 300 controlled on-ramps in the region. RMIS collects data from a Front End Processor (FEP) that, in turn, manages communications between leased line and fiber optic modems and loop controllers in the field. Each loop controller manages one or more Vehicle Detection Stations (VDS) which are connected sets of individual loops in freeway main lanes, on-ramps, and off-ramps. RMIS manages individual controllers or defined sets of controllers (e.g., I-15 NB PM peak ramps) including the uploading of new ramp meter timing plans.

2.2.2.6 Regional Arterial Management System (RAMS)

The RAMS is a two-tier IMTMS subsystem that both allows multi-jurisdictional control of traffic signals and the display of regional data to local traffic agencies. Tier 1 is a re-architecture of the existing QuicNet 4 arterial traffic control system to allow multi-agency security features for viewing and ultimately controlling external signal systems. The San Diego region is fortunate to have a unified QuicNet 4 traffic signal control system throughout its 20 state and local arterial management jurisdictions (18 cities, the County of San Diego, and Caltrans). There are some differences in roadside controller firmware from agency to

agency, but all use the same QuicNet 4 Traffic Signal Control System (TSCS). This will facilitate the integration of multiple jurisdictions using a regional communications architecture. Tier 2 is the distribution of network access to all QuicNet 4 users so that a common browser-based display is available for the dissemination of regional data collected from all network users. This display is referred to as the RIWS, although there is not a separate hardware component required for local agencies. RIWS can be integrated with existing QuicNet 4 PC displays using the personal computer's (PC's) browser. The RIWS dynamic map display can be routed to large screen displays located in local agency TMCs.

2.2.2.7 Regional Transit Management System (RTMS)

The RTMS is an existing system that supports all fixed-route transit operations for the San Diego Metropolitan Transit System (MTS) and the North County Transit District (NCTD). RTMS will be capable of supporting other regional transit operators in the future, such as regional rail systems (COASTER, SPRINTER, Amtrak), Chula Vista Transit, National City Transit, and San Diego County Transit System. The RTMS provides the following primary functions:

- Computer-Aided Dispatch (CAD) functions for the control of all data and voice communications between revenue and non-revenue buses and their respective dispatch offices for both SDMTS and NCTD, as well as regional transit operators to be added in the future.
- Global Positioning System (GPS)-based Automatic Vehicle Location (AVL) functions that are integrated with the supplied CAD functions.
- Traveler information functions to capture performance data on scheduled arrivals and departures and ridership data collected by means of the Automatic Passenger Counting System .
- Integration of the supplied CAD/AVL functions with the scheduling system and trip planning system

The operations of MTS and NCTD supported by RTMS are independent of each other, and accessibility of privileged data associated with each operator by other transit operators is controlled. Nonetheless, RTMS allows data-sharing and information exchange as needed to promote more efficient regional transit operations and coordination of transit services between operators, such as to coordinate passenger transfers between transit systems (e.g., at the North County Fair Mall in Escondido).

2.2.2.8 SPRINTER Train Control System

The SPRINTER train control system operates from the SPRINTER operations facility in Escondido and is independent of the RTMS used for bus operations. The SPRINTER currently has limited ability to share train position information, but this limitation is likely only temporary. The SPRINTER does not implement a continuous train GPS capability, but does have fixed GPS points that can be detected by on-board train equipment and used to estimate time of arrival at each station along the route. Arrival times are then transmitted to station visual and aural annunciators. The feasibility of trapping this data for ICMS display and dissemination is being investigated. Two SPRINTER stations are in the corridor: the Escondido Transit Center on West Valley Parkway and the Nordahl Road station at the Escondido/San Marcos city boundary.

2.2.2.9 Regional Event Management System (REMS)

The REMS currently consists of an XML-based, Web services interface to the CHP's CAD Media Server. When the CHP initiates an incident in the CAD as a result of a mobile 911 or call box call, the following sequence of events occurs:

- CHP call taker initiates an incident record in the CAD
- Call taker passes the record to a CHP radio dispatcher
- Radio dispatcher assigns one or more responding traffic officers via the CHP radio system

- Radio dispatcher updates incident details in the CAD as radio reports are received from officers in the field
- Initial incident details and updates are passed to the IMTMS system via a one-way interface
- IMTMS passes incident information to ATMS 2005 via two-way interface to the 511 server and to regional data servers for external agency use
- When ATMS operator confirms the incident in the ATMS system, the CHP updates are no longer provided to IMTMS – all further updates to 511 and agencies are provided by ATMS 2005

In the future, similar interfaces are planned for other public safety CAD systems in the San Diego region. For the I-15 corridor these include San Diego County Sheriff (Poway law enforcement), San Diego Police Department, San Diego Fire (also dispatches for Poway Fire), NorthCom Fire Dispatch (Escondido Fire dispatch), and Escondido Police Department.

2.2.2.10 County Operational Area Emergency Operations Center (EOC)

The San Diego County EOC is located in Kearny Mesa at the southern end of the I-15 corridor. The EOC has been fully activated twice in the past four years, both for destructive wildfires in the I-15 corridor. The EOC uses a countywide Web services application called WebEOC, which is rapidly becoming the standard system for sharing information among a wide variety of agencies during major emergencies. WebEOC is a distributed information-sharing application that can accept data from virtually any source in the county. WebEOC is linked to a Geographic Information System (GIS) display system that the ICMS can leverage to share critical transportation data during emergencies. Since virtually all of the I-15 corridor data is, or will be geo-referenced, it is feasible to supply this data as a continuous stream onto a GIS 'transportation" layer in WebEOC. Additionally, a WebEOC application will be included in the TMC to allow data to be entered on National Incident Management System (NIMS-)compliant forms and directly passed to the planning and intelligence section of the EOC.

2.2.2.11 Regional Traveler Information Management System (Regional 511)

The regional advanced traveler information system – 511 – was formally launched by SANDAG in San Diego County in February 2007. This system allows landline and cellular callers to receive tailored information via the Web, phone, and public access television about traffic conditions and driving times between selected origin and destination pairs to: use the transit trip planner; use the mobile callbox feature that allows the caller to directly connect to the San Diego County Service Authority for Freeway Emergencies (SAFE) call answering center; acquire carpool and vanpool information; get bicycle route maps and commuting information; and get FasTrak® program price announcement signs and registration information. The 511 system will in the future also include the dissemination of real-time congestion changes on the I-15 Reversible Lane and Managed Lanes facility, as well as travel-time estimates for both general purpose lanes and managed lanes. Data for the 511 system comes from the IMTMS, which acts as a clearinghouse for freeway conditions, incident data, and transit data. In the future this data storehouse will include arterial-related data.

2.2.2.12 Smart Parking System (SPS)

The SPS will be a future system that uses a variety of technologies to collect real-time parking data and provide this real-time parking information to transit users. This system is currently being deployed along the Coaster commuter rail corridor as a pilot project. The primary objective of this pilot project is to demonstrate and evaluate how smart parking system technologies can be used to:

- Improve parking management capabilities through the delivery of actual parking utilization data;
- Enhance transit services by delivering real-time information to customers as a means of increasing access, convenience, and reliability to parking availability;

- Measure user acceptance of paid and preferential-based parking strategies; and
- Develop and evaluate the application of parking pricing management strategies and business models as a means to generate alternative funding sources for increasing parking supply, maintenance, and enhanced parking facilities.

The project involves the installation of small stationary parking censors and wireless communications at the selected COASTER stations and transmission of data to a central system. These devices will transmit and provide real-time information about parking utilization and availability. Such a system will provide the ability to monitor parking supply by collecting and tabulating count data from entrance and exit points within the parking stations and occupancy at selected parking spaces. The smart parking concept introduces a powerful management system and customer information tool, which will support COASTER parking users via the Internet, cell phone, or other traveler information systems like our 511 program.

The SPS technology encompasses Web-related systems, wireless communications, dynamic databases, pricing algorithms, user and parking company partner interfaces, and parking sensor networks that will deliver new services to system users. The network sensors and interfaces capture parking information, and application programming interfaces deliver it to the dynamic databases. Users, local organizations, and media services can access the database using a variety of interfaces. The information contained in the dynamic databases is processed and consolidated based upon the intersection of user, parking facility, and local organization and media services requests.

It is anticipated that this project will provide the basis for a regional smart parking system in the San Diego area, including the I-15 corridor as part of its ICMS. Accordingly, this implementation would warrant further coordination within the proposed I-15 ICMS and Intelligent Transportation System (ITS) architecture. By providing real-time parking availability information along the I-15 corridor, SANDAG expects increased intermodal trips from the freeway to express bus services operating at future BRT stations currently under construction where, it is estimated, there are 500 parking spots will be available for possible consideration of an SPS implementation. The pricing strategies that will be implemented at these transit parking lots will be designed to encourage the use of alternative modes, increase parking management efficiency, and provide system enhancements to BRT system users (i.e., convenient access, improve reliability to parking spaces).

2.2.3 Decision Support Subsystem (DSS)

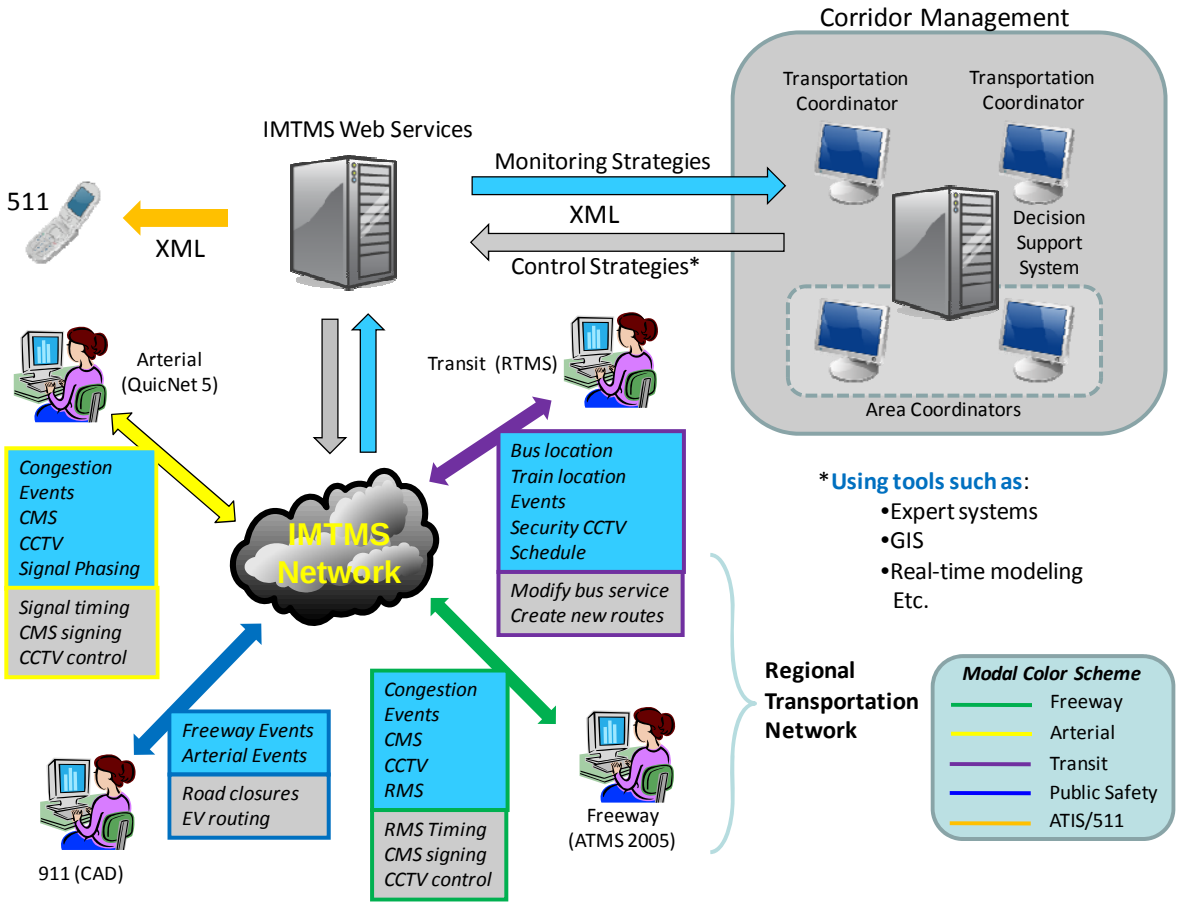
A new subsystem to support multi-modal, integrated corridor management will be added as part of the ICMS. This system will be given the generic name “Decision Support System (DSS).” Functionally, DSS will support the ability to automatically, semi-automatically, or manually generate suggested plans for modal actions in response to regional events. The significance and importance of the DSS lies in the fact that modal actions in response to short-term or long-term impacts on the corridor will be coordinated and not carried out in isolation as is usually the case. The events may be recurring, non-recurring, or scheduled. Generally DSS plans will be short-term plans, covering a range of up to several hours, or possibly days or weeks in the case of major disasters such as the recent October 2007 wildfires in San Diego County. DSS is conceptually an outgrowth of the ATMS 2005 Event Management process, where field data is added to initial incident reports to provide inputs to an Expert System.

The Expert System combines a *rule base* using incident response parameters with *knowledge base* information on roadway geometry and field device locations to automatically generate response plans consisting of CMS signing strategies and incident checklists. The Expert System *rule base* is created with operator inputs on the impact of certain types of incidents on the freeway system. For example, for the I-15 corridor, several decision trees exist for selected scenarios in the corridor that apply to Managed Lanes operations. These decision trees can be coded as part of the rule base for the Response Plan subsystem in DSS. The Expert System *knowledge base* is provided by selected ATMS configuration database tables that are read when the Expert System module starts up. As long as the configuration

database is properly maintained, the Expert System will always have the latest field configuration information. Alternative methods to generate response plans include establishing *action tables* that are keyed to projected incident locations on the freeway network.

For any method chosen, the ability to generate automatic or semi-automatic response plans requires a substantial analysis effort during the set-up phase.
Source:SANDAG

Figure 2-7 illustrates how the DSS concept combines existing modal management data sources with data fusion tools to aid in the complex decision-making inherent in corridor operations.



Source:SANDAG

Figure 2-7. ICMS Concept

2.2.3.1 Conferencing Subsystem

There are many available tools that can facilitate multiple agency conferencing. Some tools provide shared video conferencing, others provide a group “whiteboard” capability. and still others a Web-based meeting application. Some of these tools are off-the-shelf applications that can be integrated into ICMS. Two other tools specific to the San Diego region are the WebEOC emergency management application

and the 3Cs network. The WebEOC application is hosted at the County's EOC and provides a virtual information-sharing extension to many agencies that cannot be physically present at the EOC. Thus, an agency need only have a WebEOC license to run the application and be connected to the EOC for the exchange of critical event status information.

The regional 3Cs project strives to connect dispatch/emergency operations centers across the far southwest region. Spanning San Diego County (CA) and reaching into Imperial (CA), Orange (CA), Riverside (CA), and Yuma (AZ) counties, the project links public safety agencies via a high-speed, secure hybrid microwave/fiber optic network. Bridging communications between agencies, the network will provide two-way communication via video teleconferencing, publish/subscribe technology on a public safety intranet, and distribute video feeds outside the network through secure Web streaming and cable broadcasts. Currently funded through the pilot phase, unfunded future phases are planned to improve geographic coverage and add additional agencies and/or regions. As microwave access is improved, the 3Cs project plans to incorporate all local public safety dispatch and emergency centers within the coverage area at a pace of 15 to 20 agencies a year. Additional functionality in the 3Cs network includes the ability to incorporate specialized video feeds (aerial downlink, CCTV), and bridge disparate radio systems via radio/voice over IP. By incorporating 3Cs technology, responding agencies will have a fast, reliable means to contact any agency in the area, improving the ability to successfully manage any incident.

Given the diverse nature of agencies involved in I-15 corridor operations and the difficulty of setting up face-to-face meetings during a crisis, the conferencing function will be important for corridor operations under stress.

2.2.3.2 Event Management Subsystem

The Event Management Subsystem extends the existing Regional Event Management System (REMS) under IMTMS. As REMS is currently structured, it provides event collection from only the CHP CAD system. As IMTMS expands and incorporates additional arterial event data from other CAD systems for I-15 corridor agencies, an event bookkeeping function will be required. This function will maintain an integrated regional event list including freeway, arterial, and transit events from all reporting sources (ATMS 2005, REMS, and RTMS). As different agencies add their arterial incident data to the corridor event picture, it becomes more critical to maintain a "common operating picture." What this really means is that the Event Management Subsystem will maintain a harmonized picture of all the events in the corridor. This includes merging multiple incident records that refer to the same event, splitting records when a secondary event occurs from the original incident, transferring control of incidents when the jurisdiction changes, and maintaining an integrated list of active incidents (filtered for traffic related events) in ICMS.

2.2.3.3 Response Plan Subsystem

The Response Plan Subsystem is key to the entire concept of integrated corridor management in the I-15 corridor. The response plan function within ATMS 2005 provides a "template" by which the San Diego region can develop a design concept. This function uses an Expert System called G2, which combines a *rule base* of decision trees related to the severity and estimated impact of freeway incidents with a *knowledge base* of roadway geometry and field device locations and characteristics.

The *rule base* is developed by analyzing parameters of time of day, incident location, and severity of an incident and then using a decision tree of "If-Then" statements to develop recommended CMS signing and operator notification responses. The TMC operator can review these recommended actions and modify them as needed before implementation. Analysts must develop the *rule base* by using functions within the G2 application provided for that purpose.

The *knowledge base* uses the existing ATMS configuration database to "learn" about roadway geometry and field devices. Roadway geometry includes knowing where the number of lanes changes and the location of ramp intersections for arterials and connecting freeways. Field device data in the *knowledge base* includes CMS locations and type. The appropriate database tables are connected to G2 via an application program interface.

The advantage of the Expert System approach is that any changes in roadway geometry or field device locations are automatically included in future response plan recommendations. Because the G2 application in ATMS only uses a fraction of the application's capability, it is well within the bounds of feasibility to consider this application for the IMCS, using the same architecture, but expanding both the *rule base* and *knowledge base* extents. As long as the incident and its response can be captured in a reasonable number of decision paths and there is a well-formed database design to incorporate new records for arterial roadways, transit routes, arterial notification devices, etc., the G2 application or another semi-automated approach will be feasible. This would allow the introduction of new action plans (see Section 2.2.4.4 below) that, for example, would handle arterial timing plan changes, Managed Lane reconfiguration, and ramp metering plans.

2.2.3.4 Modeling Subsystem

SANDAG has recently acquired the TransModeler application from Caliper that is capable of both micro- and meso-level simulations. TransModeler can simulate ITS systems such as ramp metering, HOT lanes, driver response to ATIS information. and transit operations. With careful setup and input of data, TransModeler can be run as a mesoscopic model in a real-time or near real-time mode to affect decision-making during major incidents. Run in the micro-simulation mode in conjunction with TransCAD, TransModeler is an excellent tool for longer-range corridor management and can investigate detailed ramp meter, HOT lane, and signal timing scenarios. As an impact analysis tool, TransModeler will be used to evaluate recommended action plans coming from the response plan function and to support longer-range corridor management.

2.2.4 ICMS Concept

2.2.4.1 Overview

The I-15 corridor ICMS will uniquely exploit existing and planned ITS deployments in the San Diego region. The recently deployed IMTMS is a robust data management and routing system that has an extensible and scalable architecture for connecting a variety of data providers to a regional network; however, IMTMS does not have decision support nor impact analysis functions, therefore the IMCS requires a new DSS. DSS will take IMTMS data from existing and new modal management systems, analyze this data in response to corridor incidents of varying magnitude, and develop semi-automated and automated response plans.

Response Plan processing will be based on existing Expert System technology currently in use by the Caltrans ATMS 2005 or an equivalent table-driven application. The response plans will recommend active control measures to be implemented by *modal management systems*, such as ATMS 2005, QuicNet 4, and RTMS. The response plan is based on integrated corridor data analysis from multiple data sources, but uses action plans for individual modal management systems. The actual implementation of recommended action plans is the responsibility of the target management system.

An example may help to understand this concept. A major incident occurs on northbound I-15 between Mira Mesa Boulevard and Mercy Road/Scripps-Poway Parkway just after the end of the afternoon peak period. The general time frame is after the current reversible lanes have been converted to Managed Lanes. A limited number of CMSs are located on Black Mountain Road and Pomerado Road. Pomerado Road has some deployed CCTV sites. The San Diego County Sheriff, San Diego Police Department, and Escondido Police Department are integrated into the IMTMS network.

A multi-modal, operations-trained corridor manager is monitoring corridor operations. When the incident is first reported to CHP, ATMS 2005 automatically opens an unconfirmed incident. When CHP officers arrive on scene, the incident is confirmed, and ATMS provides freeway CMS and operator action recommendations as part of its Event Management and Response Plan functions. As the incident progresses, the corridor manager determines that additional actions are needed. Based on impact assessments from ATMS, existing traffic congestion on parallel arterials, and a growing queue on northbound I-15, the manager activates the ICMS Response Plan function. The Response Plan function recommends 5 action plans:

- Recommend timing plan changes along both Black Mountain and Pomerado Roads. These changes will be sent to the cities of San Diego and Poway as timing plan numbers for plans that have been predetermined to alleviate increasing congestion on these arterials due to motorist self-selection of alternate routes. The corridor manager reviews these plans and after approval and/or modification, they are transmitted to RAMS for system implementation using QuicNet internal functions. At the city level these plans can be reviewed and modified or overridden by city traffic engineers or allowed to execute automatically.
- On-ramps to northbound I-15 are activated with adaptable timing plans based on mainline traffic flow at that point on the freeway. The ICMS sends a timing plan identification to RMIS for execution after operator review and modification as necessary.
- A Managed Lane reconfiguration is recommended to open two additional northbound lanes. This recommendation is passed to the TMC operator for implementation by the Managed Lane control system, again after review and modification as necessary.
- The freeway is closed and anticipated to be so for an extended period so alternative routing is no longer “self-select” but advisory in nature. Traffic must be routed off the freeway upstream of the incident. An action plan is generated to deploy appropriate CMS messaging, portable signs, and Traffic Management Team (TMT) vehicles to specific locations. The action plan is sent to ATMS and to IMTMS for implementation on their respective signs. This situation actually occurred during the recent October 2007 wildfires in San Diego county, during which the Witch Creek Fire event had a direct impact within the I-15 corridor boundaries in all three corridor cities. The same issue occurred in 2003 during the Cedar Fire event.
- The regional 511 system is updated with periodic alert messages and road closures as the situation changes.

Throughout this process, the corridor manager continually monitors all modal systems for disruptions in service or situations that require additional corrective action. Much of the data fusion from multiple management systems is done through the corridor manager’s experience and training, but some fusion is done automatically. If the situation requires a corrective action, a set of action plans are input into the Impact Assessment function to model the anticipated response. The model outputs become another data source to be combined with real-time data to modify action plans.

2.2.4.2 Database Management

A number of databases currently exist for San Diego modal management systems and are planned for new ITS systems in the horizon of ICMS implementation. It is not the intent of the ICMS development plan to recreate existing databases, but to reuse these through remote access to the modal management systems. Currently these include ATMS 2005 (Caltrans District 11 freeway data), RTMS (transit data for MTS and NCTD) and the Regional Event Management System (REMS – CHP incident data).

Planned systems (RAMS, Congestion Pricing upgrades to FasTrak®, and an SPS also will develop their internal databases that the ICMS will remotely access. The ICMS will develop an organic configuration database (static data) and historical database (real-time and aggregated data) for

those elements not already included in existing external systems. The ICMS organic database instances will be combined with remotely accessible databases to give the ICMS operator access to the widest possible data sources for the support of corridor operations.
Figure 2-8 shows this concept.

In addition, remote access to the California Performance Measurement System (PeMS) is a big part of the ICMS data acquisition concept. Although in some cases, accessing PeMS data is duplicative of what will be received from ATMS 2005 (primarily in the areas of congestion and events), PeMS provides a readily accessible level of analysis that does not exist in ATMS 2005. PeMS data can be extracted and placed into comma-separated values format, thus facilitating its display in a GIS platform such as ArcView. Selected tables of this nature will be stored locally in the ICMS data environment for GIS analysis of corridor performance measures.

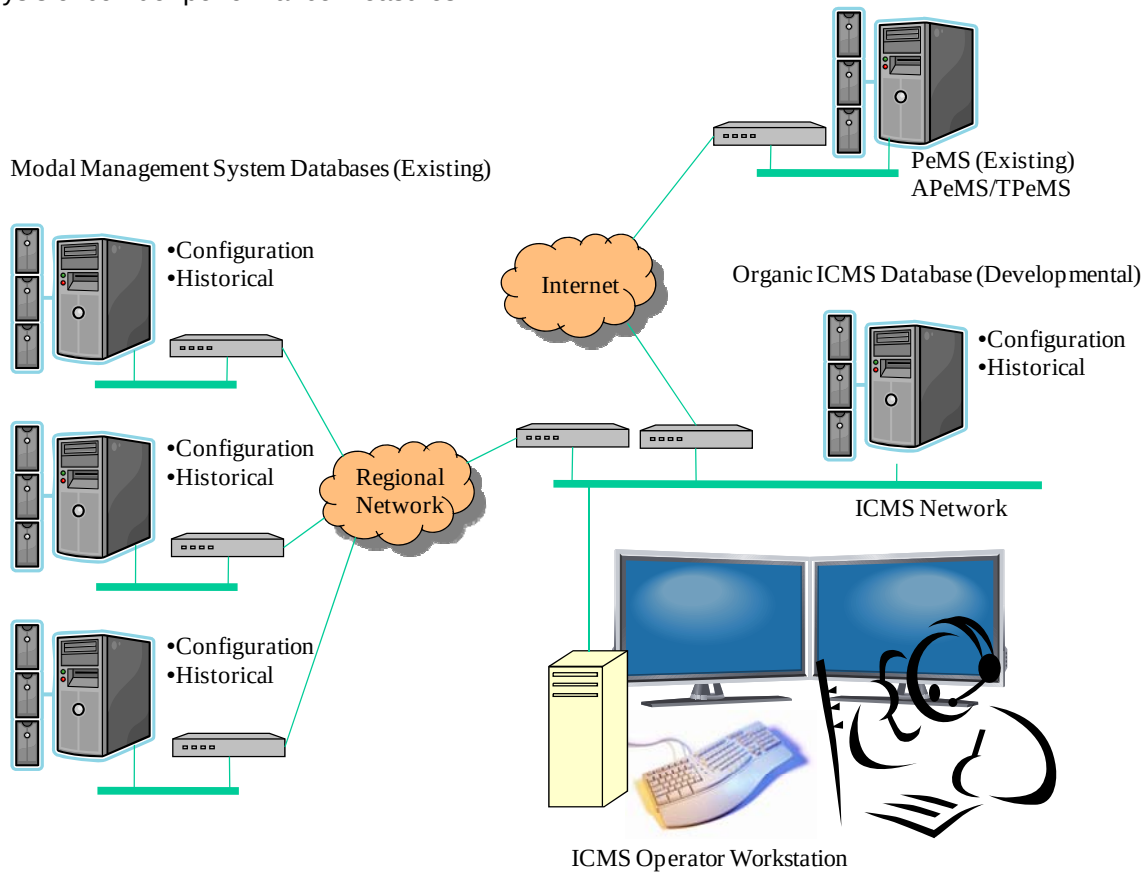


Figure 2-8. ICMS Shared Database Concept

2.2.4.3 Event Management

When incident records are initiated by multiple agencies related to a single specific event, event management becomes more complex than if just one agency is managing the event. Likewise, multiple events may exist, but only one incident record is active in a modal management system. Other similar scenarios pose challenges for regional event management. Much of this arises from the nature of public reporting via mobile 911 as the motoring public are not experienced traffic observers or may not have a good grasp of their exact location at the time of reporting. The current situation is relatively straightforward since CHP initiates most events from motorist reports and automatically transfers these to

the ATMS 2005 application. As more agencies become involved in generating events, event management will become commensurately more complex and the ICMS will need an event management protocol. This is particularly true as more public safety communications centers link into the regional IMTMS network.

Each event initiated by an ICMS agency has its own life cycle from initiation to termination. However each agency must independently manage its own events. One agency terminating an event does not automatically clear the event from all other agencies involved in that event since each agency has a particular timeline of responsibility regarding that event.

2.2.4.4 Response Plan Processing

Figure 2-9 illustrates the conceptual processing flow for response plan generation and execution. The response plan function activation generates a Response Plan for a specific incident location, type, severity and impact, based on the time of day and other operational parameters. Each response plan consists of one or more action plans. An action plan consists of one or more commands. A single command is designed to recommend a specified single action for a single modal system in a single jurisdiction. This processing scheme is designed to improve accountability and auditing for actions taken is response to corridor events. [*Example: As shown in the figure for CMS activation, one command selects a message (e.g., from a library of pre-constructed messages) and the next series of commands sends that message to one or more CMSs in a single city*.] The response plan generator is an Expert System or equivalent table-driven application that reads a *knowledge base* of the roadway configuration in the corridor (by accessing highway and field device tables in the corridor configuration database) and then applies a *rule base* of predetermined "If-Then" statements that describe the business rules for corridor operations under specified conditions.

It is important to note that the ICMS does not actually *control* corridor modal management systems – that function is left to the modal management systems themselves. What the ICMS does is send the action plan in a manner that can be reviewed by the modal management system operator (if desired) and/or input as a message that initiates action within the modal management system without operator interaction. This, in turn, requires that the modal management system (e.g., QuicNet) have an input function that triggers for example, a timing plan change at selected intersections.

Note that in Figure 2-9, response plans may vary during the life cycle of an event, or other events may impact the original event in a way that impacts the selection of a response plan. CMS messages need to be modified or terminated, Managed Lanes configuration may change, and/or traffic signal timing plans in adjacent jurisdictions may change. Logging response plans, their component parts, and times that decisions are made is an important piece of reconstructing a major event, therefore these key data elements will be stored into the corridor's historical event database.

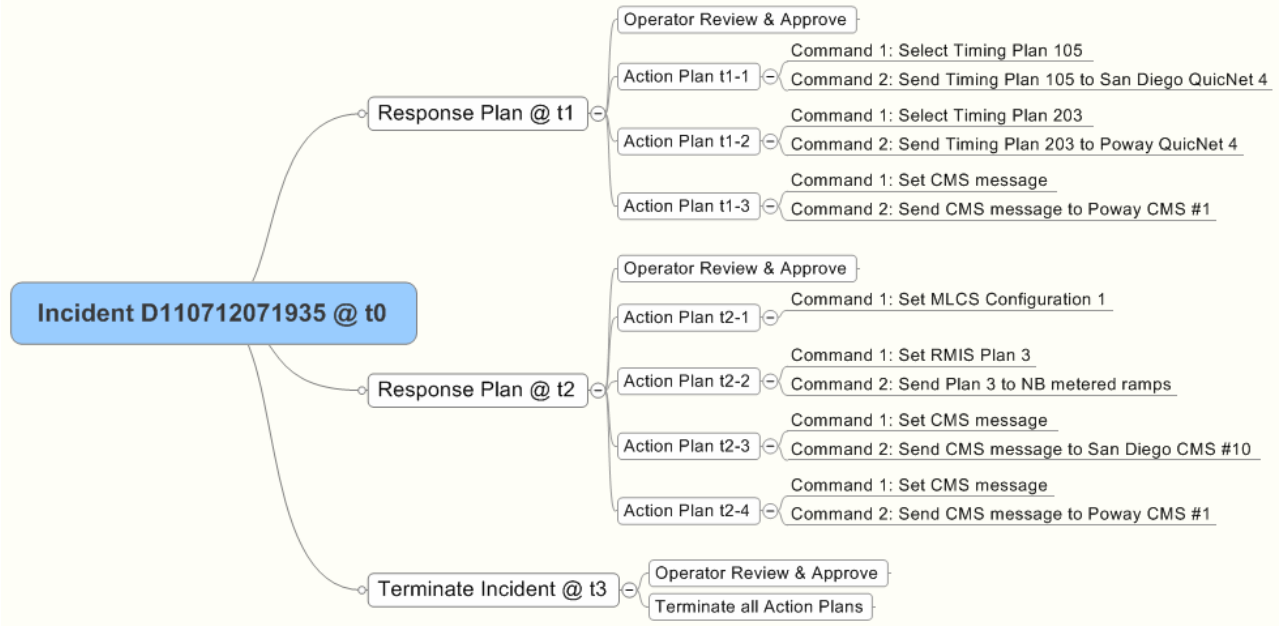


Figure 2-9. ICMS Response Plan Processing

2.2.4.5 Modeling

This project will require development of two micro-simulation applications. A traffic engineer or modeler and a dedicated PC with the traffic modeling software will be in place at the virtual traffic management center. Both traffic simulation applications will be in operation at the management center and will ultimately be tied together.

2.2.4.5.1 Analysis, Modeling, and Simulation (AMS)

The San Diego ICMS team and Cambridge Systematics will create a 2003 traffic simulation model. This simulation model will be extracted from SANDAG's base year 2003 travel demand model. The extraction will be from the demand model software TransCAD into the simulation model software TransModeler. The extraction will include two scenarios: the AM peak period (6 a.m. to 9 a.m.) and the PM peak period (3 p.m. to 6 p.m.). The extracted base year 2003 simulation model will be calibrated and validated with PeMS data.

The same extraction process will be used to create two year 2012 scenarios: the AM peak period (6 a.m. to 9 a.m.) and the PM peak period (3 p.m. to 6 p.m.). The 2012 scenario will be used because it will include completion of the three phases of the I-15 Managed Lanes construction. These two base 2012 traffic simulation scenarios will be used to create a multiple simulation alternatives that will be used to compile a comprehensive response plan database. The database will simply include the time period, link identification, a description of the incident, and the appropriate response plan for either time period. Table 2-3 is an example of how this database might look.

Table 2-3. Notional Response Database Containing Incident-Response Pairs

No	TOD	Direction/Fwy	Incident Description	Recommended Response
1	AM	SB I-15	Lane 1 is blocked between Poway Road and SR 56	a) Take no action
2	AM	SB I-15	Lanes 1 and 2 are blocked between SR 56 and Poway Road	a) Turn on upstream CMS with warning b) Lengthen meter cycle at closest 3 upstream ramp meters
3	AM	SB I-15	All lanes are blocked between SR 56 and Poway Road	a) Turn on upstream CMS with diversion to WB SR 56 to Rancho Peñasquitos Road b) Lengthen meter cycle at all upstream ramp meters c) Change signal timing on Rancho Peñasquitos Rd to accommodate traffic rerouting
4	PM	Pomerado Road & Ted Williams Parkway	Intersection closed due to a crash	a) Turn on freeway and arterial CMS with diversion b) Loosen ramp meter rates at Pomerado Road and Ted Williams Parkway c) Change signal timing on Poway Road, Scripps Poway Parkway and Carmel Mountain Road
5	PM	NB & SB I-15	All lanes blocked in both directions on the bridge over Lake Hodges	a) Turn on all CMS with diversion using SR 78 to I-5 b) Turn on all CMS with diversion using SR 56 to I-5

2.2.4.5.2 Live Feed Traffic Simulation

The second traffic simulation application will continuously monitor traffic in the corridor at the mesoscopic level. The continuous feed of volume and speed data will come from PeMS and arterial PeMS (A-PeMS). Using the mesoscopic level of traffic simulation will allow the simulation software to keep up with the large volume of input data.

2.2.4.5.3 Integration of the Two Applications

When a real world incident that has already been modeled with an appropriate response plan occurs, it is anticipated that the response plan can be set into action within five minutes from the reporting of the incident. When a real world incident that has not been modeled occurs, the incident will be modeled on the fly using the appropriate 2012 time-period simulation model created in the AMS application. The new simulation alternative will include the incident, and the simulation output will be used by the engineer/modeler to define a new response plan. It is anticipated that a new simulation model, and thus, response plan can be defined and set into place in about one hour from the reporting of the incident. All newly defined incidents and appropriate response plans will be added to the database for continuous improvement.

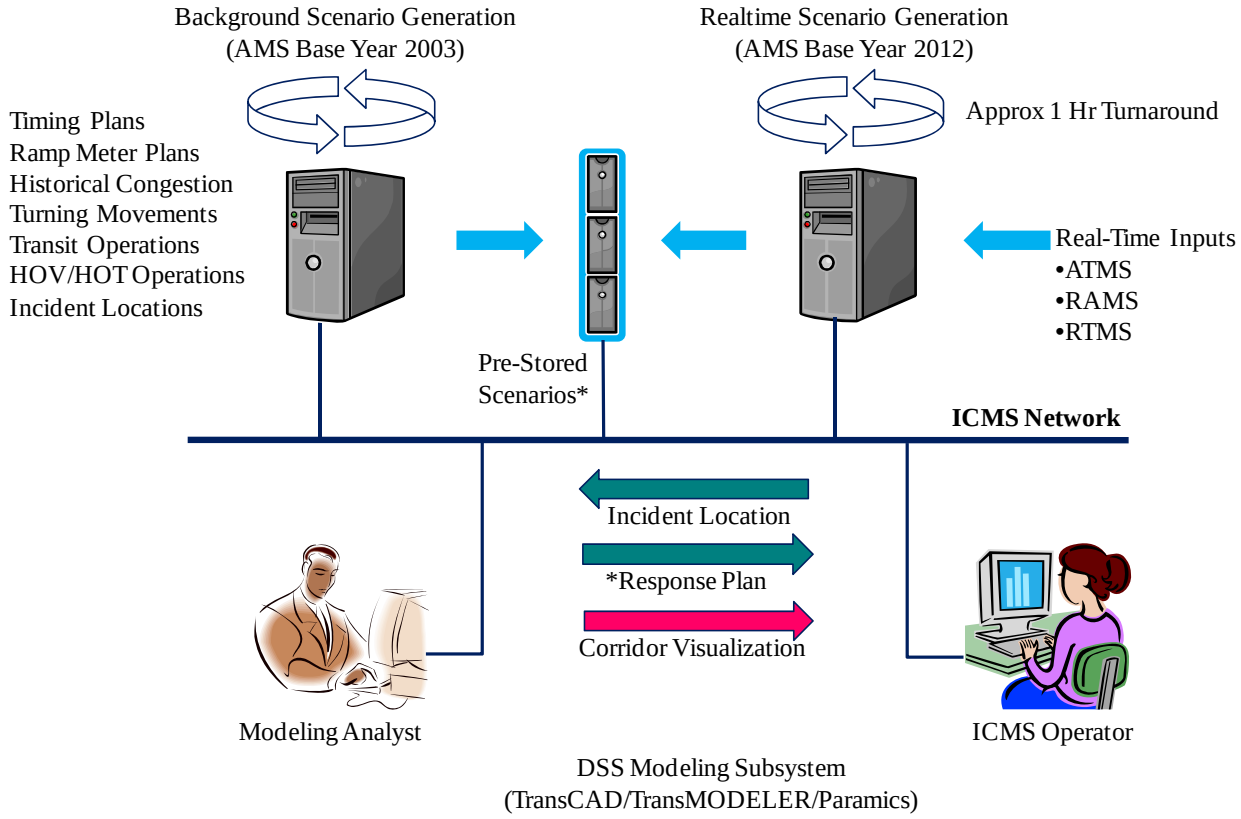


Figure 2-10. DSS Modeling Subsystem

2.3 ICMS Operational Modes

The ICMS will operate in two basic modes as illustrated in Figure 2-11:

- **Normal Mode** – day-to-day operations, including minor incidents.
- **Failure Mode** – The Failure Mode will be detected by continuous monitoring of the health of ICMS subsystems and external system communications links. The IMCS will enter the Failure Mode when any of the following conditions occur:
  - Complete system failure
  - Partial failure (one or more data feeds from external systems, one or more subsystems, etc.)
  - Planned maintenance to one or more

2.3.1 ICMS States

During ICMS operation, transitions to and from various operational states will occur in the Normal Mode. These transitions will closely track changes in state of the corridor itself (i.e., if an incident occurs in the corridor, the ICMS transitions to an event management and response plan state).

- **Event State** – when a major event (planned or unplanned) occurs, the ICMS will transition to the Event Mode in which decisions are made relative to the need to activate one or more Response Plans and/or to execute short-term modeling to test response strategies in real-time (within a reasonable run time to impact corridor operational decisions)
- **Modeling State** – the Modeling Mode of ICMS is a "parallel processing" mode, with integration of input data and model visualization through ICMS. Parallel processing means that modeling is running while other ICMS functions continue to execute. The Modeling Mode can be entered from the Event Mode (in response to planned and unplanned events) or in the Steady State Mode to test longer-term corridor management strategies to balance capacity and demand.
- **Long-Term Operations State** – Over time, the Steady-State Mode becomes Long-Term Operations as the corridor incorporates increasing amounts of operational experience and system historical data.

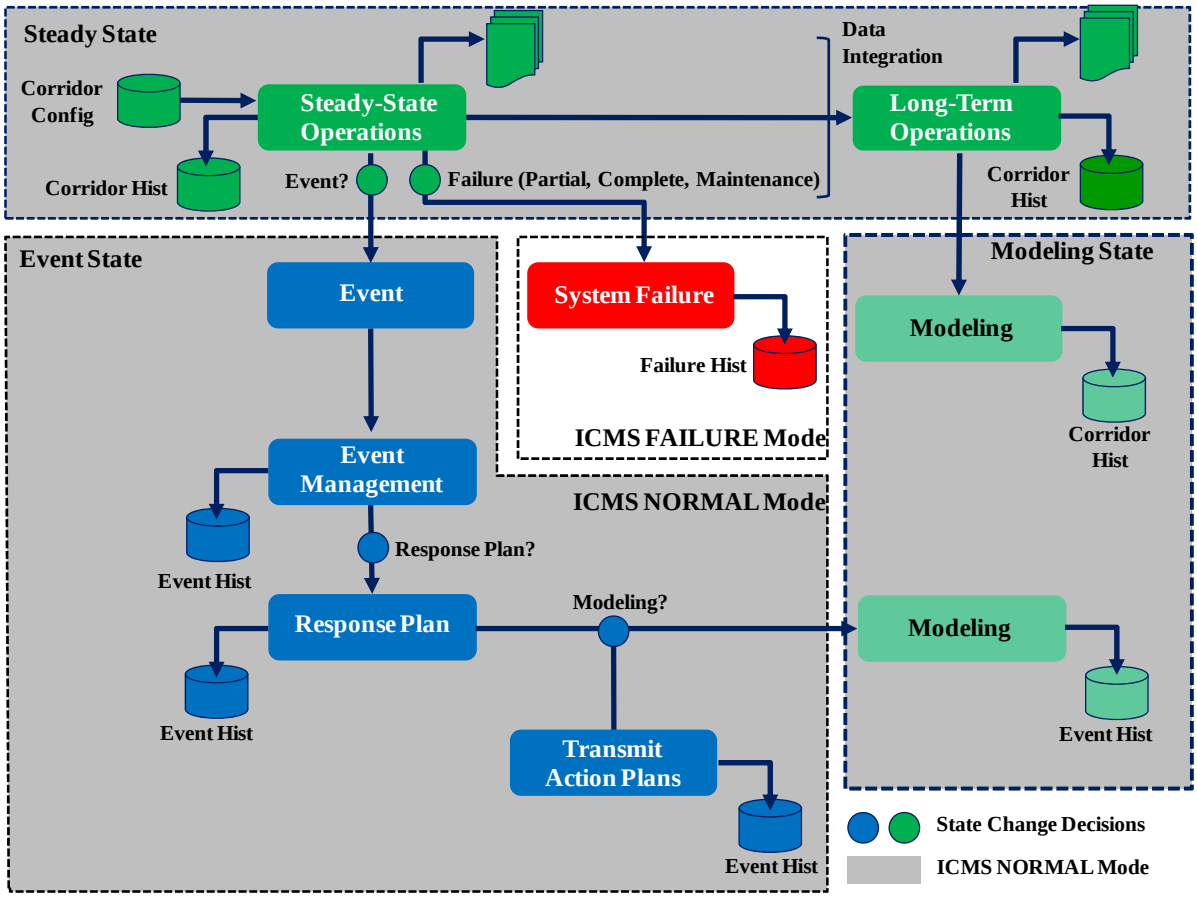


Figure 2-11. ICMS Modes and States

2.4 ICMS Life Cycle Management

The Institute of Electrical and Electronics Engineers/Electronics Industries Association (IEEE/EIA) 12207.0:1996 Standard groups the activities that may be performed during the life cycle of software into five *primary processes*, eight *supporting processes*, and four *organizational processes*. The IMCS will incorporate many, but not necessarily all of the processes described below. Tailoring of this standard is to be expected in any software development effort, and ICMS will be no exception. Complete implementation of the standard can be very costly, yet there must be some structure imposed on the ICMS development process. The following paragraphs are meant to provide a quick overview of the standard and are by no means complete. Much more guidance for application is provided in the standard, its appendices, and in a non-IEEE guidebook by Michael E.C. Schmidt.[2]

2.4.1 Primary Processes

The primary processes consist of five processes that serve primary parties during the life cycle of software. A primary party is one that initiates or performs the development, operation, or maintenance of software products. These primary parties are the acquirer, the supplier, the developer, the operator, and

[2] Michael E.C. Schmidt. 2000. *Implementing the IEEE Software Engineering Standards*. Sams Publishing, Indianapolis, IN

the maintainer of software products. For ICMS sustainability, the operation and maintenance processes will be important. The primary processes are:

1. *Acquisition process* – Defines the activities of the acquirer, the organization that acquires a system, software product, or software service.
2. *Supply process* – Defines the activities of the supplier, the organization that provides the system, software product, or software service to the acquirer.
3. *Development process* – Defines the activities of the developer, the organization that defines and develops the software product.
4. *Operation process* – Defines the activities of the operator, the organization that provides the service of operating a computer system in its live environment for its users.
5. *Maintenance process* – Defines the activities of the maintainer, the organization that provides the service of maintaining the software product; that is, managing modifications to the software product to keep it current and in operational fitness. This process includes the migration and retirement of the software product.

2.4.2 Supporting Life Cycle Processes

The supporting life cycle processes consist of eight processes. A supporting process supports another process as an integral part with a distinct purpose and contributes to the success and quality of the software project. A supporting process is employed and executed, as needed, by another process. These processes are likely to be the most germane to the ICMS development effort. The supporting processes are:

1. *Documentation process – Defines* the activities for recording the information produced by a life cycle process.
2. *Configuration management process* – Defines the configuration management activities.
3. *Quality assurance process* – Defines the activities for objectively assuring that the software products and processes are in conformance with their specified requirements and adhere to their established plans. Joint reviews, audits, verification, and validation may be used as techniques of quality assurance.
4. *Verification process* – Defines the activities (for the acquirer, the supplier, or an independent party) for verifying the software products and services in varying depth depending on the software project.
5. *Validation process* – Defines the activities (for the acquirer, the supplier, or an independent party) for validating the software products of the software project.
6. *Joint review process* – Defines the activities for evaluating the status and products of an activity. This process may be employed by any two parties, where one party (reviewing party) reviews another party (reviewed party) in a joint forum.
7. *Audit process* – Defines the activities for determining compliance with the requirements, plans, and contract. This process may be employed by any two parties, where one party (auditing party) audits the software products or activities of another party (audited party).
8. *Problem resolution process* – Defines a process for analyzing and removing the problems (including non-conformances), whatever their nature or source, that are discovered during the execution of development, operation, maintenance, or other processes.

2.4.3 Organizational Life Cycle Processes

The organizational life cycle processes consist of four processes. They are employed by an organization to establish and implement an underlying structure made up of associated life cycle processes and personnel and continuously improve the structure and processes. They are typically employed outside the

realm of specific projects and contracts; however, lessons from such projects and contracts contribute to the improvement of the organization. Organizational life cycle processes will most likely not be formalized in the ICMS development effort. The organizational processes are:

1. *Management process* – Defines the basic activities of the management, including project management, related to the execution of a life cycle process.
2. *Infrastructure process* – Defines the basic activities for establishing the underlying structure of a life cycle process.
3. *Improvement process* – Defines the basic activities that an organization (that is, acquirer, supplier, developer, operator, maintainer, or the manager of another process) performs for establishing, measuring, controlling, and improving its life cycle process.
4. *Training process* – Defines the activities for providing adequately trained personnel.

2.5 ICMS User Characteristics

Projected ICMS users represent a diverse set of unique operations and maintenance skills and include the categories, roles and system modes when primary duties are performed listed in Table 2-4.

2.6 ICMS Constraints

The ICMS will function within an existing regional ITS architecture and a comprehensive set of existing applications that exist under the IMTMS umbrella and its constituent data feeds. Each legacy application has varying degrees of flexibility in how it may be modified to support ICMS functional requirements. Detailed constraint requirements for ICMS functions will be described in Section 3.6 of this document.

2.7 Assumptions and Dependencies

2.7.1 Regional Architecture

The currently deployed IMTMS will be a core subsystem of the ICMS. IMTMS will retain its current architecture, but will be expanded to collect and distribute data from new regional ITS systems. The current IMTMS architecture does not include decision support functions; therefore, a new DSS is required for the ICMS. Planned ITS systems (CP upgrades, MLCS, expanded REMS, SPS, and the SPRINTER train control system) will become new external systems feeding data to the ICMS.

2.7.2 Partners

The EOC will become a new partner in the ICMS.

Table 2-4. ICMS User Categories

Position	Position Roles
Barrier transfer machine (BTM) operators	Operate BTM equipment to reconfigure Managed Lanes
BTM maintenance staff	Maintain BTM equipment
Broadcast media	Gather information on planned and unplanned corridor events and inform the public via radio, TV, and satellite
Caltrans maintenance dispatchers	Dispatch Caltrans maintenance vehicles and personnel
CHP traffic officers	Incident response and freeway/highway enforcement
Corridor managers	Multi-modal corridor operations management, with a working knowledge of freeway, arterial, transit, and public safety operations
District traffic manager(s)	Maintenance of lane closure system
EOC watch officer EOC planning and intelligence staff	When the EOC is activated, Intelligence and Planning Section staff collect data from many sources in the county and use this data to develop plans for the next "operational period" (usually 24 hours) during a major emergency
FasTrak customer service center operators	Operate and maintain CPS
Freeway Service Patrol drivers	Perform motorist aid duties on assigned freeway beats
IT managers	Develop IT hardware and software standards and deploy IT equipment and applications
IT maintenance staff	Operate and maintain ICMS IT equipment
Parking facility staff	Operate and maintain SPS and facilities
Public safety call takers	Receive calls for assistance from the motoring public via mobile or landline phones and initiate incident records within a CAD system
Public safety dispatchers	Dispatch and track public safety units using CAD systems and update incident records based on officer field reports
Roadway equipment maintenance staff	Monitor, troubleshoot, and maintain roadway ITS devices
TMC operators	Operate ATMS 2005 and QuicNet systems and dispatch Caltrans operations staff
Traffic engineers	Maintain traffic signal and ramp metering systems, develop signal and ramp meter timing plans, and tune system traffic algorithms
Transit dispatchers	Maintain communications with transit drivers and monitor transit vehicle schedule adherence
Transit drivers	Operate regional bus vehicles and monitor roadway conditions on their assigned routes
Transportation planners	Analyze all modes of transportation operations, run modeling software, and develop long-term corridor operations strategies

2.7.3 Regional ITS Deployments

The functioning of ICMS assumes the following general capabilities are present in addition to existing ITS applications in the San Diego region:

- Arterial data collection, capable of providing intersection controller data and traffic volume, occupancy, speed, and travel times on key arterials in the corridor
- Connections to public safety CAD systems for the cities of San Diego, Poway, and Escondido, capable of sharing selected traffic-related incident data with external agencies
- Accessibility of PeMS data via an external interface
- Accessibility to existing modal management system database tables and reporting functions via external interfaces
- Additional field elements (CCTV, CMSs, detectors) deployed along the Pomerado Road, Black Mountain Road, and Centre City Parkway arterial corridors

2.7.4 Data Management

Each modal management system (ATMS 2005, MLCS, CPS, RTMS, RAMS) will maintain its organic configuration and historical database instances – the ICMS will maintain non-redundant configuration and historical databases. The ICMS will maintain corridor event history database tables.

2.7.5 ICM Project Dates

The I-15 ICMS assumes that the following dates will apply to the overall ICM initiative at the U.S. Department of Transportation:

- AMS modeling phase – summer 2008 to summer 2009
- Begin ICMS deployment – fall 2009
- Complete ICMS deployment and start ICMS operations/evaluation – fall 2010
- Complete ICMS pioneer site project – fall 2011

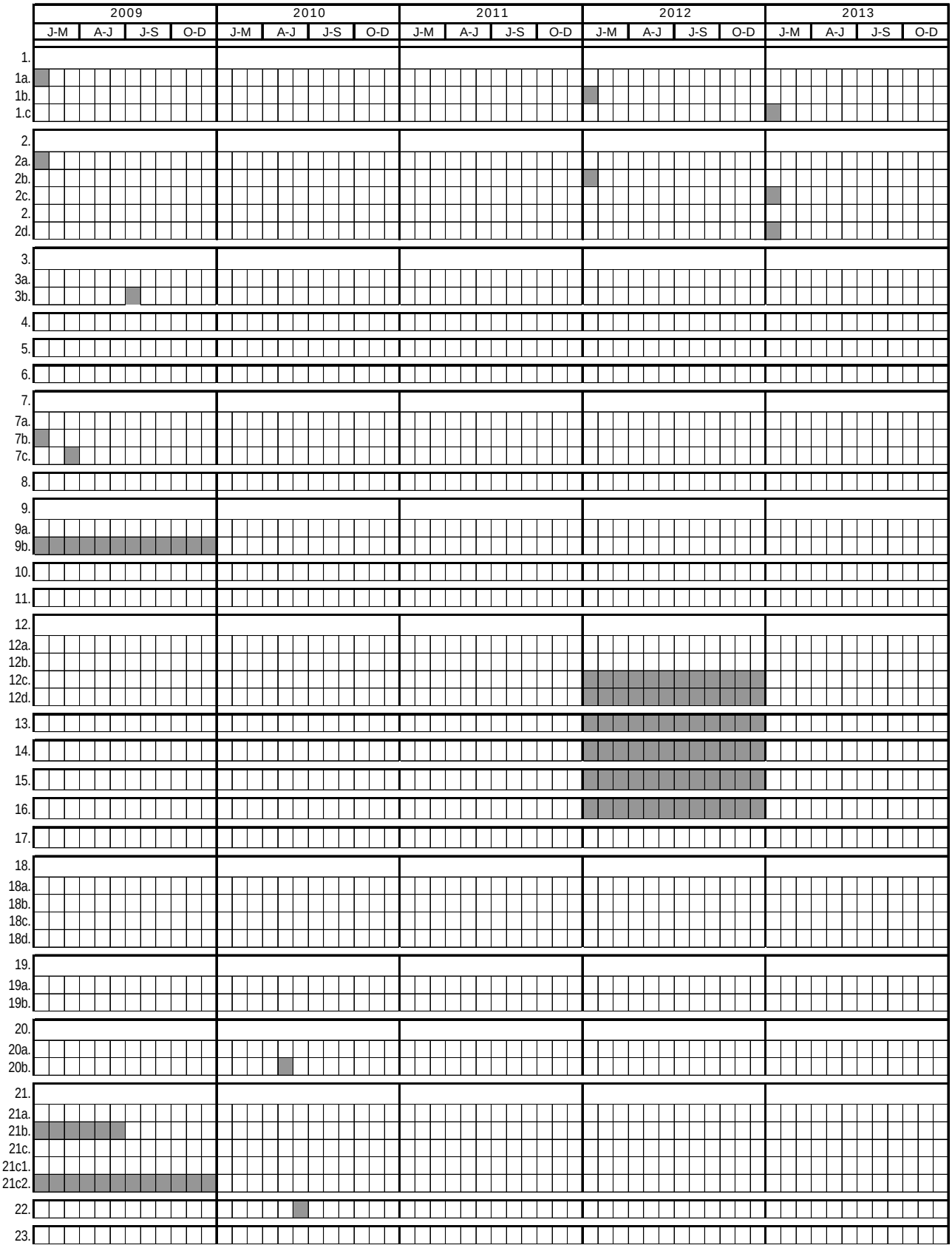
2.7.6 IMTMS New Data Feeds – Planned Dates

Table 2-5 lists the planned implementation dates for new data feeds and external systems that impact ICMS deployments.

Table 2-5. Planned Deployment Schedule for External Systems Associated with ICMS

	2007			2008			
	J	J-S	O-D	J-M	A-J	J-S	O-D
1. Managed Lanes Control System (MLCS) (together w/Congestion Pricing System)							
a. Middle Segment (phased deployment)							
b. North Segment							
c. South Segment							
2. Bus Rapid Transit Stations and Direct Access Ramps							
a. Middle Segment (phased deployment)							
b. North Segment							
c. South Segment							
2. Bus Rapid Transit							
d. New vehicles, more frequent service, Next Stop arrival signage							
3. Arterial Data Collection Capabilities							
a. A-PeMS initial deployment phase along primary I-15 arterials*							
b. Extended implementation beyond I-15 arterials							
4. Advanced Transportation Management System (ATMS 2005)		OPERATIONAL					
5. Intermodal Transportation Management System ((IMTMS) less RIWS and RAMS)		OPERATIONAL					
6. Lane Closure System (LCS)		OPERATIONAL					
7. Regional Arterial Management System (RAMS)							
a. Initial deployment phase							
b. Integration of QuicNET 4+ into the IMTMS environment							
c. Full Implementation Phase (regionalization of QuicNET 4+)							
8. Regional Event Management System ((REMS) currently is CHP CAD)		OPERATIONAL					
9. Regional Integrated Work Stations (RIWS)							
a. Acceptance testing		COMPLETED					
b. Phased implementation subject to regional agreements							
10. Regional Transit Management System (RTMS)		OPERATIONAL					
11. CHP Media Incident Feed and Integration into IMTMS Environment		OPERATIONAL					
12. Regional Communications Networks							
a. Communication plan with gaps identified and most cost-effective strategies identified; 90% complete by 2012							
b. South Segment of Managed Lanes							
c. Middle Segment of Managed Lanes							
d. North Segment of Managed Lanes							
13. Caltrans Fiber Optic Network Installed in Two Phases on I-15 Corridor							
14. Upgrades in Freeway Management System Monitoring Capabilities (more detectors & full coverage CCTV) in Two Phases							
15. Revised/Upgraded Incident Management Procedures for Automated Detection and Response in Two Phases							
16. Expanded Implementation of Changeable Message Signs (Dynamic Along I-15 Managed Lanes in Two Phases)							
17. Upgrading of I-15 Reversible Lane Control System (RLCS) on South Segment of I-15 Managed Lanes System		COMPLETED					
18. Compass Card Financial Clearinghouse System							
a. Pre-test phase		COMPLETED					
b. Employee initial test phase (SANDAG, MTS, NCTD)							
c. Mini-customer pilot test							
d. Full system launch							
19. 511 Advanced Traveler Information System							
a. Initial system launch for phone and web		COMPLETED					
b. Launch for public access TV channel							
20. Smart Parking System (SPS)							
a. Initial deployment phase (Coaster commuter rail stations along I-5)							
b. Framework for regional extensibility							
21. Performance Monitoring System (PeMS) for San Diego Area Data							
a. Freeway		OPERATIONAL					
b. Arterial (see #3 above)							
c. Transit							
c1. Framework of functionality							
c2. Initial deployment							
22. VCTMC/Decision Support System							
23. Transit Signal Priority on NCTD Bus Route 350 in Escondido (BRT Feeder)							

*Centre City Parkway, Pomerado Road, Kearny Villa/Black Mountain Road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3 INTEGRATED CORRIDOR MANAGEMENT SYSTEM (ICMS) REQUIREMENTS

3.1 Requirements Framework

In formulating the system requirements for the Interstate 15 (I-15) ICMS the project team has never lost sight of the larger picture, that is, on the ICMS itself. The team's objective is to produce a top-quality system that truly stands out as a market leader and that is able to serve as a template for other regions interested in deploying ICMSs to use as a model. To help satisfy this objective, the team developed a set of proposed requirements – in both content and quantity – for the ICMS that is based on a two-part development strategy. The first part rests on the recommended guidance and practice from Institute of Electrical and Electronics Engineers' (IEEE's) specifications[3] documents and the second part focuses specifically on the San Diego region's vision for their ICMS.

The project team has as a result, a set of system requirements that is best suited for the San Diego region's unique combination of operating characteristics, transportation assets, and mobility management strategies. Upon reviewing this system requirements document, the reader will have a complete appreciation of San Diego's ICMS, including its description, context, subsystems, users and their roles, and constraints.

Additionally, readers will grasp the system requirements from static, dynamic, and institutional perspectives. The static perspective provides system context. The dynamic perspective provides the reader with an understanding of how the ICMS will operate under its Normal (short-term and long-term) Mode and Failure Mode (degraded operations, complete system failure, and maintenance operations). In addition, we have defined states through which the system transitions during Normal Mode operations. The institutional perspective provides an understanding of who the corridor stakeholders are and how they work as a management team.

The San Diego local area stakeholder working group provided the technical and operational foundation for the document. The group conducted a series of workshops with both a "core" working group and an expanded team that included regional public safety personnel. This iterative process resulted in a set of detailed requirements reflecting the specific needs and systems of the San Diego region. The Federal Technical Assistance Team[4] visited the site and provided further guidance on the development of both user needs and system requirements themselves. Through this process, the project team significantly and comprehensively updated our original set of user needs[5] to reflect the current and proposed ICMS and listed in an ordered way that reflects the flow of corridor activities during the life cycle of the ICMS.

In the second part of the requirements development strategy, the project team created a high-level functional decomposition modeled on our updated set of 17 user needs (See Sections 3.4 (Table 3-3) and 3.5 (Figure 3-1)), which provides the benefit of maintaining a one-to-one correspondence between the requirements within each functional area and its corresponding user need. The team then partitioned the 17 functional areas two additional times according to: (1) the current implementation state of the ICMS subsystems (operational or awaiting development and implementation); and (2) the context of the ICMS subsystems (internal or external to the ICMS). This partitioning was based on the Concept of Operations and Figure 2-1 of this document.

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[3] *IEEE Guide for Developing System Requirements Specifications*, IEEE Std. 1233, The Institute of Electrical and Electronics Engineers, Inc., 1998 Edition; *IEEE Recommended Practice for Software Requirements Specifications*, IEEE Std. 830, The Institute of Electrical and Electronics Engineers, Inc., 1998 Edition.

[4] *Integrated Corridor Management – The Transition from a Concept of Operations to Requirements*, Mixon/Hill, Inc., Version 1.6, August 2007; Requirements Checklist for ATMS/ICMS Systems, Mixon/Hill, Inc., November 2007.

[5] The set of seven User Needs that appear in the August 2007 version of the Concept of Operations.

This approach has afforded the team an opportunity to take full advantage of the nature of the San Diego region's current and successful transportation management strategies. Moreover, the team has developed system requirements for the ICMS in a systematic fashion that is detailed and complete. The project team is confident that this will also allow the San Diego region to move toward the system design phase in an efficient manner. This methodology provides SANDAG with the added benefit that the I-15 ICMS should be readily transportable to other corridors within the San Diego region without major modifications. SANDAG fully intends to expand the Integrated Corridor Managemetn (ICM) corridors beyond I-15.

Guided by this two-part strategy, the project team followed a detailed and iterative process that resulted in an extensive set of requirements in both depth and breadth. The process consisted of: (1) repeated questioning as to whether each requirement describes a capability that the I-15 ICMS must have to meet its objectives, whether it is well formed, and whether it refrains from designing the system; (2) revising requirements where necessary; and (3) adding to the requirements list.

The project team views the development of system requirements as a dynamic and not a static process. While the team is confident that the current set of requirements covers all aspects of the proposed ICMS for the I-15 corridor, there will certainly be additional opportunities to again employ the described iterative requirements development process for further enhancements. Nonetheless, at this time, SANDAG and the region are fully prepared to move forward into the system design stage.

3.2 Definitions

The ICMS requirements listed in Section 3.6 use existing Intermodal Transportation Management System (IMTMS) system components and other key terms that are defined in Table 3-1.

Table 3-1. Definitions Referred to in Requirements Specifications

Term	Definition
Action Plan	An action plan is a set of one or more commands, with each command implementing a control function on one modal system in one jurisdiction.
Active Incident	An incident being managed locally with an open incident record.
Agency Data Server	An agency data server transforms legacy data formats (as defined by appropriate ICDs) into a standard XML schema based on NTCIP 2306 and TMDD v2.1. Each legacy (or newly developed external) system has its own agency data server and rules for converting legacy data into standard XML schema.
Block	In transit operations, a single bus ID and driver ID assigned to a scheduled time period on a specific route.
Bottleneck	A location on the freeway where the occupancy downstream of the bottleneck is substantially lower than the occupancy upstream.
Buffer Index	Additional time travelers must add to their average travel time when planning trips to ensure on-time arrival (on-time arrival assumes the 95th percentile of the travel time distribution).
Command	A recommended action for one modal management system in a single jurisdiction. An action plan consists of one or more commands.
Display Panel	A discretely assignable area of a large screen display.
Intermodal Agency Integration (IAI) Server	An IAI server provides XML data streams in response to Web service client requests. IAI servers are scalable as needed.

Table 3-1. Definitions Referred to in Requirements Specifications (cont'd)

Term	Definition
Inventory	Static configuration and system data maintained by I-15 partner agencies
Internet Service Provider (ISP) Server	An ISP server feeds XML data to SANDAG's ISP to support the regional 511 service.
Knowledge Base	In the response plan context, a knowledge base is a database of information regarding roadway geometries and geographic information and information about the location and characteristics of roadway field devices. The database is external and must be linked to an Expert System or table-driven application via an application programming interface.
Level I Agency	A Level I agency is one that has a "legacy" management system through which their operations are semi- or wholly-automated and who shares this data with IMTMS. Level I agencies are connected to the region's IMTMS network via an agency data server, which can be either a one-way or a two-way bridge. A "bridge" is IMTMS nomenclature for a data interface. A one-way bridge passes data from the legacy host system to IMTMS or from IMTMS to a dissemination partner; a two-way bridge also allows data to pass from IMTMS back into the host system for information and/or control. The California Highway Patrol (CHP) (data into IMTMS), and 511 (data from IMTMS) bridges are currently one-way. Caltrans and RTMS bridges are two-way, primarily for event data exchange. The planned RAMS bridge will be a two-way bridge. The Regional Event Management System (REMS) and 511 bridges are planned as future two-way bridges.
Level II Agency	A Level II agency is one that does not have a legacy data interface to IMTMS. Level II agencies can transition to a Level I agency when they acquire a management system and when a formal interface control document is created for IMTMS connection to this system. For example the city of San Diego is currently a Level II agency, but when an interface is created for their ATMS system, they will become a Level I agency. Most local agencies in the region operate the QuicNet 4 traffic signal control system, but will not directly interface to IMTMS. The RAMS project is creating a regional server that will act as the single IMTMS interface point for arterial traffic information. Thus the RAMS regional server becomes a Level I "agency," while individual QuicNet 4 users remain as Level II agencies.
Lost Productivity	Reduction in facility throughput
Map Server	A map server responds to HTTP requests and provides dynamic Java and HTML map pages to client browser applications. The map pages contain both static and dynamic elements. Map servers are scalable as needed.
Non-Redundant Data Store	A database that does not duplicate data already collected by modal database management systems (e.g., Advanced Traffic Management System (ATMS) 2005, Regional Transit Management System (RTMS), Regional Arterial Management System (RAMS), Congestion Pricing System (CPS), Managed Lanes Control System (MLCS), Smart Parking System (SPS)).
Peak Period	AM – defined period of morning commute traffic. PM – defined period of afternoon commute traffic.
Productivity	Percent utilization of the freeway network under peak conditions.
Real-Time	Received within the most recent update cycle of continuous data streams from a modal management system (e.g., 30 seconds for ATMS 2005, 2 minutes for RTMS). Does not include periodic updates of static data.
Regional Host Server	A regional host server collects data from all Level I sources and creates Web services for data distribution. Regional host servers are scalable as needed.

Table 3-1. Definitions Referred to in Requirements Specifications (cont'd)

Term	Definition
Regional Integrated Workstation (RIWS)	RIWS is a misnomer which actually refers to a browser-based map application that displays real-time data and that has a manual data entry capability. Using the RIWS, an agency can perform the following functions: ▪ Display freeway and arterial (when available)[6] congestion ▪ Select cameras for viewing and under agreed conditions and remote control ▪ Display real-time video streams, archived video clips, and/or video snapshots ▪ Display changeable message sign (CMS) status and active messages and under agreed conditions, and control CMSs ▪ Display freeway, transit, and arterial events (when available) ▪ Display transit routes ▪ Display the near real-time position of transit vehicles and schedule adherence data ▪ Manually enter event data for special events and construction in their jurisdictions An RIWS capability can be located in either a Level I or Level II agency as the jurisdiction desires. Some jurisdictions may choose not to use the RIWS, but instead integrate the XML data stream into a local application. The current implementation of RTMS is an example of this option.
Response Plan	A response plan is generated by the response plan function and consists of one or more action plans. Multiple response plans can be generated during the life cycle of a corridor event as network conditions change.
Rule Base	In the response plan context, a rule base is a database of business rules that describe the actions to be taken in response to a set of input parameters. The rule base can be implemented in an Expert System application or as part of the logic of a table-driven response plan. The rule base is generally developed with internal functions in an Expert System or as software in a table-driven application. The rule base is linked to a knowledge base (see the next definition) from which it derives its intelligence about the decision environment.
Transit Productivity	Percentage of seats occupied on transit routes.
Transit Reliability	Percentage of trips on time at departure and upon arrival.
Travel Time Index	Ratio of peak-period travel times to free-flow travel time.

[6] "when available" refers to the fact that arterial data is not currently collected but that data collection on the three primary I-15 corridor arterials (Centre City Parkway, Pomerado Road, Kearny Villa/Black Mountain Road) will occur as part of the initial deployment of arterial PeMS (APeMS) in July 2008. At that time, arterial congestion data will then be available.

3.3 Action Verbs

Table 3-2 lists action verbs used in I-15 ICMS requirements and their meanings. This table will help reduce ambiguity in the interpretation of the I-15 ICMS requirements.

Table 3-2. Action Verbs Used in Requirements Specifications

Term	Definition
Access (database)	Retrieve information stored in local database tables.
Acquire	Receive data from an external system through a defined interface.
Classify	Identify as a unique category of data.
Compute	To determine by means of calculating parameters.
Configurable	A parameter changeable by operator input to a configuration dialog or database table.
Disseminate	Send data to an external system through a defined interface (synonym for “publish” - see below).
Determine	To ascertain the meaning or value.
Display	Place an image, map, dialog box, table, or system alert on a device that an operator can view (workstation or large screen display).
Forecast	To calculate and predict the future value of, generally through modeling.
Incorporate	Include as a system function satisfied by hardware, software, human action (such as non-automated personnel notification, pager call-out, or e-mail transmission, etc.), or a combination of these.
Maintain	To update with current information.
Manage	Create, modify, delete, transfer (events), merge (events), and split (events)
Process	Convert data from one form to another, e.g., from RTMS OrbCAD format to IMTMS XML data format.
Provide	Include as a system function satisfied by hardware, software, human action (such as non-automated personnel notification, pager call-out, or e-mail transmission, etc.), or a combination of these.
Publish	Send data to an external system through a defined interface.
Remotely access	View information stored in external systems through a defined interface. For receiving data, use the term “acquire” (see above definition).
Store	Place data into a relational database table.
Transfer	To provide a handover of control to another agency (in the incident context).
Use	To incorporate an existing capability.

3.4 User Needs

The ICMS Concept of Operations documents 17 user needs as listed in Table 3-3.

Table 3-3. ICMS Concept of Operations User Needs

ID Number	Title	Description/Rationale
1	Access/Store ICMS Configuration Data	Store Configuration Data User Need provides for the creation and management of a configuration database instance that maintains static information on various parameters within the I-15 corridor.
2	Collect and Process Data	Collect and Process Data User Need is the core service of ICMS that supports most of the system functionality. Data is collected from a variety of existing and planned systems according to interface control documents, some of which need to be developed as new systems come on line. Once data is collected, certain processing algorithms are invoked that provide a higher level of information aggregation (e.g., volumes, occupancies and speeds at multiple locations are converted to travel times). Process Data function also includes conversion of host system data formats to standard XML schema for publishing information across the ICMS.
3	Access/Store ICMS Historical Information	Access/Store Historical Data User Need provides the capability to create and populate a historical database instance. This database contains real-time information on corridor performance as derived from data collected in the Collect and Process Data User Need. Accessing existing historical databases in ATMS 2005, RTMS, and RAMS is an important function of this user need. Having consistent export formats for data from these historical databases would simplify corridorwide analysis. Ad hoc reporting based on this historical data allows the system users to create a variety of reports that characterize corridor operations and performance. These reports can then be stored in the ICMS historical database.
4	Publish Information to System Managers	Publish Information to System Managers User Need disseminates ICMS data from all sources to agencies that manage one or more modes in the integrated corridor network: freeway, arterial, transit, public safety, and commercial vehicles. This information is differentiated from the information published to system users (see User Need 11).
5	Interactively Conference with Multiple Agencies	Interactive Multi-Agency Conferencing User Need allows system managers to directly collaborate in real-time prior to, during, or after a major event in the I-15 corridor. A variety of voice, video, and data formats will be supported for multi-site collaboration.
6	Display Information	The Information Display User Need covers the ability to take information produced by ICMS and its subsystems and display a variety of data formats in a form that agency decision-makers can use to visualize corridor operations, make decisions, and take actions to implement the various decision components.

Table 3-3. ICMS Concept of Operations User Needs (cont'd)

ID Number	Title	Description/Rationale
7	Coordinate Transportation and Public Safety Operations	Transportation and Public Safety Coordination User Need is another core user need for the I-15 ICMS because it addresses major institutional issues in getting the transportation and public safety communities to work closer together. This is accomplished by providing public safety users the multi-dimensional data inherent in transportation management systems, while at the same time, seeking technical solutions to extracting useful incident information from public safety CAD systems.
8	Share Control of Devices	Shared Device Control User Need allows agencies to remotely control selected functions of field devices regardless of location or agency ownership. For this user need to become real, there must be inter-agency agreements to allow such sharing under carefully defined conditions.
9	Manage Video Imagery	The San Diego region has a variety of video sources that provide a critical view of emerging and ongoing events. These video sources can produce aerial, snapshot, archived clips and real-time imagery to a wide variety of system users via high-bandwidth links.
10	Respond to Corridor Planned and Unplanned Events	The Response Plan User Need allows ICMS users and corridor managers to use some form of decision tool (Expert System or table- driven) that fuses real-time data and manually entered data derived from field communications at the event site (e.g., CHP traffic officers talking to dispatchers using the CHP radio system). The response plan is then either manually or automatically generated based on the fused data input. Once a response plan is generated, the system operator can review the plan's components and make changes as deemed necessary before transmitting plan components to the affected systems. The status of affected systems is then returned to the ICMS operator and logged in the historical database.
11	Assess Impact of Corridor Management Strategies	Impact Assessment User Need allows corridor managers to model various traffic and service management strategies for the corridor to gauge the impact of these strategies on corridor performance. The intent of this user need is to model strategies and to return results within a time frame suitable to affect decision-making during a major event in the corridor. The impact results will be displayed to corridor managers in both 2D and 3D formats. This user need also will be invoked for longer-term assessments.
12	Publish Information to System Users	Publish Information to System Users User Need is the information dissemi-nation user need that parallels the Publish Information to System Managers. The intent of this user need is to provide corridor information to the regional 511 system where it will be further disseminated to various classes of system users across a variety of media. This user need also will make available a standard XML data stream and video imagery to other entities for dissemination to system users as SANDAG policy determines (e.g., direct feeds to the media).

Table 3-3. ICMS Concept of Operations User Needs (cont'd)

ID Number	Title	Description/Rationale
13	Measure Corridor Performance	Measure Corridor Performance User Need looks at multi-modal corridor data from both a short-term and long-term perspective. Existing historical databases for ATMS 2005, RTMS, RAMS, CAD systems, CPS, and Smart Parking provide mode-specific data. Likewise, Performance Measurement System (PeMS) provides a traffic and transit operations view of data. Based on these data sources, corridor demand will be analyzed using actual data or by demand modeling techniques. Using stored corridor configuration data, excess corridor capacity can be measured for any desired time period. This user need will be most valuable for long-term corridor management.
14	Manage Corridor Demand and Capacity to Optimize Long-Term Performance	Capacity/Demand Management User Need provides the ability for corridor managers to collaboratively develop longer-term corridor management strategies. These strategies include both capacity and demand management strategies. For example, a classic demand management strategy is ramp metering. A classic capacity management strategy is managed lanes. The goal of this user need is to increase total corridor performance in the long-term by optimal balancing of capacity and demand.
15	Measure System Performance	Measure System Performance User Need provides for constant monitoring of field devices, server systems and communications networks needed to support the various integrated corridor management functions. Based on monitored data, metrics for system components, such as reliability and availability ,will be measured and stored in the ICMS historical database.
16	Manage ICMS System	System Management User Need is the administrative function of ICMS. Data management for ICMS configuration data, user account management incorporating systemwide security functions and IT-centric functions, such as data backup and archival, are included within this user need.
17	Maintain the ICMS System Throughout its Full Life Cycle	Life Cycle Maintenance User Need provides logistical support to the ICMS through its full life cycle through definition, development, testing, documentation, training, and maintenance phases.

3.5 ICMS Standards Implementation

Table 3-4 lists the standards in use or planned for use in developing ICMS subsystem interfaces.

Table 3-4. Standards Used or Planned for ICMS

Interface	Standard	Version
IMTMS Distribution	TMDD NTCIP 2306 IMTMS Systems Design Document (SDD) – Section 4	2.1 Draft 1.0
511 Dissemination	TMDD NTCIP 2306 IMTMS-511 Interface Design Document (IDD)	2.1 Draft 1.0
OrbCAD (RTMS)	Interface Control Document (ICD) FE-ICD202	1.0

Figure 3-1 shows the relationship of documentation and standards for each interface currently in use for IMTMS. New systems such as the Congestion Pricing System, Smart Parking System and RAMS Regional Server will use TMDD v2.1 for data definitions and NTCIP 2306 for Center-to-Center message interfaces. IDDs and/or ICDs are not available for these systems as of March 2008. All references to interface documentation and standards in Section 3.8 are taken to mean the below illustrated interfaces.

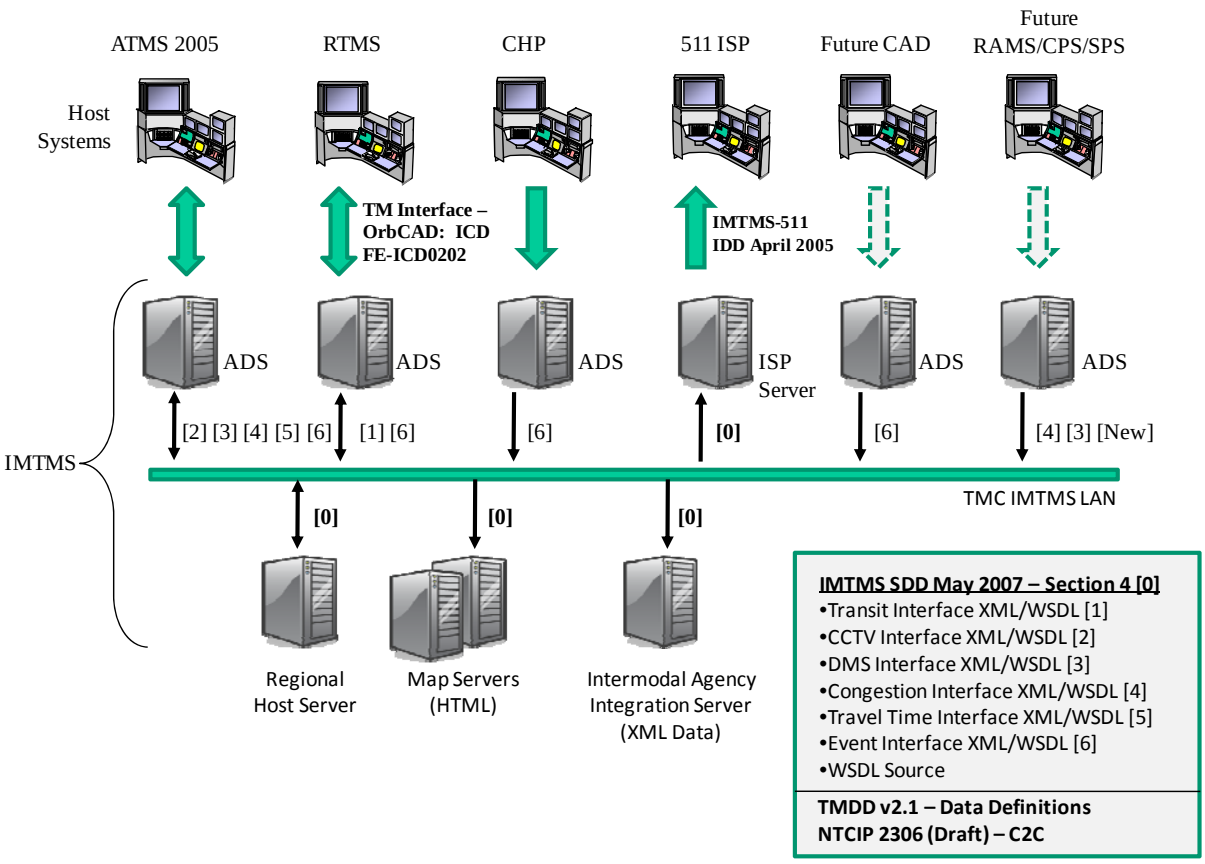

Figure 3-1. Standards and Interface Documentation in Use and Planned for ICMS

Source: SANDAG

3.6 ICMS Data Sources

IMTMS employs a number of data sources that are referenced in the requirements in Section 3.8. Table 3-5 lists the data sources for the various categories of data being used currently in IMTMS and planned for use in ICMS.

Table 3-5. ICMS Data Sources

Data Type	Source
Events	
•Incidents	
•Freeway	ATMS*, REMS (CHP)*
•Arterial	REMS* (planned)
•Transit	RTMS*
•Special Events	ATMS*, RIWS
•Lane Closures	LCS, RIWS
•Emergency Closures	ATMS*, RIWS
Congestion	ATMS*, RAMS*, CPS*
Intersection Phasing/Alarms	RAMS*
CCTV Imagery	IMTMS Video Servers
CMS Messages/Status	ATMS*
Bus Locations, Schedule Adherence	RTMS*
Parking Availability	SPS*
Dynamic Pricing – Managed Lanes	CPS*
* Via Agency Data Servers	

3.7 ICMS Requirements Overview

Figure 3-2 provides an overview of the ICMS requirements and their interrelationship at a high level.

3.8 ICMS Requirements

The following sections provide the high-level requirements for the currently defined 17 ICMS system functions based on the Concept of Operations, various guidance documents provided by U.S. Department of Transportation (U.S. DOT) during the requirements development stage of Integrated Corridor Management and existing ICMS subsystem definition documents (Software Design Descriptions, System Requirements, System Architecture Descriptions, Interface Control Documents, etc.). Each of the below functions of the ICMS and its subsystems was derived from an expanded set of user needs presented to U.S. DOT on November 8, 2007 during the ICM Requirements Workshop. Each major function will contain all its associated requirement types, including constraints, data, functional, interface, hardware and performance. The I-15 project team feels that this approach will simplify the transition to the design phase of ICM by grouping all requirements related to a single function. For example, the designer for the *Data Collection and Processing* function will need to know what systems to interface to, what data elements are involved, what computer hardware is needed to store collected data, and what functions are needed to collect and process the data.

Each requirement is coded with the following general schema: $XN.N_1.N_2.N_3.N_4. \ldots$, where X can be D (data), I (Interface), F (Functional), P (Performance), S (Security), or C (Constraint); N can take on numerical values ranging from 1 through 17 corresponding to each of the 17 functional areas/user needs of the same number; Subsequent classification levels indicated by decimal points and following numbers ($.N_1$, $.N_2$, $.N_3$, $.N_4$, etc.) indicate parent-child relationships among requirements.

3.8.1 ICMS Configuration Data Storage

ICMS configuration data will be provided by a combination of existing modal databases and new configuration database tables containing I-15 corridor-specific information. Modal databases exist for ATMS 2005 (freeway), RTMS (Metropolitan Transit System (MTS) and North County Transit District (NCTD) transit), and RAMS (certain elements of arterials). Configuration data is needed, for example, for response plan processing, for data processing algorithms, to initialize certain ICMS functions and to track various static corridor metrics such as highway capacities and transit capacities. The data will be stored in a relational database instance and managed (created, modified, deleted) through a database management application. This application will be similar to the Browse-Edit application in ATMS 2005.

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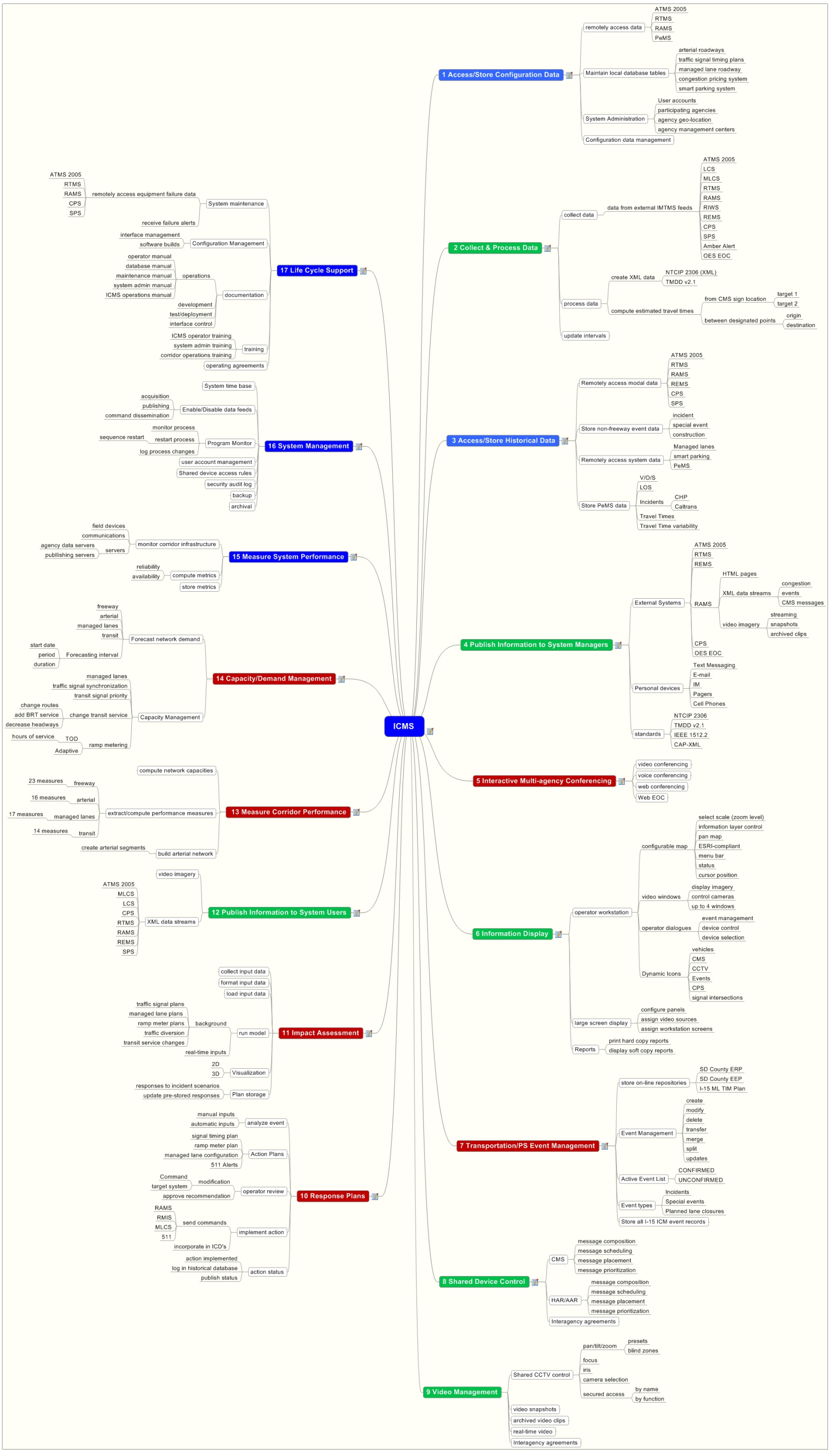

Figure 3-2. ICMS Requirements Overview

ID	Description	Subsystem Allocation	ConOps Trace
D1.1	The ICMS shall remotely access external configuration data from IMTMS subsystems (ATMS 2005, RTMS, RAMS)	System Services	User Need 1
D1.1.1	The ICMS shall remotely access configuration data (loop, vehicle detection stations (VDS), ramp, CMS, closed-circuit television (CCTV), monitor from ATMS 2005)	System Services	User Need 1
D1.1.2	The ICMS shall remotely access configuration data from RTMS	System Services	User Need 1
D1.1.3	The ICMS shall remotely access configuration data (intersection, controller, timing plan) from the RAMS regional server	System Services	User Need 1
D1.1.4	The ICMS shall remotely access I-15 congestion pricing tolling zone controller configuration data (tolling zone controller ID, tolling zone controller location)	System Services	User Need 1
D1.1.5	The ICMS shall remotely access configuration data (detector stations, incident segments, travel time segments) from the PeMS system	System Services	User Need 1
D1.2	The ICMS shall maintain database tables for configuration data (arterial roadway characteristics, traffic signal timing plans, managed lane roadway characteristics, congestion pricing system characteristics, smart parking facilities)	System Services	User Need 1
D1.2.1	The ICMS shall maintain a database table for arterial roadway characteristics containing agency name, agency ID, street name, link boundaries (start intersection, end intersection), crossing intersections, speed limit, number of lanes per link	System Services	User Need 1
D1.2.2	The ICMS shall maintain a database table for pre-determined traffic signal timing plans (jurisdiction, intersection ID, timing plan ID, I-15 incident segment start position, I-15 incident segment end position, time of day)	System Services	User Need 1
D1.2.3	The ICMS shall maintain a database table for managed lanes roadway characteristics containing entrance points, exit points, direct access ramp points, lane type (fixed, configurable), speed limit	System Services	User Need 1
D1.2.4	The ICMS shall maintain a database table for Congestion Pricing System characteristics containing tolling zone locations, toll transaction controller locations, variable toll message sign locations, variable message sign locations	System Services	User Need 1
D1.2.5	The ICMS shall maintain a database table for Smart Parking System facilities containing facility ID, facility name, capacity, operating hours, operating days, location, access points	System Services	User Need 1
D1.3	The ICMS shall maintain database tables for system administration data (user accounts, participating agency, participating agency location, participating agency management system facility)	System Services	User Need 1
D1.3.1	The ICMS shall provide a database table for user account information (username, password, first name, middle initial, last name, organization ID, location ID, office telephone number, mobile telephone number, e-mail address, fax number, pager number)	System Services	User Need 1

ID	Description	Subsystem Allocation	ConOps Trace
D1.3.2	The ICMS shall provide a database table for participating agency information (title, short name, organization ID, primary contact name, address, phone, fax, e-mail, jurisdictional boundary information)	System Services	User Need 1
D1.3.3	The ICMS shall provide a database table for participating agency location information (organization ID, location ID, street address, city, county, state, zip9, primary phone #, fax #, latitude and longitude)	System Services	User Need 1
D1.3.4	The ICMS shall provide a database table for participating agency modal management facility information (system name, short name, location ID, street address, city, county, state, zip9, primary phone #, fax #, latitude and longitude)	System Services	User Need 1
	ICMS		
D1.5	The ICMS shall provide a database application to create, edit, and delete system configuration tables	System Services	User Need 1

3.8.2 Data Collection and Processing

Data will be collected continuously drom deployed modal management systems, including those listed below. Relative to the operational start date for the ICM demonstration, which is currently scheduled for the fall of 2010, the following dates apply (see Section 2.7.6, Table 2-5 for the complete list of scheduled deployment dates).

- ATMS 2005 (currently operational)
- Managed Lanes Control System (Middle Segment of I-15 Managed Lanes will be operational by January 2009)
- Lane Closure System (currently operational)
- Regional Transit Management System (currently operational)
- Regional Arterial Management System (fully operational by March 2009)
- Regional Event Management System (currently existing as California Highway Patrol)
- Congestion Pricing System (on Middle Segment of I-15 Managed Lanes will be operational by January 2009)
- Smart Parking System (initial deployment on I-5 scheduled for summer 2008; framework for system regional extensibility completed by spring 2010)
- Manual data from Regional Integrated Workstation (currently has completed acceptance testing; scheduled deployment in 2009)

Data processing is currently accomplished by IMTMS or the region's modal management systems. For example, IMTMS converts proprietary host data formats to standard XML schema using agency data servers, and ATMS 2005 computes travel times from designated CMS locations for up to two target destinations per sign. This data will be available to the ICMS through the data collection function. However the ICMS will require additional data processing to calculate metrics such as corridor capacity and excess corridor capacity in the aggregate and by mode, non-freeway travel times, etc. and to filter data according to a variety of parameters such as type and source.

ID	Description	Subsystem Allocation	ConOps Trace
I2.1	The ICMS shall acquire information (freeway, ramp meter, lane closure, managed lanes, transit, arterial, incident, congestion pricing, parking) through connected IMTMS external data feeds as indicated in Figure 2-1	IMTMS	User Need 2
I2.1.1	The ICMS shall acquire freeway traffic information (congestion, event, CMS, video imagery) from ATMS 2005	IMTMS	User Need 2
I2.1.1.1	The ICMS shall acquire freeway congestion data (volume, occupancy, speed) from ATMS 2005	IMTMS	User Need 2
I2.1.1.2	The ICMS shall acquire freeway event data (type, location, start time, estimated duration, status, and impact) from ATMS 2005	IMTMS	User Need 2
I2.1.1.2.1	The ICMS shall acquire event type (incident, special event, emergency closure, planned lane closure) data from ATMS 2005	IMTMS	User Need 2
I2.1.1.2.2	The ICMS shall acquire event location from ATMS 2005	IMTMS	User Need 2
I2.1.1.2.3	The ICMS shall acquire event start time from ATMS 2005	IMTMS	User Need 2
I2.1.1.2.4	The ICMS shall acquire estimated event duration from ATMS 2005	IMTMS	User Need 2
I2.1.1.2.5	The ICMS shall acquire event status (confirmed, unconfirmed) data from ATMS 2005	IMTMS	User Need 2
I2.1.1.2.6	The ICMS shall acquire event impact (high, medium, low) data from ATMS 2005	IMTMS	User Need 2
I2.1.1.3	The ICMS shall acquire freeway CMS data (status, displayed message) from ATMS 2005	IMTMS	User Need 2
I2.1.1.4	The ICMS shall acquire freeway video imagery (streaming video, archived clips, snapshots) from ATMS 2005	IMTMS	User Need 2
I2.1.2	The ICMS shall acquire freeway ramp meter data (location, status, volume, occupancy) from ATMS 2005	IMTMS	User Need 2
I2.1.3	The ICMS shall acquire freeway lane closure information (freeway ID, travel direction, time, location, and impact) from the Lane Closure System (LCS)	IMTMS	User Need 2
I2.1.3.1	The ICMS shall acquire freeway lane closure time data (planned start time, actual start time, planned end time, actual end time) data from LCS	IMTMS	User Need 2
I2.1.3.2	The ICMS shall acquire freeway lane closure lane location data (lanes affected, start location, end location) from LCS	IMTMS	User Need 2
I2.1.3.3	The ICMS shall acquire freeway impact data (road closure, road detour) from LCS	IMTMS	User Need 2
I2.1.4	The ICMS shall acquire managed lanes information (lane and time) from the Managed Lane Control System (MLCS)	IMTMS	User Need 2
I2.1.4.1	The ICMS shall acquire lane data (lane configuration, number of open lanes, direction of each lane) from the MLCS	IMTMS	User Need 2
I2.1.4.2	The ICMS shall acquire time data (planned configuration time and actual configuration time) from the MLCS	IMTMS	User Need 2

ID	Description	Subsystem Allocation	ConOps Trace
I2.1.5	The ICMS shall acquire transit data (bus location, time, route/stop, and event) from the Regional Transit Management System (RTMS)	IMTMS	User Need 2
I2.1.5.1	The ICMS shall acquire bus location (bus ID, route ID, block ID, time, latitude/longitude) data from RTMS	IMTMS	User Need 2
I2.1.5.2	The ICMS shall acquire time data (published time points, actual arrival times, status) from RTMS	IMTMS	User Need 2
I2.1.5.3	The ICMS shall acquire bus status (on time, ahead of published schedule, behind published schedule) from RTMS	IMTMS	User Need 2
I2.1.5.4	The ICMS shall acquire route shape file data from RTMS	IMTMS	User Need 2
I2.1.5.5	The ICMS shall acquire event data (type, location, start time) from RTMS	IMTMS	User Need 2
I2.1.6	The ICMS shall acquire arterial data (intersection status, alarms, congestion, travel time, and video imagery) from the Regional Arterial Management System (RAMS)	IMTMS	User Need 2
I2.1.6.1	The ICMS shall acquire intersection controller status data from corridor agencies (Escondido, Poway, San Diego, and Caltrans) from RAMS	IMTMS	User Need 2
I2.1.6.1.1	The ICMS shall acquire Escondido intersection controller status data (active phase, timing plan) from RAMS	IMTMS	User Need 2
I2.1.6.1.2	The ICMS shall acquire Poway intersection controller status data (active phase, timing plan) from RAMS	IMTMS	User Need 2
I2.1.6.1.3	The ICMS shall acquire San Diego intersection controller status data (active phase, timing plan) from RAMS	IMTMS	User Need 2
I2.1.6.1.4	The ICMS shall acquire Caltrans intersection controller status data (active phase, timing plan) from RAMS	IMTMS	User Need 2
I2.1.6.2	The ICMS shall acquire intersection controller alarm data from corridor agencies (Escondido, Poway, San Diego, and Caltrans) from RAMS	IMTMS	User Need 2
I2.1.6.2.1	The ICMS shall acquire Escondido intersection controller alarm data from RAMS	IMTMS	User Need 2
I2.1.6.2.2	The ICMS shall acquire Poway intersection controller alarm data from RAMS	IMTMS	User Need 2
I2.1.6.2.3	The ICMS shall acquire San Diego signal controller alarm data from RAMS	IMTMS	User Need 2
I2.1.6.2.4	The ICMS shall acquire Caltrans signal controller alarm data from RAMS	IMTMS	User Need 2
I2.1.6.3	The ICMS shall acquire congestion data from corridor agencies (Escondido, Poway, San Diego, and Caltrans) from RAMS	IMTMS	User Need 2
I2.1.6.3.1	The ICMS shall acquire Escondido congestion data (volume, occupancy, speed) from RAMS	IMTMS	User Need 2
I2.1.6.3.1.1	The ICMS shall acquire Escondido volume data (link ID, direction of travel, time) from RAMS	IMTMS	User Need 2
I2.1.6.3.1.2	The ICMS shall acquire Escondido occupancy data (link ID, direction of travel, time) from RAMS	IMTMS	User Need 2

ID	Description	Subsystem Allocation	ConOps Trace
I2.1.6.3.1.3	The ICMS shall acquire Escondido speed data (link ID, direction of travel, time) from RAMS	IMTMS	User Need 2
I2.1.6.3.2	The ICMS shall acquire Poway congestion data (volume, occupancy, speed) from RAMS	IMTMS	User Need 2
I2.1.6.3.2.1	The ICMS shall acquire Poway volume data (link ID, direction of travel, time) from RAMS	IMTMS	User Need 2
I2.1.6.3.2.2	The ICMS shall acquire Poway occupancy data (link ID, direction of travel, time) from RAMS	IMTMS	User Need 2
I2.1.6.3.2.3	The ICMS shall acquire Poway speed data (link ID, direction of travel, time) from RAMS	IMTMS	User Need 2
I2.1.6.3.3	The ICMS shall acquire San Diego congestion data (volume, occupancy, speed) from RAMS	IMTMS	User Need 2
I2.1.6.3.3.1	The ICMS shall acquire San Diego volume data (link ID, direction of travel, time) from RAMS	IMTMS	User Need 2
I2.1.6.3.3.2	The ICMS shall acquire San Diego occupancy data (link ID, direction of travel, time) from RAMS	IMTMS	User Need 2
I2.1.6.3.3.3	The ICMS shall acquire San Diego speed data (link ID, direction of travel, time) from RAMS	IMTMS	User Need 2
I2.1.6.4	The ICMS shall acquire travel time data from corridor agencies (Escondido, Poway, San Diego, and Caltrans) from RAMS	IMTMS	User Need 2
I2.1.6.4.1	The ICMS shall acquire Escondido travel time data (segment ID, direction of travel, time) from RAMS	IMTMS	User Need 2
I2.1.6.4.2	The ICMS shall acquire Poway travel time data (segment ID, direction of travel, time) from RAMS	IMTMS	User Need 2
I2.1.6.4.3	The ICMS shall acquire San Diego travel time data (segment ID, direction of travel, time) from RAMS	IMTMS	User Need 2
I2.1.6.5	The ICMS shall acquire arterial video imagery data (streaming video, archived video clips, video snapshots) from RAMS	IMTMS	User Need 2
I2.1.7	The ICMS shall acquire arterial event data (type, location, start-time, stop-time, and status) from the Regional Integrated Workstation (RIWS)	IMTMS	User Need 2
I2.1.8	The ICMS shall acquire arterial incident data (time, location type, status update) from the Regional Event Management System (REMS)	IMTMS	User Need 2
I2.1.8.1	The ICMS shall acquire incident time data from the REMS	IMTMS	User Need 2
I2.1.8.2	The ICMS shall acquire incident location data from the REMS	IMTMS	User Need 2
I2.1.8.3	The ICMS shall acquire incident type data from the REMS	IMTMS	User Need 2
I2.1.8.4	The ICMS shall acquire incident status update data from the REMS	IMTMS	User Need 2
I2.1.9	The ICMS shall acquire congestion pricing system data (dynamic pricing, managed lanes congestion)	IMTMS	User Need 2

ID	Description	Subsystem Allocation	ConOps Trace
I2.1.9.1	The ICMS shall acquire dynamic pricing data (tolling zone ID, tolling zone price, direction of travel, time) from the FasTrak® Congestion Pricing System (CPS)	IMTMS	User Need 2
I2.1.9.2	The ICMS shall acquire managed lane congestion data (volume, speed, classification) from the FasTrak® CPS	IMTMS	User Need 2
I2.1.10	The ICMS shall acquire parking-related information (facility ID, facility location, facility access, available parking spaces) from the Smart Parking System (SPS)	IMTMS	User Need 2
I2.1.11	The ICMS shall acquire Amber Alert information from the CHP CAD	IMTMS	User Need 2
I2.1.12	The ICMS shall acquire wide area alert information (severe weather, fires, floods, earthquakes) from the SD County Office of Emergency Services (OES) Emergency Operations Center (EOC)	IMTMS	User Need 2
F2.2	The ICMS shall convert legacy subsystem data (ATMS 2005, MLCS, RTMS, RAMS, REMS, CPS, SPS) into XML schema using NTCIP 2306 and TMDD v2.1 for ICMS dissemination	IMTMS	User Need 2
F2.3	The ICMS shall compute estimated travel times from an operator-selected CMS location (freeway, arterial) for up to two destination points for each sign	IMTMS	User Need 2
F2.4	The ICMS shall compute estimated travel times between any two operator-selected locations on a corridor roadway (freeway, arterial)	IMTMS	User Need 2
P2.5	The ICMS shall acquire IMTMS subsystem data (ATMS 2005, CPS, MLCS, RTMS, RAMS, REMS, SPS) within specified intervals	IMTMS	User Need 2
P2.5.1	The ICMS shall acquire ATMS 2005 data (congestion, events, CMS, CCTV) within intervals specified for IMTMS	IMTMS	User Need 2
P2.5.1.1	The ICMS shall acquire ATMS 2005 congestion data (volume, occupancy, speed) within an interval not to exceed one minute	IMTMS	User Need 2
P2.5.1.2	The ICMS shall acquire ATMS 2005 initial event data within one minute of the ATMS operator's acquisition of the data	IMTMS	User Need 2
P2.5.1.3	The ICMS shall acquire ATMS 2005 event updates within one minute of the ATMS operator's update of the data	IMTMS	User Need 2
P2.5.1.4	The ICMS shall acquire ATMS CMS data within the interval specified for IMTMS	IMTMS	User Need 2
P2.5.1.5	The ICMS shall acquire ATMS CCTV data within one minute of a change in CMS state (new message, communications link status)	IMTMS	User Need 2
P2.5.2	The ICMS shall acquire CPS data (tolling zone dynamic pricing) within one minute of the last CPS update cycle	IMTMS	User Need 2
P2.5.3	The ICMS shall acquire MLCS data (lane configuration) within one minute of a change in configuration	IMTMS	User Need 2
P2.5.4	The ICMS shall acquire RTMS data (bus location, route ID, block ID, schedule adherence, event) within specified update cycles	IMTMS	User Need 2

ID	Description	Subsystem Allocation	ConOps Trace
P2.5.4.1	The ICMS shall acquire RTMS bus location data within one minute of an RTMS update	IMTMS	User Need 2
P2.5.4.2	The ICMS shall acquire RTMS route ID within one minute of an RTMS update	IMTMS	User Need 2
P2.5.4.3	The ICMS shall acquire RTMS Block ID within one minute of an RTMS update	IMTMS	User Need 2
P2.5.4.4	The ICMS shall acquire RTMS schedule adherence within one minute of an RTMS update	IMTMS	User Need 2
P2.5.4.5	The ICMS shall acquire RTMS event data within one minute of an RTMS update	IMTMS	User Need 2
P2.5.5	The ICMS shall acquire RAMS data (controller phase, timing plan, controller alarm) within one minute of a controller update	IMTMS	User Need 2
P2.5.6	The ICMS shall acquire REMS data (event ID, event type, event location, event time, event impact, event updates) within one minute of a REMS update	IMTMS	User Need 2
P2.5.7	The ICMS shall acquire SPS data (parking facility ID, #spaces free) within five minutes of a change in facility parking availability	IMTMS	User Need 2

3.8.3 ICMS Historical Data Storage

Data collected by ICMS and IMTMS subsystems is generally held in legacy databases for various uses. For example, the ATMS 2005 system maintains an instance of an Oracle database for historical archiving. This Oracle instance stores real-time data every data cycle and executes database routines to aggregate the real-time data into longer time periods.

Online data is stored for approximately 13 months for reporting purposes. A reports function uses the historical database and various pre-stored database procedures to display traffic congestion, operational events, and system failures across user-selectable time periods. Likewise, the RTMS transit application stores real-time bus location, schedule adherence, and event data to produce ad-hoc reports using a third-party report-creation application.

The QuicNet 4 traffic signal control system maintains a reporting function for real-time and historical intersection data, including alarms, events (timing plan changes, emergency preemption), and traffic count data. The California Performance Measurement System (PeMS) currently collects real-time data from all Caltrans districts in the state and makes a variety of configurable reports available by district and by highway.

For I-15 corridor purposes, this data must be shaped and tailored to the I-15 corridor boundaries. The ICMS will have the capability to access these reporting mechanisms as an external client. *ICMS will not maintain a separate historical database for existing corridor modal data*; however, the ICMS will maintain a historical database for corridorwide data or for modal data specific to corridor operations.

ID	Description	Subsystem Allocation	ConOps Trace
D3.1	The ICMS shall provide a non-redundant data store for real-time and historical information about the I-15 corridor	System Services	User Need 3

ID	Description	Subsystem Allocation	ConOps Trace
D3.1.1	The ICMS shall provide a non-redundant data store for real-time (most current data cycle) information for the I-15 corridor	System Services	User Need 3
D3.1.2	The ICMS shall provide a non-redundant data store for historical (aggregated) information for the I-15 corridor	System Services	User Need 3
D3.2	The ICMS shall remotely access external historical inventory data from IMTMS subsystems (ATMS 2005, RTMS, RAMS, REMS, CPS, SPS)	System Services	User Need 3
D3.2.1	The ICMS shall remotely access historical data from ATMS 2005 (congestion, CMS, event, equipment failures)	System Services	User Need 3
D3.2.1.1	The ICMS shall remotely access historical congestion data (volume, occupancy, speed) from ATMS 2005	System Services	User Need 3
D3.2.1.2	The ICMS shall remotely access historical CMS event data (CMS ID, start time, end time, message text) from ATMS 2005	System Services	User Need 3
D3.2.1.3	The ICMS shall remotely access historical event data (type, location, time, duration, impact, lane blockage, # vehicles, # injuries, # fatalities, details) from ATMS 2005	System Services	User Need 3
D3.2.1.4	The ICMS shall remotely access historical equipment failure data (equipment ID, equipment type, location, time failed, time in service)	System Services	User Need 3
D.3.2.2	The ICMS shall remotely access historical data (schedule adherence, incidents, passenger counts) from RTMS	System Services	User Need 3
D3.2.2.1	The ICMS shall remotely access historical schedule adherence inventory data (route ID, stop ID, schedule deviation (minutes), time) from RTMS	System Services	User Need 3
D3.2.2.2	The ICMS shall remotely access historical incident inventory data (incident type, incident location, time, date, #vehicles, #injuries, #fatalities, incident text, route ID, block ID) from RTMS	System Services	User Need 3
D3.2.2.2.1	The ICMS shall remotely access historical incident type inventory data (emergency alarm, driver involved traffic accident, driver observed traffic accident, crime in progress) from RTMS	System Services	User Need 3
D3.2.2.3	The ICMS shall remotely access historical passenger count inventory data (route ID, block ID, stop ID, passenger count, time, date) from RTMS	System Services	User Need 3
D3.2.3	The ICMS shall remotely access historical data (controller alarms, controller events, congestion) from the RAMS regional server	System Services	User Need 3
D3.2.3.1	The ICMS shall remotely access historical controller alarm inventory data (alarm type, intersection ID, controller ID, time, date) from the RAMS regional server	System Services	User Need 3
D3.2.3.2	The ICMS shall remotely access historical controller event inventory data (event type, intersection ID, controller ID, time date) from the RAMS regional server	System Services	User Need 3

ID	Description	Subsystem Allocation	ConOps Trace
D3.2.3.3	The ICMS shall remotely access historical congestion inventory data (intersection ID, direction of travel, controller ID, volume, occupancy, speed) from the RAMS regional server	System Services	User Need 3
D3.2.3.4	The ICMS shall remotely access historical link congestion inventory data (link ID, direction of travel, volume, occupancy, speed) from the RAMS regional server	System Services	User Need 3
D3.2.4	The ICMS shall maintain a non-freeway event (incident, special event, construction) database table	System Services	User Need 3
D3.2.4.1	The ICMS shall maintain non-freeway incident database table (originator's incident ID, incident type, location, time, reporting system, reporting agency)	System Services	User Need 3
D3.2.4.2	The ICMS shall maintain non-freeway special event database table (originator's event ID, special event description, planned start time, planned end time, actual start time, actual end time, roadways impacted)	System Services	User Need 3
D3.2.4.2.1	The ICMS shall maintain non-freeway special event data for impacted roadways (roadway ID, planned start position, planned end position, actual start position, actual end position)	System Services	User Need 3
D3.2.4.3	The ICMS shall maintain non-freeway construction database table (originator's event ID, construction description, planned start time, planned end time, actual start time, actual end time, roadways impacted)	System Services	User Need 3
D3.2.4.3.1	The ICMS shall maintain non-freeway construction data for impacted roadways (roadway ID, planned start position, planned end position, actual start position, actual end position)	System Services	User Need 3
D3.2.5	The ICMS shall remotely access managed lane historical data (lane performance, congestion pricing, barrier operations, equipment records, violations)	System Services	User Need 3
D3.2.5.1	The ICMS shall remotely access managed lane performance historical data (level of service, vehicle counts, average vehicle speed, calculated vehicle density) for every tolling zone in the I-15 Managed Lanes	System Services	User Need 3
D3.2.5.2	The ICMS shall remotely access congestion pricing historical data (entry point ID, time, direction of travel, charging rate, minimum charge, maximum charge)	System Services	User Need 3
D3.2.5.3	The ICMS shall remotely access barrier operations historical data (tolling zone ID, barrier change date/time, barrier position, traffic direction by lane)	System Services	User Need 3
D3.2.5.4	The ICMS shall remotely access managed lane equipment data (barrier transfer machines, overhead vehicle sensors, variable toll message signs, variable message signs, tolling zone controllers, variable sign controllers, toll transaction computers, electronic toll collection readers, 802.11 wireless transmitters)	System Services	User Need 3
D3.2.5.5	The ICMS shall remotely access congestion pricing historical violation data (tolling zone ID, lane ID, direction of travel)	System Services	User Need 3

ID	Description	Subsystem Allocation	ConOps Trace
D3.2.6	The ICMS shall remotely access smart parking usage data (facility ID, time, parking usage in percentage)	System Services	User Need 3
D3.2.7	The ICMS shall remotely access historical PeMS data (vehicle volume, occupance, and speed (VOS), level of service, CHP incidents, Caltrans Incidents, travel times, travel time variability) on demand	System Services	User Need 3
D3.2.7.1	The ICMS shall remotely access historical PeMS vehicle volumes (freeway direction, detector ID) on demand	System Services	User Need 3
D3.2.7.2	The ICMS shall remotely access historical PeMS vehicle occupancy (freeway direction, detector ID) on demand	System Services	User Need 3
D3.2.7.3	The ICMS shall remotely access historical PeMS vehicle speeds (freeway direction, detector ID) on demand	System Services	User Need 3
D3.2.7.4	The ICMS shall remotely access historical PeMS level of service (freeway direction, starting milepost, ending milepost) on demand	System Services	User Need 3
D3.2.7.5	The ICMS shall remotely access historical PeMS CHP incidents (type, location, starting time, incident details) on demand	System Services	User Need 3
D3.2.7.6	The ICMS shall remotely access historical PeMS Caltrans incidents (freeway ID, freeway direction, incident type, location, time of day) on demand	System Services	User Need 3
D3.2.7.7	The ICMS shall remotely access historical PeMS travel times (freeway direction, starting milepost, ending milepost, time of day) on demand	System Services	User Need 3
D3.2.7.8	The ICMS shall remotely access historical PeMS travel time variability (freeway direction, starting milepost, ending milepost, time of day) on demand	System Services	User Need 3
D3.2.8	The ICMS shall maintain a local data store of PeMS data (vehicle VOS, level of service, CHP incidents, Caltrans Incidents, travel times, travel time variability) localized for the I-15 corridor	System Services	User Need 3
D3.2.8.1	The ICMS shall maintain a local data store of PeMS vehicle volumes (freeway direction, detector ID) localized for the I-15 corridor	System Services	User Need 3
D3.2.8.2	The ICMS shall maintain a local data store of PeMS vehicle occupancy (freeway direction, detector ID) localized for the I-15 corridor	System Services	User Need 3
D3.2.8.3	The ICMS shall maintain a local data store of PeMS vehicle speeds (freeway direction, detector ID) localized for the I-15 corridor	System Services	User Need 3
D3.2.8.4	The ICMS shall maintain a local data store of PeMS level of service (freeway direction, starting milepost, ending milepost) localized for the I-15 corridor	System Services	User Need 3
D3.2.8.5	The ICMS shall maintain a local data store of PeMS CHP incidents (type, location, starting time, incident details) localized for the I-15 corridor	System Services	User Need 3
D3.2.8.6	The ICMS shall maintain a local data store of PeMS Caltrans incidents (freeway ID, freeway direction, incident type, location, time of day) localized for the I-15 corridor	System Services	User Need 3

ID	Description	Subsystem Allocation	ConOps Trace
D3.2.8.7	The ICMS shall maintain a local data store of PeMS travel times (freeway direction, starting milepost, ending mile-post, time of day) localized for the I-15 corridor	System Services	User Need 3
D3.2.8.8	The ICMS shall maintain a local data store of PeMS travel time variability (freeway direction, starting milepost, ending milepost, time of day) localized for the I-15 corridor	System Services	User Need 3

3.8.4 Information Publishing (Corridor Managers)

Processed data will be available to all participating agencies through a regional data distribution mechanism. Participating agencies will include traffic, transit, public safety, and emergency management. Data will be shared using HTML and XML data formats. HTML data will be viewable through standard PC-based browsers, such as Internet Explorer and Mozilla Firefox. XML data will be provided for third-party applications. An XML data schema will be maintained along with XML data integration guidelines for potential application developers. In addition, information publishing will support agency personnel notification systems such as pagers, e-mail, Fax, text messaging, and instant messaging. In this manner information publishing to corridor managers differs from information publishing to corridor users, where personalized alerts and travel information are provided as revenue services by the regional 511 ISP.

ID	Description	Subsystem Allocation	ConOps Trace
I4.1	The ICMS shall disseminate information to regional modal management systems (ATMS 2005, RTMS, REMS, RAMS, CPS, SD County OES)	IMTMS	User Need 4
I4.1.1	The ICMS shall disseminate data (video imagery, arterial congestion, arterial CMS, arterial events, transit events, bus location) to ATMS 2005	IMTMS	User Need 4
I4.1.1.1	The ICMS shall disseminate video imagery (arterial, transit) to ATMS 2005	IMTMS	User Need 4
I4.1.1.1.1	The ICMS shall disseminate arterial video imagery (streaming video, archived video clips, snapshots) to ATMS 2005	IMTMS	User Need 4
I4.1.1.1.2	The ICMS shall disseminate transit video imagery (streaming video, archived video clips, snapshots) to ATMS 2005	IMTMS	User Need 4
I4.1.1.2	The ICMS shall disseminate arterial congestion data (volume, occupancy, speed) to ATMS 2005	IMTMS	User Need 4
I4.1.1.3	The ICMS shall disseminate arterial CMS data (sign location, message displayed, time displayed) to ATMS 2005	IMTMS	User Need 4
I4.1.1.4	The ICMS shall disseminate event data (arterial, transit) to ATMS 2005	IMTMS	User Need 4
I4.1.1.4.1	The ICMS shall disseminate arterial event data (event type, location, time, lanes blocked, #vehicles, #injuries, #fatalities, duration, impact) to ATMS 2005	IMTMS	User Need 4

ID	Description	Subsystem Allocation	ConOps Trace
I4.1.1.4.2	The ICMS shall disseminate transit event data (emergency alarm, traffic incident – driver, traffic incident – observed, crime in progress) to ATMS 2005	IMTMS	User Need 4
I4.1.1.5	The ICMS shall disseminate transit bus location data (bus ID, driver ID, block ID, route ID, schedule adherence, latitude/longitude) to ATMS 2005	IMTMS	User Need 4
I4.1.2	The ICMS shall disseminate data (video imagery, congestion, CMS, freeway events, arterial events) to RTMS	IMTMS	User Need 4
I4.1.2.1	The ICMS shall disseminate video imagery (freeway, arterial) to RTMS	IMTMS	User Need 4
I4.1.2.1.1	The ICMS shall disseminate freeway video imagery (streaming video, archived video clips, snapshots) to RTMS	IMTMS	User Need 4
I4.1.2.1.2	The ICMS shall disseminate arterial video imagery (streaming video, archived video clips, snapshots) to RTMS	IMTMS	User Need 4
I4.1.2.2	The ICMS shall disseminate congestion data (freeway, arterial) to RTMS	IMTMS	User Need 4
I4.1.2.2.1	The ICMS shall disseminate freeway congestion data (volume, occupancy, speed) to RTMS	IMTMS	User Need 4
I4.1.2.2.2	The ICMS shall disseminate arterial congestion data (volume, occupancy, speed) to RTMS	IMTMS	User Need 4
I4.1.2.3	The ICMS shall disseminate CMS data (freeway, arterial) to RTMS	IMTMS	User Need 4
I4.1.2.3.1	The ICMS shall disseminate freeway CMS data (sign location, message displayed, time displayed) to RTMS	IMTMS	User Need 4
I4.1.2.3.2	The ICMS shall disseminate arterial CMS data (sign location, message displayed, time displayed) to RTMS	IMTMS	User Need 4
I4.1.2.4	The ICMS shall disseminate event data (freeway, arterial) to RTMS	IMTMS	User Need 4
I4.1.2.4.1	The ICMS shall disseminate freeway event data (event type, location, time, lanes blocked, #vehicles, #injuries, #fatalities, duration, impact) to RTMS	IMTMS	User Need 4
I4.1.2.4.2	The ICMS shall disseminate arterial event data (event type, location, time, lanes blocked, #vehicles, #injuries, #fatalities, duration, impact) to RTMS	IMTMS	User Need 4
I4.1.3	The ICMS shall disseminate data (video imagery, congestion, CMS, freeway events, arterial events, transit events, bus location) to REMS	IMTMS	User Need 4
I4.1.3.1	The ICMS shall disseminate video imagery (freeway, arterial, transit) to REMS	IMTMS	User Need 4
I4.1.3.1.1	The ICMS shall disseminate freeway video imagery (streaming video, archived video clips, snapshots) to REMS	IMTMS	User Need 4

ID	Description	Subsystem Allocation	ConOps Trace
I4.1.3.1.2	The ICMS shall disseminate arterial video imagery (streaming video, archived video clips, snapshots) to REMS	IMTMS	User Need 4
I4.1.3.1.3	The ICMS shall disseminate transit video imagery (streaming video, archived video clips, snapshots) to REMS	IMTMS	User Need 4
I4.1.3.2	The ICMS shall disseminate roadway congestion data (freeway, arterial) to REMS	IMTMS	User Need 4
I4.1.3.2.1	The ICMS shall disseminate freeway congestion data (volume, occupancy, speed) to REMS	IMTMS	User Need 4
I4.1.3.2.2	The ICMS shall disseminate arterial congestion data (volume, occupancy, speed) to REMS	IMTMS	User Need 4
I4.1.3.3	The ICMS shall disseminate CMS data (sign location, message displayed, time displayed) to REMS	IMTMS	User Need 4
I4.1.3.3.1	The ICMS shall disseminate freeway CMS data (sign location, message displayed, time displayed) to REMS	IMTMS	User Need 4
I4.1.3.3.2	The ICMS shall disseminate arterial CMS data (sign location, message displayed, time displayed) to REMS	IMTMS	User Need 4
I4.1.3.4	The ICMS shall disseminate event data (freeway, arterial, transit) to REMS	IMTMS	User Need 4
I4.1.3.4.1	The ICMS shall disseminate freeway event data (event type, location, time, lanes blocked, #vehicles, #injuries, #fatalities, duration, impact) to REMS	IMTMS	User Need 4
I4.1.3.4.2	The ICMS shall disseminate arterial event data (event type, location, time, lanes blocked, #vehicles, #injuries, #fatalities, duration, impact) to REMS	IMTMS	User Need 4
I4.1.3.4.3	The ICMS shall disseminate transit event data (emergency alarm, traffic incident – driver, traffic incident – observed, crime in progress) to REMS	IMTMS	User Need 4
I4.1.3.5	The ICMS shall disseminate transit bus location data (bus ID, driver ID, block ID, route ID, schedule adherence, latitude/longitude) to REMS	IMTMS	User Need 4
I4.1.4	The ICMS shall disseminate data (video imagery, congestion, CMS, freeway events, arterial events, transit events, bus location) to RAMS	IMTMS	User Need 4
I4.1.4.1	The ICMS shall disseminate video imagery (freeway, arterial, transit) to RAMS	IMTMS	User Need 4
I4.1.4.1.1	The ICMS shall disseminate freeway video imagery (streaming video, archived video clips, snapshots) to RAMS	IMTMS	User Need 4
I4.1.4.1.2	The ICMS shall disseminate arterial video imagery (streaming video, archived video clips, snapshots) to RAMS	IMTMS	User Need 4
I4.1.4.1.3	The ICMS shall disseminate transit video imagery (streaming video, archived video clips, snapshots) to RAMS	IMTMS	User Need 4

ID	Description	Subsystem Allocation	ConOps Trace
I4.1.4.2	The ICMS shall disseminate roadway congestion data (freeway, arterial) to RAMS	IMTMS	User Need 4
I4.1.4.2.1	The ICMS shall disseminate freeway congestion data (volume, occupancy, speed) to RAMS	IMTMS	User Need 4
I4.1.4.2.2	The ICMS shall disseminate arterial congestion data (volume, occupancy, speed) to RAMS	IMTMS	User Need 4
I4.1.4.3	The ICMS shall disseminate CMS data (sign location, message displayed, time displayed) to RAMS	IMTMS	User Need 4
I4.1.4.3.1	The ICMS shall disseminate freeway CMS data (sign location, message displayed, time displayed) to RAMS	IMTMS	User Need 4
I4.1.4.3.2	The ICMS shall disseminate arterial CMS data (sign location, message displayed, time displayed) to RAMS	IMTMS	User Need 4
I4.1.4.4	The ICMS shall disseminate event data (freeway, arterial, transit) to RAMS	IMTMS	User Need 4
I4.1.4.4.1	The ICMS shall disseminate freeway event data (event type, location, time, lanes blocked, #vehicles, #injuries, #fatalities, duration, impact) to RAMS	IMTMS	User Need 4
I4.1.4.4.2	The ICMS shall disseminate arterial event data (event type, location, time, lanes blocked, #vehicles, #injuries, #fatalities, duration, impact) to RAMS	IMTMS	User Need 4
I4.1.4.4.3	The ICMS shall disseminate transit event data (emergency alarm, traffic incident – driver, traffic incident – observed, crime in progress) to RAMS	IMTMS	User Need 4
I4.1.4.5	The ICMS shall disseminate transit bus location data (bus ID, driver ID, block ID, route ID, schedule adherence, latitude/longitude) to RAMS	IMTMS	User Need 4
I4.1.5	The ICMS shall disseminate data (video imagery, congestion, CMS, freeway events, transit events, bus location) to CPS	IMTMS	User Need 4
I4.1.5.1	The ICMS shall disseminate video imagery (freeway, arterial, transit) to CPS	IMTMS	User Need 4
I4.1.5.1.1	The ICMS shall disseminate freeway video imagery (streaming video, archived video clips, snapshots) to CPS	IMTMS	User Need 4
I4.1.5.1.2	The ICMS shall disseminate arterial video imagery (streaming video, archived video clips, snapshots) to CPS	IMTMS	User Need 4
I4.1.5.1.3	The ICMS shall disseminate transit video imagery (streaming video, archived video clips, snapshots) to CPS	IMTMS	User Need 4
I4.1.5.2	The ICMS shall disseminate freeway congestion data (volume, occupancy, speed) to CPS	IMTMS	User Need 4
I4.1.5.3	The ICMS shall disseminate CMS data (freeway, arterial) to CPS	IMTMS	User Need 4
I4.1.5.3.1	The ICMS shall disseminate freeway CMS data (sign location, message displayed, time displayed) to CPS	IMTMS	User Need 4
I4.1.5.3.2	The ICMS shall disseminate arterial CMS data (sign location, message displayed, time displayed) to CPS	IMTMS	User Need 4

ID	Description	Subsystem Allocation	ConOps Trace
I4.1.5.4	The ICMS shall disseminate event data (freeway, arterial, transit) to CPS	IMTMS	User Need 4
I4.1.5.4.1	The ICMS shall disseminate freeway event data (event type, location, time, lanes blocked, #vehicles, #injuries, #fatalities, duration, impact) to CPS	IMTMS	User Need 4
I4.1.5.4.2	The ICMS shall disseminate arterial event data (event type, location, time, lanes blocked, #vehicles, #injuries, #fatalities, duration, impact) to CPS	IMTMS	User Need 4
I4.1.5.4.3	The ICMS shall disseminate transit event data (emergency alarm, traffic incident – driver, traffic incident – observed, crime in progress) to CPS	IMTMS	User Need 4
I4.1.5.5	The ICMS shall disseminate transit bus location data (bus ID, driver ID, block ID, route ID, schedule adherence, latitude/longitude) to CPS	IMTMS	User Need 4
I4.1.6	The ICMS shall disseminate data (video imagery, congestion, CMS, events, bus location) to the SD County OES EOC	IMTMS	User Need 4
I4.1.6.1	The ICMS shall disseminate video imagery (freeway, arterial, transit) to the SD County OES EOC	IMTMS	User Need 4
I4.1.6.1.1	The ICMS shall disseminate freeway video imagery (streaming video, archived video clips, snapshots) to the SD County OES EOC	IMTMS	User Need 4
I4.1.6.1.2	The ICMS shall disseminate arterial video imagery (streaming video, archived video clips, snapshots) to the SD County OES EOC	IMTMS	User Need 4
I4.1.6.1.3	The ICMS shall disseminate transit video imagery (streaming video, archived video clips, snapshots) to the SD County OES EOC	IMTMS	User Need 4
I4.1.6.2	The ICMS shall disseminate roadway congestion data (freeway, arterial) to the SD County OES EOC	IMTMS	User Need 4
I4.1.6.2.1	The ICMS shall disseminate freeway congestion data (volume, occupancy, speed) to the SD County OES EOC	IMTMS	User Need 4
I4.1.6.2.2	The ICMS shall disseminate arterial congestion data (volume, occupancy, speed) to the SD County OES EOC	IMTMS	User Need 4
I4.1.6.3	The ICMS shall disseminate CMS data (sign location, message displayed, time displayed) to the SD County OES EOC	IMTMS	User Need 4
I4.1.6.3.1	The ICMS shall disseminate freeway CMS data (sign location, message displayed, time displayed) to the SD County OES EOC	IMTMS	User Need 4
I4.1.6.3.2	The ICMS shall disseminate arterial CMS data (sign location, message displayed, time displayed) to the SD County OES EOC	IMTMS	User Need 4
I4.1.6.4	The ICMS shall disseminate event data (freeway, arterial, transit) to the SD County OES EOC	IMTMS	User Need 4
I4.1.6.4.1	The ICMS shall disseminate freeway event data (event type, location, time, lanes blocked, #vehicles, #injuries, #fatalities, duration, impact) to the SD County OES EOC	IMTMS	User Need 4

ID	Description	Subsystem Allocation	ConOps Trace
I4.1.6.4.2	The ICMS shall disseminate arterial event data (event type, location, time, lanes blocked, #vehicles, #injuries, #fatalities, duration, impact) to the SD County OES EOC	IMTMS	User Need 4
I4.1.6.4.3	The ICMS shall disseminate transit event data (emergency alarm, traffic incident – driver, traffic incident – observed, crime in progress) to the SD County OES EOC	IMTMS	User Need 4
I4.1.6.5	The ICMS shall disseminate transit bus location data (bus ID, driver ID, block ID, route ID, schedule adherence, latitude/longitude) to the SD County OES EOC	IMTMS	User Need 4
I4.2	The ICMS shall disseminate information to designated corridor managers using addressable communications (text messaging, e-mail, instant messaging, pagers, mobile phones)	IMTMS	User Need 4
I4.2.1	The ICMS shall disseminate data by text messaging to designated mobile phone users	IMTMS	User Need 4
I4.2.2	The ICMS shall disseminate data by e-mail to designated e-mail users	IMTMS	User Need 4
I4.2.3	The ICMS shall disseminate data by instant messaging to designated IM users	IMTMS	User Need 4
I4.2.4	The ICMS shall disseminate data by paging to designated pager users	IMTMS	User Need 4
I4.2.5	The ICMS shall disseminate data by voice communications to designated mobile phone users	IMTMS	User Need 4
I4.3	The ICMS shall publish information to regional modal management systems using XML schema, NTCIP 2306, and TMDD v2.1	IMTMS	User Need 4
I4.3.1	The ICMS shall publish information to regional modal management systems using NTCIP 2306 protocol for message handling	IMTMS	User Need 4
I4.3.2	The ICMS shall publish information to regional transportation management systems using TMDD v2.1 compliant messages	IMTMS	User Need 4
I4.3.3	The ICMS shall publish information to regional public safety systems using IEEE 1512.2-compliant messages	IMTMS	User Need 4
I4.3.4	The ICMS shall publish information to regional modal management systems using ICD-compliant message handling and data formats for custom interfaces	IMTMS	User Need 4
I4.3.5	The ICMS shall publish information to regional modal management systems using CAP-XML-compliant messages	IMTMS	User Need 4

3.8.5 Multi-Agency Collaboration

Multi-agency collaboration will provide corridor agencies with the means to share voice, video, imagery, and data collaboratively, both for routine management and for the management of major events (planned or unplanned). Multi-agency conferencing will support the concept of a virtual corridor TMC by allowing decision-makers to share data and pool their knowledge from different physical sites. This function can be supported by systems such as the San Diego region's 3Cs high-bandwidth microwave network and commercial off-the shelf collaborative communications tools.

ID	Description	Subsystem Allocation	ConOps Trace
F5.1	The ICMS shall incorporate a videoconferencing function	DSS	User Need 5
F5.2	The ICMS shall incorporate a teleconferencing function	DSS	User Need 5
F5.3	The ICMS shall incorporate an Internet meeting function	DSS	User Need 5
F5.4	The ICMS shall be a subscriber to the San Diego County WebEOC application	DSS	User Need 5

3.8.6 Information Display

Information produced by ICMS and its subsystems will be displayable on workstations, large screen displays and handheld devices. Corridor information is displayed and managed through user dialogues on a browser-based workstation, an upgrade to the existing RIWS. A regional map will be manipulated by the operator for scale, management of display layers, panning, assignment of information to a large screen display, and selection of dynamic icons for viewing of field device data.

ID	Description	Subsystem Allocation	ConOps Trace
F6.1	The ICMS shall use a base map display of the I-15 corridor and adjacent areas on the ICMS operator workstation	IMTMS	User Need 6
F6.1.1	The ICMS base map shall use an Environmental Sciences Research Institute (ESRI-)compliant map format	IMTMS	User Need 6
F6.1.2	The ICMS shall incorporate a map panning function on the ICMS workstation	IMTMS	User Need 6
F6.1.3	The ICMS shall incorporate a map zoom function on the ICMS workstation	IMTMS	User Need 6
F6.1.3.1	The ICMS shall incorporate a display of the current map zoom level on the ICMS workstation	IMTMS	User Need 6
F6.1.4	The ICMS shall incorporate a display of the current geographic position (latitude/longitude, state plane coordinates) of the cursor on the map display	IMTMS	User Need 6
F6.1.5	The ICMS shall incorporate a function to recenter the map on a user-selectable location	IMTMS	User Need 6
F6.1.6	The ICMS shall incorporate a map-scrolling function		User Need 6
F6.2.1	The ICMS shall display dynamic icons overlaid on the base map of the ICMS operator workstation	IMTMS	User Need 6
F6.2.1.1	The ICMS shall display current system data (sensor data, event data, field device data) in response to operator selection of a dynamic icon	IMTMS	User Need 6

ID	Description	Subsystem Allocation	ConOps Trace
F6.2.1.2	The ICMS shall display user dialog windows for monitoring and control functions in response to selection of dynamic icons on the ICMS workstation	IMTMS	User Need 6
F6.3.1	The ICMS shall display an operator-selectable menu bar with the map display on the ICMS workstation	IMTMS	User Need 6
F6.3.1.1	The ICMS shall display user dialog windows for monitoring and control functions in response to operator menu selections on the ICMS workstation	IMTMS	User Need 6
F6.4	The ICMS shall display system summary data (field devices, events) in user dialog windows on the ICMS workstation	IMTMS	User Need 6
F6.5	The ICMS shall incorporate the display and control of CCTV video (streaming, archived clips, snapshots) on the ICMS operator workstation	IMTMS	User Need 6
F6.5.1	The ICMS shall display streaming video from one camera in one workstation window	IMTMS	User Need 6
F6.5.2	The ICMS shall display archived video clips from one camera in one workstation window	IMTMS	User Need 6
F6.5.3	The ICMS shall display video snapshots from one camera in one workstation window	IMTMS	User Need 6
F6.5.4	ICMS shall limit ICMS users to a maximum of four simultaneous camera views on the ICMS workstation	IMTMS	User Need 6
F6.6	The ICMS shall incorporate a function for the operator to manage a large screen display	IMTMS	User Need 6
F6.6.1	The ICMS shall provide an operator function to assign the current workstation display to a designated panel(s) on a large screen display	IMTMS	User Need 6
F6.6.2	The ICMS shall provide an operator function to assign video imagery (streaming video, video archive clips, video snapshots) from a selected CCTV site to designated large screen display panels	IMTMS	User Need 6
F6.6.2.1	The ICMS shall display streaming video (camera ID, camera location) in large screen display panels	IMTMS	User Need 6
F6.6.2.2	The ICMS shall display archived video clips (camera ID, camera location) in large screen display panels	IMTMS	User Need 6
F6.6.2.3	The ICMS shall display video snapshots (camera ID, camera location) in large screen display panels	IMTMS	User Need 6
F6.7	The ICMS shall display system-generated reports electronically	IMTMS	User Need 6
F6.8	The ICMS shall produce system-generated reports on printed media	IMTMS	User Need 6
F6.9	The ICMS shall display all event classes (incidents, planned events, emergency closures, lane closures) using distinctive icons for each class	IMTMS	User Need 6
F6.9.1	The ICMS shall display UNCONFIRMED incidents on the map as a distinctive icon	IMTMS	User Need 6

ID	Description	Subsystem Allocation	ConOps Trace
F6.9.2	The ICMS shall display CONFIRMED events on the map display as a distinctive icon	IMTMS	User Need 6
F6.9.3	The ICMS shall display active planned events on the map as a distinctive icon set	IMTMS	User Need 6
F6.9.4	The ICMS shall display future planned events as a distinctive icon set	IMTMS	User Need 6
F6.9.4.1	The ICMS shall display a control dialog for the operator to select a type filter for display of future planned events	IMTMS	User Need 6
F6.9.4.2	The ICMS shall display a control dialog for the operator to select a time filter for display of future planned events	IMTMS	User Need 6
F6.9.4.3	The ICMS shall display a control dialog for the operator to select a location filter for display of future planned events	IMTMS	User Need 6
F6.10	The ICMS shall display roadway link status by using unique colors to indicate three configurable levels of performance (volume, occupancy, speed)	IMTMS	User Need 6
F6.10.1	The ICMS shall provide the operator with the option of selecting the roadway link status parameter (volume, occupancy, speed) to be displayed	IMTMS	User Need 6
F6.10.2	The ICMS shall incorporate an operator option to display lane-by-lane roadway link status	IMTMS	User Need 6
F6.11	The ICMS shall incorporate the display of transit data (routes, route ID, bus locations, bus ID, schedule adherence, off route, emergency alarm) on the ICMS workstation	IMTMS	User Need 6
F6.11.1	The ICMS shall allow the selection of up to a configurable number of transit fixed routes (route ID, route shape file) to be displayed on the map	IMTMS	User Need 6
F6.11.2	The ICMS shall allow the selection of up to a configurable number of transit vehicles (bus ID, block ID) to be displayed on the map	IMTMS	User Need 6
F6.11.3	The ICMS shall update the last known position of selected transit vehicles at the rate provided by RTMS	IMTMS	User Need 6
F6.11.4	The ICMS shall modify a transit vehicle icon's appearance to indicate that the vehicle is ahead of schedule by a configurable period of time	IMTMS	User Need 6
F6.11.5	The ICMS shall modify a transit vehicle icon's appearance to indicate that the vehicle is behind schedule by a configurable period of time	IMTMS	User Need 6
F6.11.6	The ICMS shall modify a transit vehicle icon's appearance to indicate that the vehicle is off-route by a configurable distance	IMTMS	User Need 6
F6.11.7	The ICMS shall modify a transit vehicle's icon's appearance to indicate that the vehicle has an active emergency alarm condition	IMTMS	User Need 6
F6.12	The ICMS shall update the last known position of SPRINTER trains within designated corridor boundaries at the rate provided by the SPRINTER train control system	IMTMS	User Need 6

ID	Description	Subsystem Allocation	ConOps Trace
F6.12.1	The ICMS shall modify the SPRINTER train icon's appearance to indicate that the train is ahead of schedule by a configurable period of time	IMTMS	User Need 6
F6.12.2	The ICMS shall modify the SPRINTER train icon's appearance to indicate that the train is behind schedule by a configurable period of time	IMTMS	User Need 6
F6.13	The ICMS shall display parking facility availability as an icon with three configurable levels of remaining capacity	IMTMS	User Need 6
F6.14	The ICMS shall display roadside equipment (CMS, variable toll message sign (VTMS), video management subsystem (VMS), ramp metering system (RMS), highway advisory radio (HAR), signalized intersection) status on the map	IMTMS	User Need 6
F6.14.1	The ICMS shall display the current CMS message when the operator selects the icon for that device	IMTMS	User Need 6
F6.14.2	The ICMS shall display the current VTMS toll rate message when the operator selects the icon for that device	IMTMS	User Need 6
F6.14.3	The ICMS shall display the current VMS managed lanes message when the operator selects the icon for that device	IMTMS	User Need 6
F6.14.4	The ICMS shall display current ramp meter data (status, volume, occupancy) when the operator selects the icon for that device	IMTMS	User Need 6
F6.14.5	The ICMS shall display the current HAR message when the operator selects the icon for that device	IMTMS	User Need 6
F6.14.6	The ICMS shall display current signal system information (alarms, phasing) when the operator selects a signal icon	IMTMS	User Need 6

3.8.7 Transportation and Public Safety Event Management

Based on the receipt of non-recurring incident information from all sources (Mobile 911, callbox, CCTV, road crews, Traffic Officers, etc.), The ICMS will provide the capability to manage the complete life cycle of an event across multiple agencies. This includes the ability to: create and terminate events by agency; split one event into multiple events; merge multiple events into one event; and transfer an event from one agency to another. "Transfer" in this context means to transfer responsibility for event management. Event Management differs from the REMS subsystem of IMTMS in that the REMS subsystem collects the data via defined interfaces while Event Management provides functionality to manage event life cycles.

ID	Description	Subsystem Allocation	ConOps Trace
C7.1	The ICMS shall comply with operating agreements regarding use of information received from external agencies	DSS	User Need 7

ID	Description	Subsystem Allocation	ConOps Trace
D7.2	The ICMS shall store online repositories of regional emergency and incident management plans (SD County Emergency Response Plan (ERP), SD County Emergency Evacuation Plan (EEP), I-15 Managed Lanes Traffic Incident Management (ML TIM) Plan)	DSS	User Need 7
D7.2.1	The ICMS shall store an online repository of the San Diego County Emergency Response Plan	DSS	User Need 7
D7.2.2	The ICMS shall store an online repository of the San Diego County Emergency Evacuation Plan	DSS	User Need 7
D7.2.3	The ICMS shall store an online repository of the I-15 Managed Lanes Traffic Incident Management Plan	DSS	User Need 7
I7.4	The ICMS shall receive events (incidents, planned special events, planned lane closures emergency lane closures) from ICM corridor agencies	DSS	User Need 7
F7.5	The ICMS shall manage (create, modify, terminate, transfer, split, merge) incidents received from external agencies within corridor boundaries	DSS	User Need 7
F7.5.1	The ICMS shall manage (create, modify, terminate, transfer, split, merge) incidents received from the CHP CAD system	DSS	User Need 7
F7.5.2	The ICMS shall manage (create, modify, terminate, transfer, split, merge) incidents received from San Diego Sheriff Department (SDSD) CAD system	DSS	User Need 7
F7.5.3	The ICMS shall manage (create, modify, terminate, transfer, split, merge) incidents received from San Diego Police Department (SDPD) CAD system	DSS	User Need 7
F7.5.4	The ICMS shall manage (create, modify, terminate, transfer, split, merge) incidents received from Escondido Police Department (EPD)	DSS	User Need 7
F7.5.5	The ICMS shall manage (create, modify, terminate, transfer, split, merge) incidents received from San Diego Fire Department (SDFD) CAD system	DSS	User Need 7
F7.5.6	The ICMS shall manage (create, modify, terminate, transfer, split, merge) incidents received from Escondido Fire Department (EFD)	DSS	User Need 7
F7.6	The ICMS shall automatically display an operator alert for each new external incident report received	DSS	User Need 7
F7.7	The ICMS shall automatically create a new database record for each external incident report received	DSS	User Need 7
F7.8	The ICMS shall incorporate an event classification system	DSS	User Need 7
F7.8.1	The ICMS shall automatically classify all new external incidents received as UNCONFIRMED	DSS	User Need 7
F7.8.2	The ICMS shall allow the operator to change the status of an UNCONFIRMED event to CONFIRMED	DSS	User Need 7
F7.8.3	The ICMS shall provide an interface for the operator to modify UNCONFIRMED and CONFIRMED event records	DSS	User Need 7

ID	Description	Subsystem Allocation	ConOps Trace
F7.8.4	All UNCONFIRMED and CONFIRMED events shall be automatically placed into an “Active Event” list when they are initiated		
F7.9	The ICMS shall provide a summary table to the operator to list all received external events (ICMS event #, originating agency, originating agency’s event #., location, time, status)	DSS	User Need 7
F7.9.1	The ICMS shall provide the operator a function to select any event from the summary table for further review and modification	DSS	User Need 7
F7.9.1.1	The ICMS shall provide an interface for the operator to enter event supplementary details (lane blockage, number of vehicles, injuries, fatalities, property damage, estimated clearance time, estimated queue length, ID of responding units)	DSS	User Need 7
F7.10	The ICMS shall display and store incident updates (time-tagged, sender ID, free-text) received from external systems	DSS	User Need 7
F7.10.1.1	The ICMS shall display and store incident updates (time-tagged, sender ID, free-text) received from ATMS 2005	DSS	User Need 7
F7.10.1.2	The ICMS shall display and store incident updates (time-tagged, sender ID, free-text) received from RTMS	DSS	User Need 7
F7.10.1.3	The ICMS shall display and store incident updates (time-tagged, sender ID, free-text) received from CHP	DSS	User Need 7
F7.10.1.4	The ICMS shall display and store incident updates (time-tagged, sender ID, free-text) received from SDSD	DSS	User Need 7
F7.10.1.5	The ICMS shall display and store incident updates (time-tagged, sender ID, free-text) received from SDPD	DSS	User Need 7
F7.10.1.6	The ICMS shall display and store incident updates (time-tagged, sender ID, free-text) received from EPD	DSS	User Need 7
F7.10.1.7	The ICMS shall display and store incident updates (time-tagged, sender ID, free-text) received from SDFD	DSS	User Need 7
F7.10.1.8	The ICMS shall display and store incident updates (time-tagged, sender ID, free-text) received from EFD	DSS	User Need 7
F7.10.1.9	The ICMS shall continue to display and store periodic incident updates (time-tagged, sender ID, free-text) received from external systems (ATMS 2005, RTMS, CHP, SDSD, SDPD, EPD, SDFD, EFD) until the sending system closes the incident	DSS	User Need 7
F7.11	The ICMS shall manage incident termination	DSS	User Need 7
F7.11.1	If an incident is closed by the sending agency prior to ICMS event changing status to CONFIRMED, the event shall be automatically deleted from the ICMS active incident list	DSS	User Need 7
F7.11.2	The ICMS shall maintain a local CONFIRMED event on the active incident list after the external system closes the event	DSS	User Need 7

ID	Description	Subsystem Allocation	ConOps Trace
F7.11.3	The ICMS shall allow the operator to manually terminate an incident	DSS	User Need 7
F7.11.4	A terminated incident shall be removed from the active incident list	DSS	User Need 7
D7.11.5	A terminated incident shall have its historical data store closed	DSS	User Need 7
F7.12	The ICMS shall allow the operator to merge two incidents being managed locally into one incident	DSS	User Need 7
F7.12.1	The ICMS shall provide a function for the operator to designate which incident is being merged	DSS	User Need 7
F7.12.2	The ICMS shall cease display of the incident being merged	DSS	User Need 7
D7.12.3	The ICMS shall store the merge time in the incident historical record	DSS	User Need 7
D7.12.4	The ICMS shall remove the incident being merged from the active incident list	DSS	User Need 7
D7.12.5	The ICMS shall close the historical data record of an incident being merged	DSS	User Need 7
F7.13	The ICMS shall allow the operator to split an incident being managed locally into two separate incidents	DSS	User Need 7
F7.13.1	The ICMS shall automatically display new symbology for each new incident created from an operator split action	DSS	User Need 7
F7.13.2	The ICMS shall automatically create a new database record for each new incident created from an operator split action	DSS	User Need 7
F7.13.3	The ICMS shall place each new incident created from an operator split action on the active incident list	DSS	User Need 7
F7.14	The ICMS shall allow transfer of an active incident from local control to control by an external agency	DSS	User Need 7
F7.14.1	The ICMS shall allow the operator to transfer an active incident to another ICMS operator	DSS	User Need 7
F7.15	The ICMS shall display special events received from external agencies within corridor boundaries	DSS	User Need 7
F7.16	The ICMS shall display planned lane closures received from external agencies within corridor boundaries	DSS	User Need 7
F7.17	The ICMS shall display emergency lane closures received from external agencies within corridor boundaries	DSS	User Need 7

3.8.8 Shared Device Control

Less complex but still needing regional agreements are the shared control of CMSs and HAR. CMS functionality includes prioritization of messages, message scheduling, and message library management – shared use will take these features into account.

ID	Description	Subsystem Allocation	ConOps Trace
C8.1	The ICMS shall be subject to inter-agency operating agreements regarding the control of regional motorist information (CMS, HAR) assets by approved ICMS users	ICMS	User Need 8
I8.2	The ICMS shall provide an interface for an ICMS user to remotely control any I-15 corridor motorist information device (CMS, HAR) regardless of the owning agency	IMTMS	User Need 8
S8.3	The ICMS shall validate motorist information device (CMS, HAR) control commands against access rules for the operator requesting device control	IMTMS	User Need 8
D8.4	The ICMS shall log motorist information device (CMS, HAR) messages sent to the ICMS historical database	IMTMS	User Need 8
D8.4.1	The ICMS shall log CMS messages sent (date/time sent, operator ID, agency ID, message text, date/time terminated) to the ICMS historical database	IMTMS	User Need 8
D8.4.2	The ICMS shall log HAR messages sent (date/time sent, operator ID, agency ID, message text, date/time terminated) to the ICMS historical database	IMTMS	User Need 8
S8.5	The ICMS shall incorporate secured access to corridor motorist information devices (CMS, HAR)	IMTMS	User Need 8
S8.5.1	The ICMS shall enable/disable CMS message library access based on CMS's device ID, message ID, operator ID, operator organization ID, requested message priority, and current message priority	IMTMS	User Need 8
S8.5.2	The ICMS shall enable/disable HAR message library access based on message ID, operator ID, operator organization ID, HAR device ID, requested message priority, and current message priority	IMTMS	User Need 8
S8.5.3	The ICMS shall enable/disable CMS control based on CMS ID, operator ID, operator organization ID, message type, requested message priority, and current message priority	IMTMS	User Need 8
S8.5.4	The ICMS shall enable/disable HAR control based on HAR ID, operator ID, operator organization ID, message type, requested message priority, current message priority	IMTMS	User Need 8
F8.6	The ICMS shall incorporate a function for motorist information device (CMS, HAR) message prioritization	IMTMS	User Need 8
F8.6.1	The ICMS shall enable the next highest, uncanceled priority message for the CMS when the current CMS message is canceled	IMTMS	User Need 8
F8.6.2	The ICMS shall enable the next highest, uncanceled priority message for HAR when the current HAR message is canceled	IMTMS	User Need 8

ID	Description	Subsystem Allocation	ConOps Trace
F8.6.3	The ICMS shall store lower-priority HAR/CMS messages in a queue until higher-priority messages are canceled	IMTMS	User Need 8
F8.7	The ICMS shall incorporate a default message function for motorist information devices (CMS, HAR)	IMTMS	User Need 8
F8.7.1	The ICMS shall display a configurable default message on selected signs when no messages are in queue for the selected CMS	IMTMS	User Need 8
F8.7.2	The ICMS shall send a configurable default message to selected HARs when no messages are in queue for a HAR	IMTMS	User Need 8

3.8.9 Video Management

Arguably, the most complex and yet useful sensor system in the region is the multi-agency collection of video surveillance systems. The largest systems are owned by Caltrans for freeway monitoring and event confirmation and by MTS/NCTD for station and parking security. The ICMS will provide the capability for users to select cameras from a graphical user interface and subject to regional agreements, to control selected operations of these cameras, such as pan, tilt, zoom, focus, iris control, etc. The ICMS will support a video wall management capability for future dedicated facilities. Video display formats will include live streaming video, archived video clips, and video snapshots.

ID	Description	Subsystem Allocation	ConOps Trace
C9.1	The ICMS shall be subject to inter-agency operating agreements regarding the control of regional camera assets by approved ICMS users	ICMS	User Need 9
I9.2	The ICMS shall provide an interface for an ICMS user to remotely control any I-15 corridor camera regardless of owning agency	IMTMS	User Need 9
S9.3	The ICMS shall incorporate secured access to corridor video devices (camera, video switch, digital video recorder)	IMTMS	User Need 9
S9.3.1	The ICMS shall enable/disable camera control based on camera ID, operator ID, operator organization ID, requested video source ID, requested video destination ID, source lockout flag	IMTMS	User Need 9
S9.3.2	The ICMS shall enable/disable video switch control based on switch ID, operator ID, operator organization ID, requested video source ID, requested video destination ID, source lockout flag	IMTMS	User Need 9
S9.3.3	The ICMS shall enable/disable digital video recorder control based on recorder ID, operator ID, operator organization ID, requested video source ID, requested video destination ID, source lockout flag	IMTMS	User Need 9
F9.4	The ICMS shall provide an interface for a corridor agency to selectively release their owned cameras for external control	IMTMS	User Need 9
F9.5	The ICMS shall provide an interface for a corridor agency to selectively lock their owned cameras to external control	IMTMS	User Need 9

ID	Description	Subsystem Allocation	ConOps Trace
F9.6	The ICMS shall define and enforce a camera control prioritization protocol	IMTMS	User Need 9
F9.6.1	The ICMS shall provide an interface for the operator to dynamically assign camera control prioritization	IMTMS	User Need 9
F9.6.1.1	The ICMS shall provide an interface for the operator to dynamically assign camera control prioritization protocol by agency	IMTMS	User Need 9
F9.6.1.2	The ICMS shall provide an interface for the operator to dynamically assign camera control prioritization protocol by operator	IMTMS	User Need 9
F9.6.1.3	The ICMS shall provide an interface for the operator to dynamically assign camera control prioritization protocol by time of day	IMTMS	User Need 9
F9.6.2	The ICMS shall ensure that the owning jurisdiction retains the highest priority for camera access and control	IMTMS	User Need 9
F9.6.3	The ICMS shall ensure that the owning jurisdiction has first priority to regain camera control once relinquished to a remote user	IMTMS	User Need 9
F9.7	The ICMS shall provide an interface for a camera operator to selectively lock out remote users from camera control (pan, tilt, zoom, iris, focus)	IMTMS	User Need 9
F9.8	The ICMS shall provide a feature to automatically revert control of a camera to the owning jurisdiction if no control action by a remote user is taken for a configurable interval of time	IMTMS	User Need 9
F9.9	The ICMS shall provide current camera control status (controlling agency, control operator) to the camera owner	IMTMS	User Need 9
F9.10	The ICMS shall provide multi-jurisdictional video management for operator functions (selection of camera icons from map, video display from cameras, remote control of cameras)	IMTMS	User Need 9
F9.10.1	The ICMS shall provide operators the tools to select a maximum of four simultaneous camera icons from any owning jurisdiction from a corridorwide map	IMTMS	User Need 9
F9.10.2	The ICMS shall display video (camera parameters, streamed, archived clips, snapshots) from the selected cameras with one window per selected camera	IMTMS	User Need 9
F9.10.2.1	The ICMS shall display camera parameters (camera ID, camera direction) in the camera video viewing window	IMTMS	User Need 9
F9.10.2.2	The ICMS shall display streamed video from the selected cameras with one window per selected camera	IMTMS	User Need 9
F9.10.2.3	The ICMS shall display archived clips video (start time, end time) from the selected cameras with one window per selected camera	IMTMS	User Need 9
F9.10.2.3.1	The ICMS shall provide an interface to select a start time and end time for archived clips video from the selected cameras with one window per selected camera	IMTMS	User Need 9

ID	Description	Subsystem Allocation	ConOps Trace
F9.10.2.4	The ICMS shall display the most recent snapshot video from the selected cameras with one window per selected camera	IMTMS	User Need 9
F9.11	The ICMS shall provide operators an interface to remotely control (pan, tilt, zoom, iris, focus) selected external cameras	IMTMS	User Need 9
I9.11.1	The ICMS shall implement the camera switching protocol in use by each ICMS participating agency CCTV owner	IMTMS	User Need 9
F9.11.1.1	The ICMS shall automatically select the correct protocol handler when an agency's camera is selected on the map	IMTMS	User Need 9
I9.11.2	The ICMS shall implement the camera control protocol in use by each ICMS participating agency CCTV owner	IMTMS	User Need 9
F9.11.2.1	The ICMS shall automatically select the correct protocol handler when an agency's camera is given a control command	IMTMS	User Need 9
F9.11.3	The ICMS shall provide operators an interface to remotely pan selected external cameras	IMTMS	User Need 9
F9.11.3.1	The ICMS shall provide an interface for operators to control pan speed of the camera	IMTMS	User Need 9
F9.11.4	The ICMS shall provide operators an interface to remotely tilt external selected cameras	IMTMS	User Need 9
F9.11.4.1	The ICMS shall provide an interface for operators to control tilt speed of the camera	IMTMS	User Need 9
F9.11.5	The ICMS shall provide operators an interface to remotely zoom selected external cameras	IMTMS	User Need 9
F9.11.5.1	The ICMS shall provide an interface for operators to control zoom speed of the camera	IMTMS	User Need 9
F9.11.6	The ICMS shall provide operators an interface to remotely control iris opening for selected external cameras	IMTMS	User Need 9
F9.11.7	The ICMS shall provide operators an interface to remotely control the focus of selected external cameras	IMTMS	User Need 9
F9.12	The ICMS shall provide an interface for the owning agency to define camera presets (individual cameras, camera groups, blind zones)	IMTMS	User Need 9
F9.12.1	The ICMS shall provide an interface for the owning agency to define individual camera presets (preset ID, pan position, tilt position, zoom level, iris setting, focus setting)	IMTMS	User Need 9
F9.12.2	The ICMS shall provide an interface for the owning agency to define camera groups (group ID, group name, included camera IDs)	IMTMS	User Need 9
F9.12.2.1	The ICMS shall provide an interface for the owning agency to define camera group presets (preset ID, pan position, tilt position, zoom level, iris setting, focus setting)	IMTMS	User Need 9
F9.12.3	The ICMS shall provide an interface for the owning agency to activate "blind zones" (start pan position, end pan position, start tilt position, end tilt position) to block sensitive images from external access	IMTMS	User Need 9

ID	Description	Subsystem Allocation	ConOps Trace
F9.13	The ICMS shall provide a viewing window for video down linked from an aerial platform	IMTMS	User Need 9
D9.14	The ICMS shall provide a list of available video sources (agency name, camera ID, camera location, video type, compression protocol)	IMTMS	User Need 9

3.8.10 Response Plan

The ICMS will determine the appropriate response for managing traffic in response to major perturbations in "normal" traffic due to traffic incidents, special events, emergency closures, construction, and/or major disasters. The heart of the DSS subsystem within the ICMS is the ability to analyze collected data, ascertain abnormal or scheduled events, determine appropriate responses, and suggest a set of actions that collectively form a "Response Plan." The Response Plan may be manually or automatically generated, but if automatically generated, will include the capability for human operator review and modification. This is particularly critical for field device (i.e., CMS and camera) control actions.

ID	Description	Subsystem Allocation	ConOps Trace
F10.1	The ICMS shall automatically create a response plan upon ICMS operator command	DSS	User Need 10
F10.1.1	The ICMS response plan shall use automatic inputs from external systems	DSS	User Need 10
F10.1.2	The ICMS response plan shall use manual inputs from the ICMS operator	DSS	User Need 10
P10.1.3	The ICMS response plan function shall produce a recommended response plan within one minute of operator request	DSS	User Need 10
F10.2	The ICMS response plan shall recommend one or more action plans based on an operator-selected incident	DSS	User Need 10
F10.2.1	The ICMS action plan shall consist of a set of recommended commands for a single modal management system (Ramp Meter Information System (RMIS), MLCS, QuicNet, 511) in a single jurisdiction	DSS	User Need 10
F10.2.1.1	An action plan shall develop a recommended set of commands (ramp meters on, ramp meters off, systemwide ramp metering) for the RMIS system	DSS	User Need 10
F10.2.1.2	An action plan shall develop a recommended set of commands (lane reconfiguration) for the MLCS	DSS	User Need 10
C10.2.1.2.1	MLCS action plans shall conform to the logic outlined in the I-15 Managed Lane Traffic Incident Management Manual	DSS	User Need 10
F10.2.1.3	An action plan shall develop a recommended set of commands (signal timing plan change) for the QuicNet system	DSS	User Need 10
C10.2.1.3.1	QuicNet action plans shall conform to pre-agreed, multi-jurisdictional signal timing plans	DSS	User Need 10

ID	Description	Subsystem Allocation	ConOps Trace
C10.2.1.3.2	QuicNet action plans shall be selectable from a list of pre-stored signal timing plans	DSS	User Need 10
F10.2.1.4	An action plan shall develop a recommended incident alert message for the 511 system	DSS	User Need 10
F10.3	The ICMS operator shall have a control dialogue to review all response plan-generated action plans	DSS	User Need 10
F10.3.1	The ICMS operator shall have control dialogues to modify (Command, target system) a response plan-generated action plans	DSS	User Need 10
F10.3.1.1	The ICMS operator shall be able to modify a command generated as part of an action plan	DSS	User Need 10
F10.3.1.2	The ICMS operator shall be able to modify a target system generated as part of an action plan	DSS	User Need 10
F10.3.2	The ICMS operator shall be able to approve a response plan-generated action plan	DSS	User Need 10
F10.4	The ICMS operator shall be able to send a response plan-generated action plan to the target system	DSS	User Need 10
F10.4.1	The target system shall respond to a received action plan by sending an acknowledgement to the ICMS	DSS	User Need 10
F10.4.1.1	RMIS shall respond to a received action plan by sending an acknowledgement to the ICMS	DSS	User Need 10
F10.4.1.2	MLCS shall respond to a received action plan by sending an acknowledgement to the ICMS	DSS	User Need 10
F10.4.1.3	QuicNet shall respond to a received action plan by sending an acknowledgement to the ICMS	DSS	User Need 10
F10.4.1.4	511 shall respond to a received action plan by sending an acknowledgement to the ICMS	DSS	User Need 10
D10.5	Response plans (action plans, commands) generated by the ICMS shall be automatically stored to the historical database instance	DSS	User Need 10
D10.5.1	Action plans (time sent, identification, associated event number, command list, time acknowledged) shall be stored to the historical database instance	DSS	User Need 10
D10.5.2	Commands (action, target system, associated event number) shall be stored to the historical database instance	DSS	User Need 10
I10.6	The ICMS shall incorporate action plans in ICDs for target systems (RMIS, MLCS, RAMS, 511)	DSS/IMTMS	User Need 10
I10.6.1	The ICMS shall incorporate RMIS action plans in the IMTMS-RMIS ICD	DSS/IMTMS	User Need 10
I10.6.2	The ICMS shall incorporate MLCS action plans in the IMTMS-MLCS ICD	DSS/IMTMS	User Need 10
I10.6.3	The ICMS shall incorporate RAMS action plans in the IMTMS-RAMS ICD	DSS/IMTMS	User Need 10
I10.6.4	The ICMS shall incorporate 511 action plans in the IMTMS-511 ICD	DSS/IMTMS	User Need 10

3.8.11 Impact Assessment

The ICMS will use a micro/meso scale modeling tool to assess the impact of both short-term responses to planned and unplanned events in the corridor (such as the recent wildfires in San Diego) and long-term strategies to optimize corridor performance based on cumulative measures of corridor performance.

ID	Description	Subsystem Allocation	ConOps Trace
F11.1	The ICMS shall incorporate a modeling application (application to be determined) for meso- and micro-simulation of corridor operational conditions	DSS	User Need 11
P11.2	The ICMS short-term impact assessment function shall provide modeling results and resulting 2D display within one hour	DSS	User Need 11
F11.3	The ICMS shall incorporate a modeling interface (data input, visualization) to assess short term impacts of unscheduled events and resulting mitigation strategies (ramp metering, MLCS operation, traffic signal timing, traffic diversion, transit service changes)	DSS	User Need 11
F11.3.1.1	The ICMS shall incorporate a modeling data input interface to assess changes in ramp metering plans	DSS	User Need 11
F11.3.1.2	The ICMS shall provide a 2D visualization of model results from changing ramp metering plans	DSS	User Need 11
F11.3.1.3	The ICMS shall provide a 3D visualization of model results from changing ramp metering plans	DSS	User Need 11
F11.3.2.1	The ICMS shall incorporate a modeling data input interface to assess MLCS operational changes	DSS	User Need 11
F11.3.2.2	The ICMS shall provide a 2D visualization of model results from MLCS operational changes	DSS	User Need 11
F11.3.2.3	The ICMS shall provide a 3D visualization of model results from MLCS operational changes	DSS	User Need 11
F11.3.3.1	The ICMS shall incorporate a modeling data input interface to assess changes in traffic signal timing	DSS	User Need 11
F11.3.3.2	The ICMS shall provide a 2D visualization of model results from changing traffic signal timing	DSS	User Need 11
F11.3.3.3	The ICMS shall provide a 3D visualization of model results from changing traffic signal timing	DSS	User Need 11
F11.3.4.1	The ICMS shall incorporate a modeling data input interface to assess traffic diversion plans	DSS	User Need 11
F11.3.4.2	The ICMS shall provide a 2D visualization of model results from using traffic diversion plans	DSS	User Need 11
F11.3.4.3	The ICMS shall provide a 3D visualization of model results from using traffic diversion plans	DSS	User Need 11
F11.3.5.1	The ICMS shall incorporate a modeling data input interface to assess changes in transit operations plans	DSS	User Need 11
F11.3.5.2	The ICMS shall provide a 2D visualization of model results from changing transit operations plans	DSS	User Need 11
F11.3.5.3	The ICMS shall provide a 3D visualization of model results from changing transit operations plans	DSS	User Need 11

ID	Description	Subsystem Allocation	ConOps Trace
F11.4	The ICMS shall provide an interface to request incident/event assessment and recommend actions	DSS	User Need 11
F11.5	The ICMS shall provide an interface to request incident/event mitigation assessment and recommend changes	DSS	User Need 11
F11.6	The ICMS shall provide an operator interface to input and review model input data	DSS	User Need 11
F11.7	The ICMS shall maintain a data store of computer responses to corridor events based on previous model runs	DSS	User Need 11
F11.7.1	The ICMS shall provide a user interface to query the stored responses based on previous model runs	DSS	User Need 11
F11.8	The ICM system shall incorporate a feed for real-time data (freeway congestion, arterial congestion, event locations, bus locations, intersection timing plans)	DSS	User Need 11

3.8.12 Information Publishing (Corridor Users)

Processed data will be made continuously available to the regional 511 program for public dissemination. This includes freeway, arterial and transit incidents, congestion data, travel times, ramp meter status, and any future data types such as parking availability, congestion pricing, etc. The 511 system will be responsible for selecting and activating all appropriate means of delivery, including the worldwide Web, e-mail, pagers, wireless devices, and landline telephones.

ID	Description	Subsystem Allocation	ConOps Trace
I12.1	The ICMS shall continuously publish corridor data (ATMS 2005, MLCS, LCS, CPS, RTMS, RAMS, SPS) to the ISP server	IMTMS	User Need 12
I12.1.1	The ICMS shall continuously publish ATMS 2005 data (congestion, CMS status, CCTV imagery, events) to the ISP server	IMTMS	User Need 12
I12.1.2	The ICMS shall continuously publish MLCS data (lane #, direction of flow, status) to the ISP server	IMTMS	User Need 12
I12.1.3	The ICMS shall continuously publish MLCS data (freeway ID, direction of travel, lanes affected, planned start time, planned end time, actual start time, actual end time, planned start point, planned end point, actual start point, actual end point) to the ISP server	IMTMS	User Need 12
I12.1.4	The ICMS shall continuously publish CPS data (tolling zone, current toll, ML travel time) to the ISP server	IMTMS	User Need 12
I12.1.5	The ICMS shall continuously publish RTMS bus data (bus ID, bus location, scheduled time point, actual time point, status, event) to the ISP server	IMTMS	User Need 12
I12.1.6	The ICMS shall continuously publish RAMS data (arterial ID, direction of travel, travel time, speed) to the ISP server	IMTMS	User Need 12

ID	Description	Subsystem Allocation	ConOps Trace
I12.1.7	The ICMS shall continuously publish REMS event data (type, time, location, status updates) to the ISP server	IMTMS	User Need 12
I12.1.8	The ICMS shall continuously publish SPS data (facility ID, facility location, facility access, available spaces) to the ISP server	IMTMS	User Need 12

3.8.13 Corridor Performance Measurement

Corridor performance is characterized by freeway, high occupancy vehicle (HOV) and arterial metrics, transit route performance (on-time, average speed, ridership), smart parking usage, the impact of congestion pricing algorithms, ramp metering, etc. The level of detail of data collected will be sufficient to support corridor management strategies for demand and capacity management.

In this section we focus on performance measures encompassing the following four major categories: Mobility, Reliability, Productivity, and Safety. Examples of specific performance measures include:

- Traffic volumes;
- Speeds;
- Level of service;
- Travel time;
- Vehicle/people miles traveled;
- Vehicle/people hours traveled;
- Vehicle hours of delay;
- Transit productivity;
- Transit reliability;
- Travel time;
- Number of incidents;
- Incident rate;
- Number of injuries and fatalities, and
- Injury and fatality rates.

ID	Description	Subsystem Allocation	ConOps Trace
F13.1	The ICMS shall compute available network (freeway lanes, HOV/HOT/Managed Lane, arterial, transit parking, transit rider) capacities	DSS	User Need 13
F13.1.1	The ICMS shall compute available freeway link capacities	DSS	User Need 13
F13.1.2	The ICMS shall compute available arterial link capacities	DSS	User Need 13
F13.1.3	The ICMS shall compute available transit parking capacities at each bus rapid transit (BRT) station along I-15	DSS	User Need 13

ID	Description	Subsystem Allocation	ConOps Trace
F13.1.4	The ICMS shall compute HOV/HOT/Managed Lane link capacities	DSS	User Need 13
F13.1.5	The ICMS shall compute transit rider capacities	DSS	User Need 13
F13.2	The ICMS shall determine current network (freeway, arterial, HOV/HOT/ML, transit) performance measures	DSS	User Need 13
F13.2.1	The ICMS shall determine performance measures (traffic volumes, travel speeds, travel times, level of service (LOS), bottlenecks, bottleneck duration, bottleneck length (miles), vehicle hours of delay, person hours of delay, travel time index, vehicle-miles traveled, vehicle-hours traveled, person-miles traveled, person-hours traveled, productivity, number of incidents, incident rate, number of fatalities, fatality rate, number of injuries, injury rate, incident response time, incident clearance time) for the freeway	DSS	User Need 13
F13.2.1.1	The ICMS shall determine current freeway traffic volumes (direction of travel, time of day)	DSS	User Need 13
F13.2.1.1.1	The ICMS shall determine current freeway traffic volumes (northbound, AM peak)	DSS	User Need 13
F13.2.1.1.2	The ICMS shall determine current freeway traffic volumes (northbound, PM peak)	DSS	User Need 13
F13.2.1.1.3	The ICMS shall determine current freeway traffic volumes (southbound, AM peak)	DSS	User Need 13
F13.2.1.1.4	The ICMS shall determine current freeway traffic volumes (southbound, PM peak)	DSS	User Need 13
F13.2.1.2	The ICMS shall determine current freeway travel speeds (direction of travel, time of day)	DSS	User Need 13
F13.2.1.2.1	The ICMS shall determine current freeway travel speeds (northbound, AM peak)	DSS	User Need 13
F13.2.1.2.2	The ICMS shall determine current freeway travel speeds (northbound, PM peak)	DSS	User Need 13
F13.2.1.2.3	The ICMS shall determine current freeway travel speeds (southbound, AM peak)	DSS	User Need 13
F13.2.1.2.4	The ICMS shall determine current freeway travel speeds (southbound, PM peak)	DSS	User Need 13
F13.2.1.3	The ICMS shall determine current freeway travel times (direction of travel, time of day)	DSS	User Need 13
F13.2.1.3.1	The ICMS shall determine current freeway travel times (northbound, AM peak)	DSS	User Need 13
F13.2.1.3.2	The ICMS shall determine current freeway travel times (northbound, PM peak)	DSS	User Need 13
F13.2.1.3.3	The ICMS shall determine current freeway travel times (southbound, AM peak)	DSS	User Need 13
F13.2.1.3.4	The ICMS shall determine current freeway travel times (southbound, PM peak)	DSS	User Need 13
F13.2.1.4	The ICMS shall determine current freeway LOS (direction of travel, time of day)	DSS	User Need 13

ID	Description	Subsystem Allocation	ConOps Trace
F13.2.1.4.1	The ICMS shall determine current freeway LOS (northbound, AM peak)	DSS	User Need 13
F13.2.1.4.2	The ICMS shall determine current freeway LOS (northbound, PM peak)	DSS	User Need 13
F13.2.1.4.3	The ICMS shall determine current freeway LOS (southbound, AM peak)	DSS	User Need 13
F13.2.1.4.4	The ICMS shall determine current freeway LOS (southbound, PM peak)	DSS	User Need 13
F13.2.1.5	The ICMS shall determine freeway bottlenecks (direction of travel, time of day)	DSS	User Need 13
F13.2.1.5.1	The ICMS shall determine freeway bottlenecks (northbound, AM peak)	DSS	User Need 13
F13.2.1.5.2	The ICMS shall determine freeway bottlenecks (northbound, PM peak)	DSS	User Need 13
F13.2.1.5.3	The ICMS shall determine freeway bottlenecks (southbound, AM peak)	DSS	User Need 13
F13.2.1.5.4	The ICMS shall determine freeway bottlenecks (southbound, PM peak)	DSS	User Need 13
F13.2.1.6	The ICMS shall determine freeway bottlenecks duration (direction of travel, time of day)	DSS	User Need 13
F13.2.1.6.1	The ICMS shall determine freeway bottlenecks duration (northbound, AM peak)	DSS	User Need 13
F13.2.1.6.2	The ICMS shall determine freeway bottlenecks duration (northbound, PM peak)	DSS	User Need 13
F13.2.1.6.3	The ICMS shall determine freeway bottlenecks duration (southbound, AM peak)	DSS	User Need 13
F13.2.1.6.4	The ICMS shall determine freeway bottlenecks duration (southbound, PM peak)	DSS	User Need 13
F13.2.1.7	The ICMS shall determine the length (miles) of the freeway bottlenecks (direction of travel, time of day)	DSS	User Need 13
F13.2.1.7.1	The ICMS shall determine the length (miles) of the freeway bottlenecks (northbound, AM peak)	DSS	User Need 13
F13.2.1.7.2	The ICMS shall determine the length (miles) of the freeway bottlenecks (northbound, PM peak)	DSS	User Need 13
F13.2.1.7.3	The ICMS shall determine the length (miles) of the freeway bottlenecks (southbound, AM peak)	DSS	User Need 13
F13.2.1.7.4	The ICMS shall determine the length (miles) of the freeway bottlenecks (southbound, PM peak)	DSS	User Need 13
F13.2.1.8	The ICMS shall determine freeway vehicle hours of delay (direction of travel, time of day)	DSS	User Need 13
F13.2.1.8.1	The ICMS shall determine freeway vehicle hours of delay (northbound, AM peak)	DSS	User Need 13
F13.2.1.8.2	The ICMS shall determine freeway vehicle hours of delay(northbound, PM peak)	DSS	User Need 13

ID	Description	Subsystem Allocation	ConOps Trace
F13.2.1.8.3	The ICMS shall determine freeway vehicle hours of delay (southbound, AM peak)	DSS	User Need 13
F13.2.1.8.4	The ICMS shall determine freeway vehicle hours of delay (southbound, PM peak)	DSS	User Need 13
F13.2.1.9	The ICMS shall determine freeway person hours of delay (direction of travel, time of day)	DSS	User Need 13
F13.2.1.9.1	The ICMS shall determine freeway person hours of delay (northbound, AM peak)	DSS	User Need 13
F13.2.1.9.2	The ICMS shall determine freeway person hours of delay (northbound, PM peak)	DSS	User Need 13
F13.2.1.9.3	The ICMS shall determine freeway person hours of delay (southbound, AM peak)	DSS	User Need 13
F13.2.1.9.4	The ICMS shall determine freeway person hours of delay (southbound, PM peak)	DSS	User Need 13
F13.2.1.10	The ICMS shall determine the freeway travel time index (direction of travel, time of day)	DSS	User Need 13
F13.2.1.10.1	The ICMS shall determine the freeway travel time index (northbound, AM peak)	DSS	User Need 13
F13.2.1.10.2	The ICMS shall determine the freeway travel time index (northbound, PM peak)	DSS	User Need 13
F13.2.1.10.3	The ICMS shall determine the freeway travel time index (southbound, AM peak)	DSS	User Need 13
F13.2.1.10.4	The ICMS shall determine the freeway travel time index (southbound, PM peak)	DSS	User Need 13
F13.2.1.11	The ICMS shall determine current freeway vehicle miles traveled (direction of travel, time of day)	DSS	User Need 13
F13.2.1.11.1	The ICMS shall determine current freeway vehicle miles traveled (northbound, AM peak)	DSS	User Need 13
F13.2.1.11.2	The ICMS shall determine current freeway vehicle miles traveled (northbound, PM peak)	DSS	User Need 13
F13.2.1.11.3	The ICMS shall determine current freeway vehicle miles traveled (southbound, AM peak)	DSS	User Need 13
F13.2.1.11.4	The ICMS shall determine current freeway vehicle miles traveled (southbound, PM peak)	DSS	User Need 13
F13.2.1.12	The ICMS shall determine current freeway person miles traveled (direction of travel, time of day)	DSS	User Need 13
F13.2.1.12.1	The ICMS shall determine current freeway person miles traveled (northbound, AM peak)	DSS	User Need 13
F13.2.1.12.2	The ICMS shall determine current freeway person miles traveled (northbound, PM peak)	DSS	User Need 13
F13.2.1.12.3	The ICMS shall determine current freeway person miles traveled (southbound, AM peak)	DSS	User Need 13
F13.2.1.12.4	The ICMS shall determine current freeway person miles traveled (southbound, PM peak)	DSS	User Need 13

ID	Description	Subsystem Allocation	ConOps Trace
F13.2.1.13	The ICMS shall determine current freeway vehicle hours traveled (direction of travel, time of day)	DSS	User Need 13
F13.2.1.13.1	The ICMS shall determine current freeway vehicle hours traveled (northbound, AM peak)	DSS	User Need 13
F13.2.1.13.2	The ICMS shall determine current freeway vehicle hours traveled (northbound, PM peak)	DSS	User Need 13
F13.2.1.13.3	The ICMS shall determine current freeway vehicle hours traveled (southbound, AM peak)	DSS	User Need 13
F13.2.1.13.4	The ICMS shall determine current freeway vehicle hours traveled (southbound, PM peak)	DSS	User Need 13
F13.2.1.14	The ICMS shall determine current freeway people hours traveled (direction of travel, time of day)	DSS	User Need 13
F13.2.1.14.1	The ICMS shall determine current freeway people hours traveled (northbound, AM peak)	DSS	User Need 13
F13.2.1.14.2	The ICMS shall determine current freeway people hours traveled (northbound, PM peak)	DSS	User Need 13
F13.2.1.14.3	The ICMS shall determine current freeway people hours traveled (southbound, AM peak)	DSS	User Need 13
F13.2.1.14.4	The ICMS shall determine current freeway people hours traveled (southbound, PM peak)	DSS	User Need 13
F13.2.1.15	The ICMS shall determine current freeway productivity (direction of travel, time of day)	DSS	User Need 13
F13.2.1.15.1	The ICMS shall determine current freeway productivity (northbound, AM peak)	DSS	User Need 13
F13.2.1.15.2	The ICMS shall determine current freeway productivity (northbound, PM peak)	DSS	User Need 13
F13.2.1.15.3	The ICMS shall determine current freeway productivity (southbound, AM peak)	DSS	User Need 13
F13.2.1.15.4	The ICMS shall determine current freeway productivity (southbound, PM peak)	DSS	User Need 13
F13.2.1.16	The ICMS shall determine the number of freeway incidents (direction of travel, time of day)	DSS	User Need 13
F13.2.1.16.1	The ICMS shall determine the number of freeway incidents (northbound, AM peak)	DSS	User Need 13
F13.2.1.16.2	The ICMS shall determine the number of freeway incidents (northbound, PM peak)	DSS	User Need 13
F13.2.1.16.3	The ICMS shall determine the number of freeway incidents (southbound, AM peak)	DSS	User Need 13
F13.2.1.16.4	The ICMS shall determine the number of freeway incidents (southbound, PM peak)	DSS	User Need 13
F13.2.1.17	The ICMS shall determine the freeway incident rate (direction of travel, time of day)	DSS	User Need 13
F13.2.1.17.1	The ICMS shall determine the freeway incident rate (northbound, AM peak)	DSS	User Need 13

ID	Description	Subsystem Allocation	ConOps Trace
F13.2.1.17.2	The ICMS shall determine the freeway incident rate (northbound, PM peak)	DSS	User Need 13
F13.2.1.17.3	The ICMS shall determine the freeway incident rate (southbound, AM peak)	DSS	User Need 13
F13.2.1.17.4	The ICMS shall determine the freeway incident rate (southbound, PM peak)	DSS	User Need 13
F13.2.1.18	The ICMS shall determine the number of fatalities on the freeway network (direction of travel, time of day)	DSS	User Need 13
F13.2.1.18.1	The ICMS shall determine the number of fatalities on the freeway network (northbound, AM peak)	DSS	User Need 13
F13.2.1.18.2	The ICMS shall determine the number of fatalities on the freeway network (northbound, PM peak)	DSS	User Need 13
F13.2.1.18.3	The ICMS shall determine the number of fatalities on the freeway network (southbound, AM peak)	DSS	User Need 13
F13.2.1.18.4	The ICMS shall determine the number of fatalities on the freeway network (southbound, PM peak)	DSS	User Need 13
F13.2.1.19	The ICMS shall determine the fatality rate on the freeway network (direction of travel, time of day)	DSS	User Need 13
F13.2.1.19.1	The ICMS shall determine the fatality rate on the freeway network (northbound, AM peak)	DSS	User Need 13
F13.2.1.19.2	The ICMS shall determine the fatality rate on the freeway network (northbound, PM peak)	DSS	User Need 13
F13.2.1.19.3	The ICMS shall determine the fatality rate on the freeway network (southbound, AM peak)	DSS	User Need 13
F13.2.1.19.4	The ICMS shall determine the fatality rate on the freeway network (southbound, PM peak)	DSS	User Need 13
F13.2.1.20	The ICMS shall determine the number of injuries on the freeway network (direction of travel, time of day)	DSS	User Need 13
F13.2.1.20.1	The ICMS shall determine the number of injuries on the freeway network (northbound, AM peak)	DSS	User Need 13
F13.2.1.20.2	The ICMS shall determine the number of injuries on the freeway network (northbound, PM peak)	DSS	User Need 13
F13.2.1.20.3	The ICMS shall determine the number of injuries on the freeway network (southbound, AM peak)	DSS	User Need 13
F13.2.1.20.4	The ICMS shall determine the number of injuries on the freeway network (southbound, PM peak)	DSS	User Need 13
F13.2.1.21	The ICMS shall determine the injury rate on the freeway network (direction of travel, time of day)	DSS	User Need 13
F13.2.1.21.1	The ICMS shall determine the injury rate on the freeway network (northbound, AM peak)	DSS	User Need 13
F13.2.1.21.2	The ICMS shall determine the injury rate on the freeway network (northbound, PM peak)	DSS	User Need 13
F13.2.1.21.3	The ICMS shall determine the injury rate on the freeway network (southbound, AM peak)	DSS	User Need 13

ID	Description	Subsystem Allocation	ConOps Trace
F13.2.1.21.4	The ICMS shall determine the injury rate on the freeway network (southbound, PM peak)	DSS	User Need 13
F13.2.1.22	The ICMS shall determine freeway incident response times (direction of travel, time of day)	DSS	User Need 13
F13.2.1.22.1	The ICMS shall determine freeway incident response times (northbound, AM peak)	DSS	User Need 13
F13.2.1.22.2	The ICMS shall determine freeway incident response times (northbound, PM peak)	DSS	User Need 13
F13.2.1.22.3	The ICMS shall determine freeway incident response times (southbound, AM peak)	DSS	User Need 13
F13.2.1.22.4	The ICMS shall determine freeway incident response times (southbound, PM peak)	DSS	User Need 13
F13.2.1.23	The ICMS shall determine freeway incident clearance times (direction of travel, time of day)	DSS	User Need 13
F13.2.1.23.1	The ICMS shall determine freeway incident clearance times (northbound, AM peak)	DSS	User Need 13
F13.2.1.23.2	The ICMS shall determine freeway incident clearance times (northbound, PM peak)	DSS	User Need 13
F13.2.1.23.3	The ICMS shall determine freeway incident clearance times (southbound, AM peak)	DSS	User Need 13
F13.2.1.23.4	The ICMS shall determine freeway incident clearance times (southbound, PM peak)	DSS	User Need 13
F13.2.2	The ICMS shall provide a means to add roads to the arterial network part of the I-15 corridor	DSS	User Need 13
F13.2.2.1	The ICMS shall provide a means to define segments (start location, end location) of roadways added to the arterial network	DSS	User Need 13
F13.2.2.2	The ICMS shall determine performance measures (traffic volumes, travel speeds, travel times, level of service, vehicle miles traveled, vehicle hours traveled, person miles traveled, person hours traveled, number of incidents, incident rate, number of fatalities, fatality rate, number of injuries, injury rate, incident response time, incident clearance time) for defined arterial roadway segments	DSS	User Need 13
F13.2.2.2.1	The ICMS shall determine traffic volumes for defined arterial roadway segments (direction of travel, time of day)	DSS	User Need 13
F13.2.2.2.1.1	The ICMS shall determine traffic volumes for defined roadway segments (northbound, AM peak)	DSS	User Need 13
F13.2.2.2.1.2	The ICMS shall determine traffic volumes for defined roadway segments (northbound, PM peak)	DSS	User Need 13
F13.2.2.2.1.3	The ICMS shall determine traffic volumes for defined roadway segments (southbound, AM peak)	DSS	User Need 13
F13.2.2.2.1.4	The ICMS shall determine traffic volumes for defined roadway segments (southbound, PM peak)	DSS	User Need 13
F13.2.2.2.2	The ICMS shall determine travel speeds for defined arterial roadway segments (direction of travel, time of day)	DSS	User Need 13

ID	Description	Subsystem Allocation	ConOps Trace
F13.2.2.2.2.1	The ICMS shall determine travel speeds for defined roadway segments (northbound, AM peak)	DSS	User Need 13
F13.2.2.2.2.2	The ICMS shall determine travel speeds for defined roadway segments (northbound, PM peak)	DSS	User Need 13
F13.2.2.2.2.3	The ICMS shall determine travel speeds for defined roadway segments (southbound, AM peak)	DSS	User Need 13
F13.2.2.2.2.4	The ICMS shall determine travel speeds for defined roadway segments (southbound, PM peak)	DSS	User Need 13
F13.2.2.2.3	The ICMS shall determine travel times for defined arterial roadway segments (direction of travel, time of day)	DSS	User Need 13
F13.2.2.2.3.1	The ICMS shall determine travel times for defined roadway segments (northbound, AM peak)	DSS	User Need 13
F13.2.2.2.3.2	The ICMS shall determine travel times for defined roadway segments (northbound, PM peak)	DSS	User Need 13
F13.2.2.2.3.3	The ICMS shall determine travel times for defined roadway segments (southbound, AM peak)	DSS	User Need 13
F13.2.2.2.3.4	The ICMS shall determine travel times for defined roadway segments (southbound, PM peak)	DSS	User Need 13
F13.2.2.2.4	The ICMS shall determine current LOS for defined arterial roadway segments (direction of travel, time of day)	DSS	User Need 13
F13.2.2.2.4.1	The ICMS shall determine current LOS for defined roadway segments (northbound, AM peak)	DSS	User Need 13
F13.2.2.2.4.2	The ICMS shall determine current LOS for defined roadway segments (northbound, PM peak)	DSS	User Need 13
F13.2.2.2.4.3	The ICMS shall determine current LOS for defined roadway segments (southbound, AM peak)	DSS	User Need 13
F13.2.2.2.4.4	The ICMS shall determine current LOS for defined roadway segments (southbound, PM peak)	DSS	User Need 13
F13.2.2.2.5	The ICMS shall determine current vehicle miles traveled for defined arterial roadway segments (direction of travel, time of day)	DSS	User Need 13
F13.2.2.2.5.1	The ICMS shall determine current vehicle miles traveled for defined roadway segments (northbound, AM peak)	DSS	User Need 13
F13.2.2.2.5.2	The ICMS shall determine current vehicle miles traveled for defined roadway segments (northbound, PM peak)	DSS	User Need 13
F13.2.2.2.5.3	The ICMS shall determine current vehicle miles traveled for defined roadway segments (southbound, AM peak)	DSS	User Need 13
F13.2.2.2.5.4	The ICMS shall determine current vehicle miles traveled for defined roadway segments (southbound, PM peak)	DSS	User Need 13
F13.2.2.2.6	The ICMS shall determine current vehicle hours traveled for defined arterial roadway segments (direction of travel, time of day)	DSS	User Need 13
F13.2.2.2.6.1	The ICMS shall determine current vehicle hours traveled for defined roadway segments (northbound, AM peak)	DSS	User Need 13

ID	Description	Subsystem Allocation	ConOps Trace
F13.2.2.2.6.2	The ICMS shall determine current vehicle hours traveled for defined roadway segments (northbound, PM peak)	DSS	User Need 13
F13.2.2.2.6.3	The ICMS shall determine current vehicle hours traveled for defined roadway segments (southbound, AM peak)	DSS	User Need 13
F13.2.2.2.6.4	The ICMS shall determine current vehicle hours traveled for defined roadway segments (southbound, PM peak)	DSS	User Need 13
F13.2.2.2.7	The ICMS shall determine current people miles traveled for defined arterial roadway segments (direction of travel, time of day)	DSS	User Need 13
F13.2.2.2.7.1	The ICMS shall determine current people miles traveled for defined roadway segments (northbound, AM peak)	DSS	User Need 13
F13.2.2.2.7.2	The ICMS shall determine current people miles traveled for defined roadway segments (northbound, PM peak)	DSS	User Need 13
F13.2.2.2.7.3	The ICMS shall determine current people miles traveled for defined roadway segments (southbound, AM peak)	DSS	User Need 13
F13.2.2.2.7.4	The ICMS shall determine current people miles traveled for defined roadway segments (southbound, PM peak)	DSS	User Need 13
F13.2.2.2.8	The ICMS shall determine current people hours traveled for defined arterial roadway segments (direction of travel, time of day)	DSS	User Need 13
F13.2.2.2.8.1	The ICMS shall determine current people hours traveled for defined roadway segments (northbound, AM peak)	DSS	User Need 13
F13.2.2.2.8.2	The ICMS shall determine current people hours traveled for defined roadway segments (northbound, PM peak)	DSS	User Need 13
F13.2.2.2.8.3	The ICMS shall determine current people hours traveled for defined roadway segments (southbound, AM peak)	DSS	User Need 13
F13.2.2.2.8.4	The ICMS shall determine current people hours traveled for defined roadway segments (southbound, PM peak)	DSS	User Need 13
F13.2.2.2.9	The ICMS shall determine current number of incidents for defined arterial roadway segments (direction of travel, time of day)	DSS	User Need 13
F13.2.2.2.9.1	The ICMS shall determine current number of incidents for defined roadway segments (northbound, AM peak)	DSS	User Need 13
F13.2.2.2.9.2	The ICMS shall determine current number of incidents for defined roadway segments (northbound, PM peak)	DSS	User Need 13
F13.2.2.2.9.3	The ICMS shall determine current number of incidents for defined roadway segments (southbound, AM peak)	DSS	User Need 13
F13.2.2.2.9.4	The ICMS shall determine current number of incidents for defined roadway segments (southbound, PM peak)	DSS	User Need 13
F13.2.2.2.10	The ICMS shall determine current incident rate for defined arterial roadway segments (direction of travel, time of day)	DSS	User Need 13
F13.2.2.2.10.1	The ICMS shall determine current incident rate for defined roadway segments (northbound, AM peak)	DSS	User Need 13
F13.2.2.2.10.2	The ICMS shall determine current incident rate for defined roadway segments (northbound, PM peak)	DSS	User Need 13

ID	Description	Subsystem Allocation	ConOps Trace
F13.2.2.2.10.3	The ICMS shall determine current incident rate for defined roadway segments (southbound, AM peak)	DSS	User Need 13
F13.2.2.2.10.4	The ICMS shall determine current incident rate for defined roadway segments (southbound, PM peak)	DSS	User Need 13
F13.2.2.2.11	The ICMS shall determine current number of fatalities for defined arterial roadway segments (direction of travel, time of day)	DSS	User Need 13
F13.2.2.2.11.1	The ICMS shall determine current number of fatalities for defined roadway segments (northbound, AM peak)	DSS	User Need 13
F13.2.2.2.11.2	The ICMS shall determine current number of fatalities for defined roadway segments (northbound, PM peak)	DSS	User Need 13
F13.2.2.2.11.3	The ICMS shall determine current number of fatalities for defined roadway segments (southbound, AM peak)	DSS	User Need 13
F13.2.2.2.11.4	The ICMS shall determine current number of fatalities for defined roadway segments (southbound, PM peak)	DSS	User Need 13
F13.2.2.2.12	The ICMS shall determine current fatality rate for defined arterial roadway segments (direction of travel, time of day)	DSS	User Need 13
F13.2.2.2.12.1	The ICMS shall determine current fatality rate for defined roadway segments (northbound, AM peak)	DSS	User Need 13
F13.2.2.2.12.2	The ICMS shall determine current fatality rate for defined roadway segments (northbound, PM peak)	DSS	User Need 13
F13.2.2.2.12.3	The ICMS shall determine current fatality rate for defined roadway segments (southbound, AM peak)	DSS	User Need 13
F13.2.2.2.12.4	The ICMS shall determine current fatality rate for defined roadway segments (southbound, PM peak)	DSS	User Need 13
F13.2.2.2.13	The ICMS shall determine current number of injuries for defined arterial roadway segments (direction of travel, time of day)	DSS	User Need 13
F13.2.2.2.13.1	The ICMS shall determine current number of injuries for defined roadway segments (northbound, AM peak)	DSS	User Need 13
F13.2.2.2.13.2	The ICMS shall determine current number of injuries for defined roadway segments (northbound, PM peak)	DSS	User Need 13
F13.2.2.2.13.3	The ICMS shall determine current number of injuries for defined roadway segments (southbound, AM peak)	DSS	User Need 13
F13.2.2.2.13.4	The ICMS shall determine current number of injuries for defined roadway segments (southbound, PM peak)	DSS	User Need 13
F13.2.2.2.14	The ICMS shall determine current injury rate for defined arterial roadway segments (direction of travel, time of day)	DSS	User Need 13
F13.2.2.2.14.1	The ICMS shall determine current injury rate for defined roadway segments (northbound, AM peak)	DSS	User Need 13
F13.2.2.2.14.2	The ICMS shall determine current injury rate for defined roadway segments (northbound, PM peak)	DSS	User Need 13
F13.2.2.2.14.3	The ICMS shall determine current injury rate for defined roadway segments (southbound, AM peak)	DSS	User Need 13

ID	Description	Subsystem Allocation	ConOps Trace
F13.2.2.2.14.4	The ICMS shall determine current injury rate for defined roadway segments (southbound, PM peak)	DSS	User Need 13
F13.2.2.2.15	The ICMS shall determine current incident response time for defined arterial roadway segments (direction of travel, time of day)	DSS	User Need 13
F13.2.2.2.15.1	The ICMS shall determine current incident response time for defined roadway segments (northbound, AM peak)	DSS	User Need 13
F13.2.2.2.15.2	The ICMS shall determine current incident response time for defined roadway segments (northbound, PM peak)	DSS	User Need 13
F13.2.2.2.15.3	The ICMS shall determine current incident response time for defined roadway segments (southbound, AM peak)	DSS	User Need 13
F13.2.2.2.15.4	The ICMS shall determine current incident response time for defined roadway segments (southbound, PM peak)	DSS	User Need 13
F13.2.2.2.16	The ICMS shall determine current incident clearance time for defined arterial roadway segments (direction of travel, time of day)	DSS	User Need 13
F13.2.2.2.16.1	The ICMS shall determine current incident clearance time for defined roadway segments (northbound, AM peak)	DSS	User Need 13
F13.2.2.2.16.2	The ICMS shall determine current incident clearance time for defined roadway segments (northbound, PM peak)	DSS	User Need 13
F13.2.2.2.16.3	The ICMS shall determine current incident clearance time for defined roadway segments (southbound, AM peak)	DSS	User Need 13
F13.2.2.2.16.4	The ICMS shall determine current incident clearance time for defined roadway segments (southbound, PM peak)	DSS	User Need 13
F13.2.3	The ICMS shall determine performance measures (traffic volumes, travel speeds, travel times, LOS, vehicle miles traveled, vehicle hours traveled, person miles traveled, person hours traveled, productivity, number of incidents, incident rate, number of fatalities, fatality rate, number of injuries, injury rate, incident response time, incident clearance time) for the freeway	DSS	User Need 13
F13.2.3.1	The ICMS shall determine current HOV/HOT/ML traffic volumes (direction of travel, time of day)	DSS	User Need 13
F13.2.3.1.1	The ICMS shall determine current HOV/HOT/ML traffic volumes (northbound, AM peak)	DSS	User Need 13
F13.2.3.1.2	The ICMS shall determine current HOV/HOT/ML traffic volumes (northbound, PM peak)	DSS	User Need 13
F13.2.3.1.3	The ICMS shall determine current HOV/HOT/ML traffic volumes (southbound, AM peak)	DSS	User Need 13
F13.2.3.1.4	The ICMS shall determine current HOV/HOT/ML traffic volumes (southbound, PM peak)	DSS	User Need 13
F13.2.3.2	The ICMS shall determine current HOV/HOT/ML travel speeds (direction of travel, time of day)	DSS	User Need 13
F13.2.3.2.1	The ICMS shall determine current HOV/HOT/ML travel speeds (northbound, AM peak)	DSS	User Need 13
F13.2.3.2.2	The ICMS shall determine current HOV/HOT/ML travel speeds (northbound, PM peak)	DSS	User Need 13

ID	Description	Subsystem Allocation	ConOps Trace
F13.2.3.2.3	The ICMS shall determine current HOV/HOT/ML travel speeds (southbound, AM peak)	DSS	User Need 13
F13.2.3.2.4	The ICMS shall determine current HOV/HOT/ML travel speeds (southbound, PM peak)	DSS	User Need 13
F13.2.3.3	The ICMS shall determine current HOV/HOT/ML travel times (direction of travel, time of day)	DSS	User Need 13
F13.2.3.3.1	The ICMS shall determine current HOV/HOT/ML travel times (northbound, AM peak)	DSS	User Need 13
F13.2.3.3.2	The ICMS shall determine current HOV/HOT/ML travel times (northbound, PM peak)	DSS	User Need 13
F13.2.3.3.3	The ICMS shall determine current HOV/HOT/ML travel times (southbound, AM peak)	DSS	User Need 13
F13.2.3.3.4	The ICMS shall determine current HOV/HOT/ML travel times (southbound, PM peak)	DSS	User Need 13
F13.2.3.4	The ICMS shall determine current HOV/HOT/ML LOS (direction of travel, time of day)	DSS	User Need 13
F13.2.3.4.1	The ICMS shall determine current HOV/HOT/ML LOS (northbound, AM peak)	DSS	User Need 13
F13.2.3.4.2	The ICMS shall determine current HOV/HOT/ML LOS (northbound, PM peak)	DSS	User Need 13
F13.2.3.4.3	The ICMS shall determine current HOV/HOT/ML LOS (southbound, AM peak)	DSS	User Need 13
F13.2.3.4.4	The ICMS shall determine current HOV/HOT/ML LOS (southbound, PM peak)	DSS	User Need 13
F13.2.3.5	The ICMS shall determine current HOV/HOT/ML vehicle miles traveled (direction of travel, time of day)	DSS	User Need 13
F13.2.3.5.1	The ICMS shall determine current HOV/HOT/ML vehicle miles traveled (northbound, AM peak)	DSS	User Need 13
F13.2.3.5.2	The ICMS shall determine current HOV/HOT/ML vehicle miles traveled (northbound, PM peak)	DSS	User Need 13
F13.2.3.5.3	The ICMS shall determine current HOV/HOT/ML vehicle miles traveled (southbound, AM peak)	DSS	User Need 13
F13.2.3.5.4	The ICMS shall determine current HOV/HOT/ML vehicle miles traveled (southbound, PM peak)	DSS	User Need 13
F13.2.3.6	The ICMS shall determine current HOV/HOT/ML person miles traveled (direction of travel, time of day)	DSS	User Need 13
F13.2.3.6.1	The ICMS shall determine current HOV/HOT/ML person miles traveled (northbound, AM peak)	DSS	User Need 13
F13.2.3.6.2	The ICMS shall determine current HOV/HOT/ML person miles traveled (northbound, PM peak)	DSS	User Need 13
F13.2.3.6.3	The ICMS shall determine current HOV/HOT/ML person miles traveled (southbound, AM peak)	DSS	User Need 13
F13.2.3.6.4	The ICMS shall determine current HOV/HOT/ML person miles traveled (southbound, PM peak)	DSS	User Need 13

ID	Description	Subsystem Allocation	ConOps Trace
F13.2.3.7	The ICMS shall determine current HOV/HOT/ML vehicle hours traveled (direction of travel, time of day)	DSS	User Need 13
F13.2.3.7.1	The ICMS shall determine current HOV/HOT/ML vehicle hours traveled (northbound, AM peak)	DSS	User Need 13
F13.2.3.7.2	The ICMS shall determine current HOV/HOT/ML vehicle hours traveled (northbound, PM peak)	DSS	User Need 13
F13.2.3.7.3	The ICMS shall determine current HOV/HOT/ML vehicle hours traveled (southbound, AM peak)	DSS	User Need 13
F13.2.3.7.4	The ICMS shall determine current HOV/HOT/ML vehicle hours traveled (southbound, PM peak)	DSS	User Need 13
F13.2.3.8	The ICMS shall determine current HOV/HOT/ML people hours traveled (direction of travel, time of day)	DSS	User Need 13
F13.2.3.8.1	The ICMS shall determine current HOV/HOT/ML people hours traveled (northbound, AM peak)	DSS	User Need 13
F13.2.3.8.2	The ICMS shall determine current HOV/HOT/ML people hours traveled (northbound, PM peak)	DSS	User Need 13
F13.2.3.8.3	The ICMS shall determine current HOV/HOT/ML people hours traveled (southbound, AM peak)	DSS	User Need 13
F13.2.3.8.4	The ICMS shall determine current HOV/HOT/ML people hours traveled (southbound, PM peak)	DSS	User Need 13
F13.2.3.9	The ICMS shall determine current HOV/HOT/ML productivity (direction of travel, time of day)	DSS	User Need 13
F13.2.3.9.1	The ICMS shall determine current HOV/HOT/ML productivity (northbound, AM peak)	DSS	User Need 13
F13.2.3.9.2	The ICMS shall determine current HOV/HOT/ML productivity (northbound, PM peak)	DSS	User Need 13
F13.2.3.9.3	The ICMS shall determine current HOV/HOT/ML productivity (southbound, AM peak)	DSS	User Need 13
F13.2.3.9.4	The ICMS shall determine current HOV/HOT/ML productivity (southbound, PM peak)	DSS	User Need 13
F13.2.3.10	The ICMS shall determine the number of HOV/HOT/ML incidents (direction of travel, time of day)	DSS	User Need 13
F13.2.3.10.1	The ICMS shall determine the number of HOV/HOT/ML incidents (northbound, AM peak)	DSS	User Need 13
F13.2.3.10.2	The ICMS shall determine the number of HOV/HOT/ML incidents (northbound, PM peak)	DSS	User Need 13
F13.2.3.10.3	The ICMS shall determine the number of HOV/HOT/ML incidents (southbound, AM peak)	DSS	User Need 13
F13.2.3.10.4	The ICMS shall determine the number of HOV/HOT/ML incidents (southbound, PM peak)	DSS	User Need 13
F13.2.3.11	The ICMS shall determine the HOV/HOT/ML incident rate (direction of travel, time of day)	DSS	User Need 13
F13.2.3.11.1	The ICMS shall determine the HOV/HOT/ML incident rate (northbound, AM peak)	DSS	User Need 13

ID	Description	Subsystem Allocation	ConOps Trace
F13.2.3.11.2	The ICMS shall determine the HOV/HOT/ML incident rate (northbound, PM peak)	DSS	User Need 13
F13.2.3.11.3	The ICMS shall determine the HOV/HOT/ML incident rate (southbound, AM peak)	DSS	User Need 13
F13.2.3.11.4	The ICMS shall determine the HOV/HOT/ML incident rate (southbound, PM peak)	DSS	User Need 13
F13.2.3.12	The ICMS shall determine the number of fatalities on the HOV/HOT/ML network (direction of travel, time of day)	DSS	User Need 13
F13.2.3.12.1	The ICMS shall determine the number of fatalities on the HOV/HOT/ML network (northbound, AM peak)	DSS	User Need 13
F13.2.3.12.2	The ICMS shall determine the number of fatalities on the HOV/HOT/ML network (northbound, PM peak)	DSS	User Need 13
F13.2.3.12.3	The ICMS shall determine the number of fatalities on the HOV/HOT/ML network (southbound, AM peak)	DSS	User Need 13
F13.2.3.12.4	The ICMS shall determine the number of fatalities on the HOV/HOT/ML network (southbound, PM peak)	DSS	User Need 13
F13.2.3.13	The ICMS shall determine the fatality rate on the HOV/HOT/ML network (direction of travel, time of day)	DSS	User Need 13
F13.2.3.13.1	The ICMS shall determine the fatality rate on the HOV/HOT/ML network (northbound, AM peak)	DSS	User Need 13
F13.2.3.13.2	The ICMS shall determine the fatality rate on the HOV/HOT/ML network (northbound, PM peak)	DSS	User Need 13
F13.2.3.13.3	The ICMS shall determine the fatality rate on the HOV/HOT/ML network (southbound, AM peak)	DSS	User Need 13
F13.2.3.13.4	The ICMS shall determine the fatality rate on the HOV/HOT/ML network (southbound, PM peak)	DSS	User Need 13
F13.2.3.14	The ICMS shall determine the number of injuries on the HOV/HOT/ML network (direction of travel, time of day)	DSS	User Need 13
F13.2.3.14.1	The ICMS shall determine the number of injuries on the HOV/HOT/ML network (northbound, AM peak)	DSS	User Need 13
F13.2.3.14.2	The ICMS shall determine the number of injuries on the HOV/HOT/ML network (northbound, PM peak)	DSS	User Need 13
F13.2.3.14.3	The ICMS shall determine the number of injuries on the HOV/HOT/ML network (southbound, AM peak)	DSS	User Need 13
F13.2.3.14.4	The ICMS shall determine the number of injuries on the HOV/HOT/ML network (southbound, PM peak)	DSS	User Need 13
F13.2.3.15	The ICMS shall determine the injury rate on the HOV/HOT/ML network (direction of travel, time of day)	DSS	User Need 13
F13.2.3.15.1	The ICMS shall determine the injury rate on the HOV/HOT/ML network (northbound, AM peak)	DSS	User Need 13
F13.2.3.15.2	The ICMS shall determine the injury rate on the HOV/HOT/ML network (northbound, PM peak)	DSS	User Need 13
F13.2.3.15.3	The ICMS shall determine the injury rate on the HOV/HOT/ML network (southbound, AM peak)	DSS	User Need 13

ID	Description	Subsystem Allocation	ConOps Trace
F13.2.3.15.4	The ICMS shall determine the injury rate on the HOV/HOT/ML network (southbound, PM peak)	DSS	User Need 13
F13.2.3.16	The ICMS shall determine HOV/HOT/ML incident response times (direction of travel, time of day)	DSS	User Need 13
F13.2.3.16.1	The ICMS shall determine HOV/HOT/ML incident response times (northbound, AM peak)	DSS	User Need 13
F13.2.3.16.2	The ICMS shall determine HOV/HOT/ML incident response times (northbound, PM peak)	DSS	User Need 13
F13.2.3.16.3	The ICMS shall determine HOV/HOT/ML incident response times (southbound, AM peak)	DSS	User Need 13
F13.2.3.16.4	The ICMS shall determine HOV/HOT/ML incident response times (southbound, PM peak)	DSS	User Need 13
F13.2.3.17	The ICMS shall determine HOV/HOT/ML incident clearance times (direction of travel, time of day)	DSS	User Need 13
F13.2.3.17.1	The ICMS shall determine HOV/HOT/ML incident clearance times (northbound, AM peak)	DSS	User Need 13
F13.2.3.17.2	The ICMS shall determine HOV/HOT/ML incident clearance times (northbound, PM peak)	DSS	User Need 13
F13.2.3.17.3	The ICMS shall determine HOV/HOT/ML incident clearance times (southbound, AM peak)	DSS	User Need 13
F13.2.3.17.4	The ICMS shall determine HOV/HOT/ML incident clearance times (southbound, PM peak)		
F13.2.4	The ICMS shall determine current transit network performance measures (service speeds, travel times, transit productivity, transit/auto travel time difference, reliability, number of incidents, incident rate, number of fatalities, fatality rate, number of injuries, injury rate, incident response times, incident clearance times, buffer index)	DSS	User Need 13
F13.2.4.1	The ICMS shall determine current transit service speeds (Route ID, Block ID, Driver ID, Bus ID) (AM and PM peak periods)	DSS	User Need 13
F13.2.4.1.1	The ICMS shall determine current transit service speeds (Route ID, Block ID, Driver ID, Bus ID) (AM peak)	DSS	User Need 13
F13.2.4.1.2	The ICMS shall determine current transit service speeds (Route ID, Block ID, Driver ID, Bus ID) (PM peak)	DSS	User Need 13
F13.2.4.2	The ICMS shall determine current transit travel times (Route ID, Block ID, Driver ID, Bus ID) (AM and PM peak periods)	DSS	User Need 13
F13.2.4.2.1	The ICMS shall determine current transit travel times (Route ID, Block ID, Driver ID, Bus ID) (AM peak)	DSS	User Need 13
F13.2.4.2.2	The ICMS shall determine current transit travel times (Route ID, Block ID, Driver ID, Bus ID) (PM peak)	DSS	User Need 13
F13.2.4.3	The ICMS shall determine current transit productivity (Route ID, Block ID, Driver ID, Bus ID) (AM and PM peak periods)	DSS	User Need 13

ID	Description	Subsystem Allocation	ConOps Trace
F13.2.4.3.1	The ICMS shall determine current transit productivity (Route ID, Block ID, Driver ID, Bus ID) (AM peak)	DSS	User Need 13
F13.2.4.3.2	The ICMS shall determine current transit productivity (Route ID, Block ID, Driver ID, Bus ID) (PM peak)	DSS	User Need 13
F13.2.4.4	The ICMS shall determine current transit/auto travel time difference (Route ID, Block ID, Driver ID, Bus ID) (AM and PM peak periods)	DSS	User Need 13
F13.2.4.4.1	The ICMS shall determine current transit/auto travel time difference (Route ID, Block ID, Driver ID, Bus ID) (AM peak)	DSS	User Need 13
F13.2.4.4.2	The ICMS shall determine current transit/auto travel time difference (Route ID, Block ID, Driver ID, Bus ID) (PM peak)	DSS	User Need 13
F13.2.4.5	The ICMS shall determine current transit reliability (Route ID, Block ID, Driver ID, Bus ID) (AM and PM peak periods)	DSS	User Need 13
F13.2.4.5.1	The ICMS shall determine current transit reliability (Route ID, Block ID, Driver ID, Bus ID) (AM peak)	DSS	User Need 13
F13.2.4.5.2	The ICMS shall determine current transit reliability (Route ID, Block ID, Driver ID, Bus ID) (PM peak)	DSS	User Need 13
F13.2.4.6	The ICMS shall determine the number of incidents for the transit network (Route ID, Block ID, Driver ID, Bus ID) (AM and PM peak periods)	DSS	User Need 13
F13.2.4.6.1	The ICMS shall determine the number of incidents for the transit network (Route ID, Block ID, Driver ID, Bus ID) (AM peak)	DSS	User Need 13
F13.2.4.6.2	The ICMS shall determine the number of incidents for the transit network (Route ID, Block ID, Driver ID, Bus ID) (PM peak)	DSS	User Need 13
F13.2.4.7	The ICMS shall determine the incident rate for the transit network (Route ID, Block ID, Driver ID, Bus ID) (AM and PM peak periods)	DSS	User Need 13
F13.2.4.7.1	The ICMS shall determine the incident rate for the transit network (Route ID, Block ID, Driver ID, Bus ID) (AM peak)	DSS	User Need 13
F13.2.4.7.2	The ICMS shall determine the incident rate for the transit network (Route ID, Block ID, Driver ID, Bus ID) (PM peak)	DSS	User Need 13
F13.2.4.8	The ICMS shall determine the number of fatalities for the transit network (Route ID, Block ID, Driver ID, Bus ID) (AM and PM peak periods)	DSS	User Need 13
F13.2.4.8.1	The ICMS shall determine the number of fatalities for the transit network (Route ID, Block ID, Driver ID, Bus ID) (AM peak)	DSS	User Need 13
F13.2.4.8.2	The ICMS shall determine the number of fatalities for the transit network (Route ID, Block ID, Driver ID, Bus ID) (PM peak)	DSS	User Need 13
F13.2.4.9	The ICMS shall determine the fatality rate for the transit network (Route ID, Block ID, Driver ID, Bus ID) (AM and PM peak periods)	DSS	User Need 13

ID	Description	Subsystem Allocation	ConOps Trace
F13.2.4.9.1	The ICMS shall determine the fatality rate for the transit network (Route ID, Block ID, Driver ID, Bus ID) (AM peak)	DSS	User Need 13
F13.2.4.9.2	The ICMS shall determine the fatality rate for the transit network (Route ID, Block ID, Driver ID, Bus ID) (PM peak)	DSS	User Need 13
F13.2.4.10	The ICMS shall determine the number of injuries for the transit network (Route ID, Block ID, Driver ID, Bus ID) (AM and PM peak periods)	DSS	User Need 13
F13.2.4.10.1	The ICMS shall determine the number of injuries for the transit network (Route ID, Block ID, Driver ID, Bus ID) (AM peak)	DSS	User Need 13
F13.2.4.10.2	The ICMS shall determine the number of injuries for the transit network (Route ID, Block ID, Driver ID, Bus ID) (PM peak)	DSS	User Need 13
F13.2.4.11	The ICMS shall determine the injury rate for the transit network (Route ID, Block ID, Driver ID, Bus ID) (AM and PM peak periods)	DSS	User Need 13
F13.2.4.11.1	The ICMS shall determine the injury rate for the transit network (Route ID, Block ID, Driver ID, Bus ID) (AM peak)	DSS	User Need 13
F13.2.4.11.2	The ICMS shall determine the injury rate for the transit network (Route ID, Block ID, Driver ID, Bus ID) (PM peak)	DSS	User Need 13
F13.2.4.12	The ICMS shall determine the incident response times for the transit network (Route ID, Block ID, Driver ID, Bus ID) (AM and PM peak periods)	DSS	User Need 13
F13.2.4.12.1	The ICMS shall determine the incident response times for the transit network (Route ID, Block ID, Driver ID, Bus ID) (AM peak)	DSS	User Need 13
F13.2.4.12.2	The ICMS shall determine the incident response times for the transit network (Route ID, Block ID, Driver ID, Bus ID) (PM peak)	DSS	User Need 13
F13.2.4.13	The ICMS shall determine the incident clearance times for the transit network (Route ID, Block ID, Driver ID, Bus ID) (AM and PM peak periods)	DSS	User Need 13
F13.2.4.13.1	The ICMS shall determine the incident clearance times for the transit network (Route ID, Block ID, Driver ID, Bus ID) (AM peak)	DSS	User Need 13
F13.2.4.13.2	The ICMS shall determine the incident clearance times for the transit network (Route ID, Block ID, Driver ID, Bus ID) (PM peak)	DSS	User Need 13
F13.2.4.14	The ICMS shall determine the buffer index (Route ID, Block ID, Driver ID, Bus ID) (AM and PM peak periods)	DSS	User Need 13
F13.2.4.14.1	The ICMS shall determine the buffer index for the transit network (Route ID, Block ID, Driver ID, Bus ID) (AM peak)	DSS	User Need 13
F13.2.4.14.2	The ICMS shall determine the buffer index for the transit network (Route ID, Block ID, Driver ID, Bus ID) (PM peak)	DSS	User Need 13
F13.2.5	The ICMS shall determine information for travelers performance measures	DSS	User Need 13

ID	Description	Subsystem Allocation	ConOps Trace
F13.2.5.1	The ICMS shall determine the number of I-15 corridor-related telephone calls into the regional 511 system (time, date)	DSS	User Need 13
F13.2.5.2	The ICMS shall determine the call duration for I-15 corridor-related telephone calls into the regional 511 system (time, date)	DSS	User Need 13
F13.2.5.3	The ICMS shall determine the number of I-15 corridor-related Web visits to the regional 511 system (time, date)	DSS	User Need 13
F13.2.5.4	The ICMS shall determine the Web session duration for I-15 corridor-related Web visits to the regional 511 system (time, date)	DSS	User Need 13

3.8.14 Capacity and Demand Management

Long-term corridor management is needed to optimize traveler throughput and other metrics established by regional policy. This entails measuring highway, transit, parking, and congestion pricing performance over an extended period (see Section 3.8.13 above) and applying this data to various demand and capacity management strategies. Demand management in the corridor includes van pooling, mode shift with smart parking, ramp metering, and congestion pricing. Capacity management includes managed lanes, traffic signal synchronization, transit service changes, and transit signal priority. The testing and deployment recommendation of these strategies will be done using long-term impact assessment tools such as macro-, meso- and micro-level simulations (and combinations of these). Simulation outputs then guide the application of appropriate measures to optimize corridor performance.

ID	Description	Subsystem Allocation	ConOps Trace
F14.1	The ICMS shall forecast network (freeway, arterial, HOV/HOT/ML, transit) demand	DSS	User Need 14
F14.1.1	The ICMS shall forecast freeway network demand	DSS	User Need 14
F14.1.1.1	The ICMS shall forecast freeway demand in both northbound and southbound directions with operator configurable parameters (start date, interval, duration)	DSS	User Need 14
F14.1.1.1.1	The ICMS shall forecast freeway demand in the northbound direction with operator configurable parameters (start date, interval, duration)	DSS	User Need 14
F14.1.1.1.2	The ICMS shall forecast freeway demand in the southbound direction with operator configurable parameters (start date, interval, duration)	DSS	User Need 14
F14.1.2	The ICMS shall provide a means to identify the arterial network part of the I-15 corridor	DSS	User Need 14
F14.1.3	The ICMS shall provide a means to identify segments (start location, end location) of roadways added to the arterial network	DSS	User Need 14
F14.1.4	The ICMS shall forecast arterial network demand for defined arterial roadway segments	DSS	User Need 14

ID	Description	Subsystem Allocation	ConOps Trace
F14.1.4.1	The ICMS shall forecast demand for defined arterial roadway segments in both northbound and southbound directions with operator configurable parameters (start date, interval, duration)	DSS	User Need 14
F14.1.4.1.1	The ICMS shall forecast demand for defined arterial roadway segments in the northbound direction with operator configurable parameters (start date, interval, duration)	DSS	User Need 14
F14.1.4.1.2	The ICMS shall forecast demand for defined arterial roadway segments in the southbound direction with operator configurable parameters (start date, interval, duration)	DSS	User Need 14
F14.1.5	The ICMS shall forecast HOV/HOT/ML network demand	DSS	User Need 14
F14.1.5.1	The ICMS shall forecast HOV/HOT/ML demand in both northbound and southbound directions with operator configurable parameters (start date, interval, duration)	DSS	User Need 14
F14.1.5.1.1	The ICMS shall forecast HOV/HOT/ML demand in the northbound direction with operator configurable parameters (start date, interval, duration)	DSS	User Need 14
F14.1.5.1.2	The ICMS shall forecast HOV/HOT/ML demand in the southbound direction with operator configurable parameters (start date, interval, duration)	DSS	User Need 14
F14.1.6	The ICMS shall forecast transit network demand	DSS	User Need 14
F14.1.6.1	The ICMS shall forecast transit network demand using Route ID, Block ID, Block ID Start Time, Block ID End Time with operator configurable parameters (interval and duration)	DSS	User Need 14
F14.2	The ICMS shall determine network (freeway, arterial, HOV/HOT/ML, transit) capacities	DSS	User Need 14
F14.2.1	The ICMS shall determine freeway network capacity	DSS	User Need 14
F14.2.1.1	The ICMS shall determine freeway network capacity in both northbound and southbound directions	DSS	User Need 14
F14.2.1.1.1	The ICMS shall determine freeway network capacity in the northbound direction	DSS	User Need 14
F14.2.1.1.2	The ICMS shall determine freeway network capacity in the southbound direction	DSS	User Need 14
F14.2.2	The ICMS shall determine arterial network capacities for defined arterial roadway segments	DSS	User Need 14
F14.2.2.1	The ICMS shall determine capacity for defined arterial roadway segments in both northbound and southbound directions	DSS	User Need 14
F14.2.2.1.1	The ICMS shall determine capacity for defined arterial roadway segments in the northbound direction	DSS	User Need 14
F14.2.2.1.2	The ICMS shall determine capacity for defined arterial roadway segments in the southbound direction	DSS	User Need 14
F14.2.3	The ICMS shall determine HOV/HOT/ML network capacity	DSS	User Need 14

ID	Description	Subsystem Allocation	ConOps Trace
F14.2.3.1	The ICMS shall determine HOV/HOT/ML network capacity in both northbound and southbound directions	DSS	User Need 14
F14.2.3.1.1	The ICMS shall determine HOV/HOT/ML network capacity in the northbound direction	DSS	User Need 14
F14.2.3.1.2	The ICMS shall determine HOV/HOT/ML network capacity in the southbound direction	DSS	User Need 14
F14,2.4	The ICMS shall determine transit network capacity	DSS	User Need 14
F14.2.4.1	The ICMS shall determine transit network capacity using Route ID, Block ID, Block ID Start Time, Block ID End Time	DSS	User Need 14
F14.3	The ICMS system shall maintain corridor capacities (freeway, arterial, HOV/HOT/ML, Transit) in a local configuration database	System Services	User Need 1 User Need 14
F14.4	The ICMS system shall maintain real-time demand data (freeway, arterials, HOV/HOT/ML, transit in a local historical database	System Services	User Need 3 User Need 14
F14.5	The ICMS system shall calculate excess capacity by comparing current real-time demand against stored capacity (freeway, arterial, HOV/HOT/ML, transit)	DSS	User Need 14
F14.5.1	The ICMS system shall store real-time excess capacities in a local historical database (freeway, arterial, HOV/HOT/ML, transit)	System Services	User Need 3 User Need 14
F14.5.2	The ICMS system shall calculate and store real-time excess capacities using pre-defined roadway segments (freeway, arterial, HOV/HOT/ML)	System Services	User Need 3 User Need 14
F14.5.3	The ICMS system shall calculate and store real-time excess capacities by pre-defined transit route segments	System Services	User Need 3 User Need 14
F14.6	The ICMS system shall incorporate a modeling application (application to be determined) for macro-, meso- and micro-simulation of corridor operational conditions for long-term strategic analysis	DSS	User Need 14
F14.6.1	The ICMS system shall incorporate a modeling interface (data input, visualization) to assess long-term impacts of excess capacities and resulting management strategies (ramp metering, MLCS operation, traffic signal timing, transit service changes)	DSS	User Need 14
F14.6.1.1	The ICMS system shall incorporate a data input function for long term modeling (modal capacities, modal demands, ramp meter operational parameters, arterial signal timing plans, HOV/HOT/ML configurations, transit routes and service headways)	DSS	User Need 14
F14.6.1.2	The ICMS system long-term impact assessment function shall provide modeling visualization in both 2D and 3D formats	DSS	User Need 14
F14.6.2	The ICMS system long-term impact assessment function shall provide modeling results for assessing long-term van pool management strategies (van pools, mode-shift with smart parking, ramp metering, congestion pricing)	DSS	User Need 14

ID	Description	Subsystem Allocation	ConOps Trace
F14.6.2.1	The ICMS system long-term impact assessment function shall provide modeling results for assessing long-term van pool management strategies	DSS	User Need 14
F14.6.2.2	The ICMS system long-term impact assessment function shall provide modeling results for assessing long-term mode-shift strategies (smart parking availability, BRT service, feeder routes, destination shuttle service, traveler information systems)	DSS	User Need 14
F14.6.2.3	The ICMS system long-term impact assessment function shall provide modeling results for assessing long-term ramp metering strategies (metering time, metering modes, metered ramps for AM peak, metered ramps for PM peak)	DSS	User Need 14
F14.6.2.4	The ICMS system long-term impact assessment function shall provide modeling results for assessing long-term congestion pricing strategies (congestion pricing algorithm adjustments)	DSS	User Need 14
F14.6.3	The ICMS system long-term impact assessment function shall provide modeling results for assessing long-term capacity management strategies (Managed Lanes, traffic signal timing, transit service changes, transit signal priority)	DSS	User Need 14
F14.6.3.1	The ICMS system long-term impact assessment function shall provide modeling results for assessing long-term managed lane strategies (lane re-configuration times, lane re-configuration patterns)	DSS	User Need 14
F14.6.3.2	The ICMS system long-term impact assessment function shall provide modeling results for assessing long-term traffic signal timing strategies (timing plan adjustments, multi-jurisdictional timing plans, recurring special event timing plans, coordinated signal locations)	DSS	User Need 14
F14.6.3.3	The ICMS system long-term impact assessment function shall provide modeling results for assessing long-term transit service strategies (new conventional routes, new BRT routes, origin feeder routes, destination shuttle routes, new stops, new transit centers)	DSS	User Need 14
F14.6.3.4	The ICMS system long-term impact assessment function shall provide modeling results for assessing long-term transit signal priority strategies	DSS	User Need 14

3.8.15 System Performance Measurement

System performance measurement encompasses the collection of data related to system failures, bandwidth allocation, server reliability and availability, communication link performance, and other metrics related to the management of ICMS subsystems.

ID	Description	Subsystem Allocation	ConOps Trace
P15.1	The ICMS (servers, routers, firewalls) shall function on a continuous 24/7 schedule	System Services	User Need 15

ID	Description	Subsystem Allocation	ConOps Trace
P15.2	The ICMS agency data servers (ATMS 2005, RMIS, CHP, RTMS, RAMS, MLCS, CPS, SPS, REMS) shall maintain an availability of 716 out of every 720 consecutive hours	System Services	User Need 15
P15.3	The ICMS data publishing servers (IAI, Map, ISP) shall maintain an availability of 716 out of every 720 consecutive hours	System Services	User Need 15
P15.4	The ICMS communications links to external systems (ATMS 2005, RMIS, CHP, RTMS, RAMS, MLCS, CPS, SPS, REMS) shall maintain an availability of 716 out of every 720 consecutive hours	System Services	User Need 15
F15.5	The ICMS shall incorporate a network management system capable of 24/7 monitoring of ICMS networks and connected IT equipment (servers, routers, firewalls)	System Services	User Need 15

3.8.16 System Management

The ICMS will implement a security system that allows the shared viewing of regional resources and the shared control of selected field devices. Shared viewing and control will be subject to regional agreements to be determined. System security will as a minimum implement user privilege levels and a password system linked to user levels. The ICMS will provide the capability to add new users, delete users, and modify user privileges. System management also will include the ability to backup critical files on an automatic schedule and to archive data to offline storage for retention purposes.

ID	Description	Subsystem Allocation	ConOps Trace
F16.1	The ICMS shall acquire an Internet-based standard time source	System Services	User Need 16
F16.1.1	The ICMS shall use a standard time source to synchronize all connected systems to a common time reference	System Services	User Need 16
F16.1.2	The ICMS shall automatically adjust the standard time source for daylight savings time	System Services	User Need 16
F16.2	The ICMS shall provide tools to enable and disable data acquisition feeds from external systems (ATMS 2005, RMIS, MLCS, CPS, RTMS, RAMS, REMS, SPS)	System Services	User Need 16
F16.3	The ICMS shall provide controls to enable and disable data publishing feeds from ICMS to external systems (ATMS 2005, RMIS, MLCS, CPS, RTMS, RAMS, REMS, SPS)	System Services	User Need 16
F16.4	The ICMS shall provide controls to enable and disable response plan recommendations to external systems (ATMS 2005, MLCS, RMIS, CPS, RAMS)	System Services	User Need 16
F16.5	The ICMS shall provide a program monitor process	System Services	User Need 16
F16.5.1	The ICMS program monitor shall automatically initialize and start all processes in required order	System Services	User Need 16
F16.5.2	The ICMS program monitor shall continuously monitor all ICMS processes	System Services	User Need 16

ID	Description	Subsystem Allocation	ConOps Trace
F16.5.3	The ICMS program monitor shall automatically restart processes that terminate abnormally	System Services	User Need 16
F16.5.4	The ICMS program monitor shall automatically sequence a process restart to include the correct order of associated process restarts	System Services	User Need 16
F16.5.5	The ICMS program monitor shall log all system process restarts with process ID, failure time, restart time and associated process restarts	System Services	User Need 16
F16.6	The ICMS shall provide a system administration (administrator, user) user interface	System Services	User Need 16
F16.6.1	The ICMS shall provide a user interface to log on and off the system with a username and password	System Services	User Need 16
F16.6.2	The ICMS shall provide a system administrator function to manage (create, modify, delete) user accounts	System Services	User Need 16
F16.6.2.1	The ICMS shall provide an interface to create operator/administrator accounts	System Services	User Need 16
F16.6.2.2	The ICMS shall provide an interface to modify operator/administrator accounts	System Services	User Need 16
F16.6.2.3	The ICMS shall provide an interface to delete operator/administrator accounts	System Services	User Need 16
F16.7	The ICMS shall ensure there is always at least one active administrator account per server	System Services	User Need 16
F16.8	The ICMS shall provide an interface to manage (create, modify, delete) user groups	System Services	User Need 16
F16.8.1	The ICMS shall provide an interface to create user groups	System Services	User Need 16
F16.8.2	The ICMS shall provide an interface to modify (add users, delete users, modify privileges) user groups	System Services	User Need 16
F16.8.3	The ICMS shall provide an interface to delete user groups	System Services	User Need 16
F16.8.4	The ICMS shall incorporate a function to assign system privileges (ITS device access) by user group	System Services	User Need 16
F16.9	The ICMS shall provide an interface to edit ITS device access rules for motorist information devices (CMS, HAR)	System Services	User Need 16
F16.9.1	The ICMS shall provide an interface to edit ITS device access rules for CMS (organization ID, user ID, time period, allowed functions)	System Services	User Need 16
F16.9.2	The ICMS shall provide an interface to edit ITS device access rules for HAR (organization ID, user ID, time period, allowed functions)	System Services	User Need 16
F16.10	The ICMS shall provide an interface to edit ITS device access rules for video devices (cameras, switches, digital video recorders)	System Services	User Need 16
F16.10.1	The ICMS shall provide an interface to edit ITS device access rules for cameras (organization ID, user ID, time period, allowed functions)	System Services	User Need 16

ID	Description	Subsystem Allocation	ConOps Trace
F16.10.2	The ICMS shall provide an interface to edit ITS device access rules for video switches (organization ID, user ID, time period, allowed functions)	System Services	User Need 16
F16.10.3	The ICMS shall provide an interface to edit ITS device access rules for digital video recorders (organization ID, user ID, time period, allowed functions)	System Services	User Need 16
F16.11	The ICMS shall provide an interface to log system user logons and logoffs	System Services	User Need 16
F16.11.1	The ICMS shall provide an interface to audit the system security log	System Services	User Need 16
F16.12	The ICMS shall use a network firewall to isolate the ICMS local area network	System Services	User Need 16
F16.13	The ICMS shall incorporate a system backup function using an off-the-shelf application	System Services	User Need 16
F16.13.1	The ICMS backup function shall incorporate an automatic scheduling feature	System Services	User Need 16
F16.13.2	The ICMS backup function shall allow the designation of directories and files for backup	System Services	User Need 16
F16.13.3	The ICMS backup process shall include system software applications	System Services	User Need 16
F16.13.4	The ICMS backup process shall include all ICMS database files	System Services	User Need 16
F16.14	The ICMS shall incorporate an archival function for historical inventory data using an off-the-shelf application	System Services	User Need 16
F16.14.1	The ICMS archival tool shall include a process to create removable media archives	System Services	User Need 16

3.8.17 Life Cycle Management

Software will form an integral part of the ICMS. There is a proliferation of standards, procedures, methods, tools, and environments for developing and managing software. This proliferation has created difficulties in software management and engineering, especially in integrating products and services. The ICMS will use an industry-standard framework that can be used by ICMS developers, managers, operators, maintainers, and trainers to "speak the same language" to create and manage the software component of the ICMS. The IEEE/Electronics Industries Association (EIA) 12207.0-1996 Standard for Life Cycle processes will provide such a framework for the ICMS and guide its use throughout the ICMS life cycle.

The framework covers the life cycle of software from conceptualization of ideas through retirement and consists of processes for acquiring and supplying software products and services. In addition, the framework provides for controlling and improving these processes.

The processes in this IEEE Standard form a comprehensive set. The standard is, therefore, designed to be tailored for an individual project, in this case the ICMS. It is designed to be used when software is an embedded or integral part of the total system, such as is the case with the ICMS.

ID	Description	Subsystem Allocation	ConOps Trace
F17.1	The ICMS shall remotely access equipment failure reports from connected subsystems (ATMS 2005, RTMS, RAMS, CPS, SPS)	System Services	User Need 17
F17.1.1	The ICMS shall remotely access equipment failure reports from ATMS 2005	System Services	User Need 17
F17.1.1.1	The ICMS shall receive equipment failure alerts from ATMS 2005	System Services	User Need 17
F17.1.2	The ICMS shall remotely access equipment failure reports from RTMS	System Services	User Need 17
F17.1.2.1	The ICMS shall receive equipment failure alerts from RTMS	System Services	User Need 17
F17.1.3	The ICMS shall remotely access equipment failure reports from RAMS	System Services	User Need 17
F17.1.3.1	The ICMS shall receive equipment failure alerts from RAMS	System Services	User Need 17
F17.1.4	The ICMS shall remotely access equipment failure reports from CPS	System Services	User Need 17
F17.1.4.1	The ICMS shall receive equipment failure alerts from CPS	System Services	User Need 17
F17.1.5	The ICMS shall remotely access equipment failure reports from SPS	System Services	User Need 17
F17.1.5.1	The ICMS shall receive equipment failure alerts from SPS	System Services	User Need 17
F17.2	The ICMS shall maintain an alert log for system and equipment failures	System Services	User Need 17
F17.3	The ICMS shall store online configuration management records (CM plan, configuration records, configuration change board minutes)	System Services	User Need 17
F17.4	The ICMS shall store online system development documentation (concept of operations, system requirements specification, system architecture description, system design description, system release notes)	System Services	User Need 17
F17.5	The ICMS shall store online system test and deployment documentation (system test plan, system test procedures, system test report, system installation plans, system cutover plan)	System Services	User Need 17
F17.6	The ICMS shall store online interface control documents for ICMS subsystems (ATMS 2005, MLCS, RMIS, LCS, CPS, RTMS, RAMS, SPS, CHP CAD, SDSD CAD, SDPD CAD, EPD CAD, SDFD CAD, EFD CAD, WebEOC)	System Services	User Need 17
F17.6.1	The ICMS shall store an online interface control document for ATMS 2005	System Services	User Need 17
F17.6.2	The ICMS shall store an online interface control document for MLCS	System Services	User Need 17
F17.6.3	The ICMS shall store an online interface control document for RMIS	System Services	User Need 17

ID	Description	Subsystem Allocation	ConOps Trace
F17.6.4	The ICMS shall store an online interface control document for LCS	System Services	User Need 17
F17.6.5	The ICMS shall store an online interface control document for CPS	System Services	User Need 17
F17.6.6	The ICMS shall store an online interface control document for RTMS	System Services	User Need 17
F17.6.7	The ICMS shall store an online interface control document for RAMS	System Services	User Need 17
F17.6.8	The ICMS shall store an online interface control document for SPS	System Services	User Need 17
F17.6.9	The ICMS shall store an online interface control document for the CHP CAD	System Services	User Need 17
F17.6.10	The ICMS shall store an online interface control document for the SDSD CAD	System Services	User Need 17
F17.6.11	The ICMS shall store an online interface control document for the SDPD CAD	System Services	User Need 17
F17.6.12	The ICMS shall store an online interface control document for the EPD CAD	System Services	User Need 17
F17.6.13	The ICMS shall store an online interface control document for SD Fire CAD	System Services	User Need 17
F17.6.14	The ICMS shall store an online interface control document for Escondido Fire CAD	System Services	User Need 17
F17.6.15	The ICMS shall store an online interface control document for WebEOC	System Services	User Need 17
F17.7	The ICMS shall store an online system operator user manual	System Services	User Need 17
F17.7.1	The ICMS shall store online training presentations for operations staff	System Services	User Need 17
F17.8	The ICMS shall store an online system maintenance manual	System Services	User Need 17
F17.8.1	The ICMS shall store online training presentations for maintenance staff	System Services	User Need 17
F17.9	The ICMS shall store an online system administrator's manual	System Services	User Need 17
F17.9.1	The ICMS shall store online training presentations for system administrators	System Services	User Need 17
F17.10	The ICMS shall store an online database manual	System Services	User Need 17
F17.10.1	The ICMS shall store online training presentations for database administrators	System Services	User Need 17
F17.11	The ICMS shall store an online external user operations manual	System Services	User Need 17
F17.11.1	The ICMS shall store online training presentations for ICMS external users	System Services	User Need 17

ID	Description	Subsystem Allocation	ConOps Trace
F17.12	The ICMS shall provide physical and logical interfaces for connected subsystems according to each external system's interface control document (ICD)	IMTMS	User Need 17
F17.12.1	The ICMS shall provide physical and logical interfaces for sending and receiving information to ATMS 2005 according to the IMTMS-ATMS 2005 ICD	IMTMS	User Need 17
F17.12.2	The ICMS shall provide physical and logical interfaces for sending and receiving information to the Managed Lane Control System according to the IMTMS-MLCS ICD	IMTMS	User Need 17
F17.12.3	The ICMS shall provide physical and logical interfaces for sending and receiving information to the Ramp Meter Information System according to the IMTMS-RMIS ICD	IMTMS	User Need 17
F17.12.4	The ICMS shall provide physical and logical interfaces for sending and receiving information to the Congestion Pricing System according to the IMTMS-CPS ICD	IMTMS	User Need 17
F17.12.5	The ICMS shall provide physical and logical interfaces for sending and receiving information to the Lane Closure System according to the IMTMS-LCS ICD	IMTMS	User Need 17
F17.12.6	The ICMS shall provide physical and logical interfaces for sending and receiving information to the Regional Arterial Management System according to the IMTMS-RAMS ICD	IMTMS	User Need 17
F17.12.7	The ICMS shall provide physical and logical interfaces for sending and receiving information to the Regional Transit Management System according to the IMTMS-RTMS ICD	IMTMS	User Need 17
F17.12.8	The ICMS shall provide physical and logical interfaces for sending and receiving information to the Smart Parking System according to the IMTMS-SPS ICD	IMTMS	User Need 17
F17.12.9	The ICMS shall provide physical and logical interfaces for sending and receiving information to CHP CAD according to the IMTMS-CHP CAD ICD	IMTMS	User Need 17
F17.12.10	The ICMS shall provide physical and logical interfaces for sending and receiving information to SDSD CAD according to the IMTMS-SDSD CAD ICD	IMTMS	User Need 17
F17.12.11	The ICMS shall provide physical and logical interfaces for sending and receiving information to SDPD CAD according to the IMTMS-SDPD CAD ICD	IMTMS	User Need 17
F17.12.12	The ICMS shall provide physical and logical interfaces for sending and receiving information to EPD CAD according to the IMTMS-EPD CAD ICD	IMTMS	User Need 17
F17.12.13	The ICMS shall provide physical and logical interfaces for sending and receiving information to SDFD according to the IMTMS-SDFD CAD ICD	IMTMS	User Need 17
F17.12.14	The ICMS shall provide physical and logical interfaces for sending and receiving information to EFD according to the IMTMS-EFD CAD ICD	IMTMS	User Need 17
F17.12.15	The ICMS shall provide physical and logical interfaces for sending and receiving information to WebEOC (EOC) according to the IMTMS-WebEOC ICD	IMTMS	User Need 17

Appendix A – Acronyms and Abbreviations

511	–	Regional Traveler Information Phone Number
911	–	Regional Emergency Phone Number
ADS	–	Agency Data Server
AID	–	Automatic Incident Detection
ALPR		Automatic License Plate Recognition
AMS		Analysis, Modeling, and Simulation
A-PeMS	–	Arterial Performance Management System
ATIMS	–	Advanced Traveler Information Management System
ATIS	–	Advanced Traveler Information System
ATMS	–	Advanced Traffic Management System
AVL	–	Automatic Vehicle Location
BRT	–	Bus Rapid Transit
BTM	–	Barrier Transfer Machine
CAD	–	Computer-Aided Dispatch
Caltrans	–	California Department of Transportation
CCTV	–	Closed-Circuit Television
CHP	–	California Highway Patrol
CMS	–	Changeable Message Sign
COASTER	–	Express Rail Service between San Diego and Oceanside
ConOps	–	Concept of Operations
CPS	–	Congestion Pricing System
DAR	–	Direct Access Ramp
DHS	–	Department of Homeland Security
DOT	–	Department of Transportation
DSS	–	Decision Support Subsystem (ICMS)
ECC	–	Emergency Communications Center (San Diego Sheriff Dispatch)
EEP	–	Emergency Evacuation Plan
EFD	–	Escondido Fire Department

EIA	–	Electronics Industries Association
EPD	–	Escondido Police Department
EOC	–	Emergency Operation Center
ERP	–	Emergency Response Plan
ESRI	–	Environmental Sciences Research Institute
FasTrak®	–	Fee-Based Transportation Program Allowing Single Drivers Use of I–15 Fast Lanes
FEP	–	Front End Processor
FTA	–	Federal Transit Administration
FWHA	–	Federal Highway Administration
GIS	–	Geographic Information System
GPS	–	Global Positioning System
GUI	–	Graphical User Interface
HAZMAT	–	Hazardous Material
HAR	–	Highway Advisory Radio
HOT	–	High Occupancy Toll
HOV	–	High Occupancy Vehicle
HTML	–	Hypertext Markup Language
HTTP	–	Hypertext Transfer Protocol
IAI	–	Intermodal Agency Integration
IAP	–	Intermediate Access Point (managed lanes)
ICD	–	Interface Control Document
ICM	–	Integrated Corridor Management
ICMS	–	Integrated Corridor Management System
IDD	–	Interface Design Document
IEEE	–	Institute of Electrical and Electronic Engineers
I-15	–	Interstate 15
IMTMS	–	Intermodal Transportation Management System
ISP	–	Internet Service Provider
ITS	–	Intelligent Transportation Systems
LCS	–	Lane Closure System
LOS	–	Level of Service

ML	–	Managed Lanes
MLCS	–	Managed Lanes Control System
ML TIM	–	Managed Lanes Traffic Incident Management
MOMS	–	Maintenance Online Management System
MTS	–	Metropolitan Transit System
NCTD	–	North County Transit District
NIMS	–	National Incident Management System
NorthCom	–	North County Fire Communications Joint Powers Authority
NTCIP	–	National Transportation Communications ITS Protocol
OES	–	Office of Emergency Services
PDA	–	Personal Digital Assistant
PeMS	–	Performance Management System
QuicNet 4	–	Traffic Signal Control Platform
QuicNet 4+	–	(QuicNet 5) - Upgraded Version of QuicNet 4 for RAMS
RAMS	–	Regional Arterial Management System
RCS	–	Regional Communications System
REMS	–	Regional Event Management System
RFID	–	Radio Frequency Identification
RHS	–	Regional Host Server
RideLink	–	Region Commuter and Employer Transportation Assistance Programs
RIWS	–	Regional Integrated Workstation
RLCS	–	Reversible Lane Control System
R[M]LCS	–	Reversible [Managed] Lane Control System
RMIS	–	Ramp Meter Information System
RMS	–	Ramp Metering System
RTMS	–	Regional Transit Management System
SAFE	–	Service Authority for Freeway Emergencies
SANDAG	–	San Diego Association of Governments
SDD	–	Systems Design Document
SDFD	–	San Diego Fire Department
SDPD	–	San Diego Police Department

SDSD	–	San Diego Sheriff's Department
SOA	–	Service-Oriented Architecture
SOV	–	Single Occupany Vehicle
SPRINTER	–	Commuter Light Rail Service between Oceanside and Escondido
SPS	–	Smart Parking System
TDM	–	Transportation Demand Management
3Cs	–	Command, Control, and Communications Network
TMC	–	Transportation Management Center
TMDD	–	Traffic Management Data Dictionary
TMT	–	Traffic Management Team
T-PeMS	–	Transit Performance Measurement System
TSCS	–	Traffic Signal Control System
U.S. DOT	–	United States Department of Transportation
VDS	–	Vehicle Detection Stations
VMS	–	Video Management Subsystem (IMTMS)
VJTOC	–	Virtual Joint Transportation Operation Center
VOS	–	Volume, Occupancy, and Speed
VOTT	–	Value of Travel Time
VTMS	–	Variable Toll Message Sign
WebEOC	–	Countywide Web services application currently used for sharing information among a wide variety of agencies during major emergencies
XML	–	eXtensible Markup Language

Appendix B – Requirements Management Metadata

Requirements Management Metadata

The following requirement attribute data dictionary provides a consistent definition of terms and values that will be used to manage the requirements database. These attributes are associated with each tagged (numbered) requirement in the project requirements database and will be assigned by the Project Team or specific user representation as indicated.

Attribute: Status

Condition of Use

Set after negotiation and review by the project management team. Tracks progress during definition of the project baseline.

Values

Proposed	Used to describe requirements that are under discussion but have not yet been reviewed and accepted by the project stakeholders.
Approved	Capabilities that are deemed useful and feasible and have been approved for implementation by project stakeholders.
Incorporated	Requirements incorporated into the system baseline at a specific point in time.

Applicability

Status attribute applies to system requirements and user interface requirements.

Attribute: Priority

Condition of Use

Set by modal stakeholders. All requirements are not created equal. Ranking requirements by their relative benefit to the end user opens a dialogue with customers, analysts and members of the development team. Used in managing scope and determining development priority.

Values

Critical	Essential requirements. Failure to implement means the system will not meet stakeholder needs. All critical features must be implemented in the release or the schedule will slip.
Important	Features important to the effectiveness and efficiency of the IMTMS for most applications. The functionality cannot be easily provided in some other way. Lack of inclusion of an important requirement may affect customer or user satisfaction, but release will not be delayed due to lack of any important feature.

Useful	Requirements that are useful in less typical applications, will be used less frequently, or for which reasonably efficient workarounds can be achieved. No significant stakeholder satisfaction impact can be expected if such a requirement is not implemented in a release.

Applicability

Priority attribute applies to system requirements and user interface requirements.

Attribute: Level of Effort

Condition of Use

Set by the development team. Because some features require more time and resources than others, estimating the number of team or person-weeks, lines of code required or function points, for example, is the best way to gauge complexity and set expectations of what can and cannot be accomplished in a given time frame. Used in managing scope and determining development priority.

Values

Effort will be quantified in person-weeks.

Applicability

Level of Effort attribute applies to system requirements and user interface requirements.

Attribute: Risk

Condition of Use

Set by development team based on the probability that implementation of this requirement will result in undesirable events, such as cost overruns, schedule delays, or technical hurdles.

Values

Critical	A 75% or greater probability that this requirement implementation will result in an adverse schedule, cost or technical impact to the project
Significant	A 50-74% probability that this requirement implementation will result in an adverse schedule, cost or technical impact to the project
Moderate	A 25-49% probability that this requirement implementation will result in an adverse schedule, cost or technical impact to the project
Minimal	Less than a 25% probability that this requirement implementation will result in an adverse schedule, cost or technical impact to the project

Applicability

Risk attribute applies to System Requirements and User Interface Requirements.

Attribute: Stability

Condition of Use

Set by the project management team based on the probability the requirement will change or the team's understanding of the requirement will change. Used to help establish development priorities and determine those items for which additional elicitation is the appropriate next action.

Values

5	Unanimous consensus among stakeholders on requirement
4	Majority of stakeholders agree with requirement
3	Stakeholders split evenly on requirement
2	Majority of stakeholders disagree with requirement
1	Unanimous consensus against requirement

Applicability

Stability attribute applies to System Requirements and User Interface Requirements.

Attribute: Target Release

Condition of Use

Records the intended system version in which the requirement will first appear. This field can be used to allocate requirements into a particular baseline release. When combined with the status field, the project team can propose, record and discuss various features of the release without committing them to development. Only features whose Status is set to Incorporated and whose Target Release is defined will be implemented. When scope management occurs, the Target Release Version Number can be increased so the item will remain in the requirements document but will be scheduled for a later release.

Values

Target Release attribute will be expressed as a decimal number, e.g., 1.0, 2.1, 3.2, etc.

Applicability

Target Release attribute applies to system requirements and user interface requirements.

Attribute: Assigned To

Condition of Use

Personnel responsible for further elicitation, development of software requirements and implementation. This simple pull down list will help everyone on the project team better understand responsibilities.

Values

This attribute will consist of individual or group names.

Attribute: Assigned To (cont'd)

Applicability

This attribute applies to system requirements and user interface requirements.

Attribute: Source

Condition of Use

This text field is used to track the source of the requested requirement. Requirements exist for specific reasons. This field records an explanation or a reference to an explanation. For example, the reference might be to a page and line number of a system requirement specification, or to a counter setting on a tape recording of an important user interview.

Values

This attribute value is a free text field that can be used to describe a variety of source types, such as previous documentation, meeting agenda items, etc.

Applicability

This attribute applies to system requirements and user interface requirements.

Appendix C – SANDAG Responses to the United States Department of Transportation Comments on ICMS Requirements

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For Official Use Only

U.S. Department of Transportation (U.S. DOT)
Integrated Corridor Management (ICM)

Comments on the
Draft System Requirements Specification (SyRS)
San Diego ICM Pioneer Site

February 29, 2008

AOTR:
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Washington, DC 20590
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202-493-0459

Table of Contents

1 REVIEW APPROACH AND STRUCTURE OF COMMENTS

The Pioneer Site Draft SyRS review approach is to provide *Recommendations*, *General Comments*, and *Specific Comments*. The Specific Comment focus on two areas—System Description; and ICM System Requirements. Note that the focus is on ensuring the systems engineering elements that clearly describe the system you plan to build and correctly present the requirements that this system must fulfill.

Specific Comments Sections and General Questions

Review Section	***Description and general questions***
4.1	System Description Did you clearly identify the purpose of the system you are planning to build? Did you clearly define the scope (problems to be addressed, goals, objectives) of the proposed system? Did you clearly identify the context (i.e., system boundaries and significant interfaces that cross those boundaries) of your proposed system? Did you clearly identify the major characteristics (operational needs) of your proposed system? Did you clearly describe the characteristics of all users of your proposed system? Did you clearly identify all the major constraints that limit what your proposed system can do? Did you clearly describe all assumptions and dependencies affecting your system?
4.2	System Requirements Are all requirements written as well-formed requirements[7]? Do all requirements have the following characteristics? ▸ Abstract (each requirement should be implementation independent) ▸ Unambiguous (each requirement should be stated such that it can be interpreted in only one way) ▸ Traceable (for each requirement it should be feasible to determine a relationship between specific operational needs and specific statements in the definition of the system in the SyRS as evidence of the requirement's source) ▸ Validatable (each requirement should have the means to prove that the system satisfies the requirement)[8] Are, at a minimum, the following types of requirements present? ▸ Functional ▸ Performance ▸ Security ▸ Data ▸ Reliability ▸ Interface

[7] A well-formed requirement is defined as one is "a statement of system functionality (a capability) that can be validated, and that must be met or possessed by a system to solve a customer problem or to achieve a customer objective, and is qualified by measurable conditions and bounded by constraints." This definition is taken from IEEE-Std. 1233-1998, *IEEE Guide for Developing System Requirements Specifications.*

[8] Taken from IEEE-Std. 1233-1998, *IEEE Guide for Developing System Requirements Specifications.*

Both the *General* and *Specific Comments* are meant to be precise and actionable, but they should not be considered exhaustive. Furthermore, the comments are uniquely identified by Item, Page, and Section number for easy reference to your SyRS.

2 RECOMMENDATIONS

1. This review does not cover every requirement in the SyRS. We recommend applying the comments discussed in this review to all requirements in the SyRS.
2. It would be helpful to add a brief explanation of the meaning of the letters and numbers that comprise the requirement ID.
3. It would make the document easier to read if table headings repeated on each page and cells within the tables did not break across pages.

3 GENERAL COMMENTS

The *General Comments* address either the overall perception of the SyRS or a response to a particular section or sections in the SyRS.

1. The purpose of the document is addressed in Section 1, however this section should clearly describe the purpose of the ICMS. Also, the scope of the project is listed but it does not adequately address the problems to be addressed, goals, and objectives.

   RESPONSE: *This is the same as Items 1 and 2 from Section 4.1 of this document. Please see our response to these items.*

2. The system boundaries and interfaces are inconsistent between the diagrams in the document. The document explains the functionality of each component, and identifies which components exist and which are new.

   RESPONSE: *This is generally the same as Item 4 of Section 4.1 of this document. Please see our response to this item.*

3. The operational characteristics are described in section 2.3.

   RESPONSE: *The comment is noted; no other response is necessary.*

4. The user characteristics are provided in section 2.4.

   RESPONSE: *The comment is noted; no other response is necessary.*

5. The description of constraints in section 2.5 includes institutional, technological, and operational constraints that are well-described and appropriate for the project.

   RESPONSE: *The comment is noted; no other response is necessary.*

6. Assumptions and dependencies are briefly discussed in section 2.6.

   RESPONSE: *The comment is noted; no other response is necessary.*

7. Requirements identification (numbering) is understandable and facilitates traceability. While all of the requirements are traceable to one of the 17 documented needs, it is not immediately obvious how this traceability is accomplished. It appears that the parent needs identified in Table 3-3 (ID Number) are used in conjunction with a letter to form the prefix of each requirement. However, the ConOps trace column is blank.

   RESPONSE: *This is the same as specific comments in Items 9 and 10 in Section 4.2 of this document. Please see our responses to these items.*

8. Most of the requirements are well-formed and understandable. The inclusion of a list of "action verbs" and a definition explaining what they mean in the context of the specification is very helpful to the understanding of the requirements.

   RESPONSE: *The comment is noted; no other response is necessary.*

9. The detailed requirements for the DSS appear to include current roads and freeways, but there are not any requirements for the DSS to be able to include additional roads and freeways.

   RESPONSE: *We very much appreciate this comment and have made the appropriate changes to the requirements in Functional Area 13 (Section 3.8.13 Corridor Performance Measurement) so that we no longer specify by name the three primary arterials within the I-15 corridor but allow for the inclusion of any defined arterial roadway segment.*

10. With some clarification, the document would provide enough information for a design team to prepare a System Architecture Description and to proceed with the system design activities.

    RESPONSE: *With the changes we have made in producing this Final System Requirements document, we believe it has provided the clarification referred to in this comment.*

11. A clear and concise approach to defining the system and its automation boundaries (system boundaries) should be developed. Please explain the approach used to define what is internal to the system and what is external.

    RESPONSE: *This comment is similar to Item 4 of Section 4.1 of this document. Please see our response to this item.*

12. The requirements discussed on page 128 for system life-cycle management as defined, may not conform to industry accepted terminology. System life-cycle is broader than just documentation, training, and maintenance. ISO/IEC 15288:2002 defines system life cycle as, "the evolution with time of a system-of-interest from conception through to retirement".

RESPONSE: *We have consulted IEEE/EIA 12207.0-1996 Software Life Cycle Process and IEEE/EIA 12207.1-1997 Software Lifecycle Process – Lifecycle Data to address this comment in the Final System Requirements document. A new Section 2.4 has been added addressing this issue as well as a modified lead-in paragraph for Section 3.8.17.*

4 SPECIFIC COMMENTS

4.1 Specific System Description Comments

This section provides specific comments on the system description contained in the SyRS—i.e., the SyRS must clearly identify the system you are trying to build, its scope, context, major characteristics, user characteristics, major constraints, and all assumptions and dependencies. The specific comments below request clarification of some items.

Item	**1.**
Page	**1**
Section	**1.1 Purpose**
Comment	This section describes the purpose of the document and not the purpose of the system. Please consider the following: "The ICMS will provide stakeholder agencies with the means to implement the agreed upon ICM operational concept …"
San Diego ICM Pioneer Site Response 3/31/2008	*We have addressed this comment by re-writing Section 1.1 Purpose to focus on the purpose of ICMS, not purpose of the document.*

Item	**2.**
Page	**1**
Section	**1.2 System Scope**
Comment	Section 1.2 System Scope does not clearly define the problems to be addressed or the goals and objectives of the proposed system. Please consider adding text that discusses what type of problems are faced by stakeholders that requires the deployment of an ICMS and how the ICMS will enable stakeholders to mitigate the problems. However, a description of the ICMS can be found in Section 2.2.
San Diego ICM Pioneer Site Response 3/31/2008	*We have addressed this omission in the Final System Requirements document by providing text similar to that suggested above in the comment. Section 1.2 now clearly reviews stakeholder needs, vision, goals and objectives.*

Item	**3.**
Page	**4**
Section	**2.2 ICMS System Description**
Comment	Please define the term "Systems of Systems" and provide an ICMS system description that meets the definition. Below is a suggested definition taken from the Department of Defense's "System of Systems Engineering Guide: Considerations for Systems Engineering in a Systems of Systems Environment."[9] It's important to have a clear understanding of the type of system the ICMS is when defining the automation boundaries and partitioning the system. **"1.5. Definition of Terms** **1.5.1. System of Systems** This guide uses the following as a representative definition for **system**: an integrated set of elements that accomplish a defined objective [INCOSE, 2004]. A **capability** is the ability to achieve a desired effect under specified standards and conditions through combinations of ways and means to perform a set of tasks [CJCS, 2007(2)]. An **SoS** is defined as a set or arrangement of systems that results when independent and useful systems are integrated into a larger system that delivers unique capabilities [DoD, 2004(1)]. When integrated, the independent systems can become interdependent, which is a relationship of mutual dependence and benefit between the integrated systems. Both systems and SoS conform to the accepted definition of a system in that each consists of parts, relationships, and a whole that is greater than the sum of the parts; however, although an SoS is a system, not all systems are SoS."
San Diego ICM Pioneer Site Response 3/31/2008	*We have addressed this comment in the Final System Requirements document. Reference to "System of Systems" was removed and the description simplified to refer to ICMS as consisting of three major Subsystems: System Services, IMTMS and DSS.*

Item	**4.**
Page	**4**
Section	**2.2 ICMS System Description**
Comment	Figure 2-1 ICMS System Context Diagram and Figure 2-2 ICMS System-Subsystem Architecture are logically inconsistent when compared to each other. Figure 2-1 provides a clear and concise context for the system and it's automation boundaries. Figure 2-1 depicts an ICMS that has three subsystems and 14 external interfaces to other systems, e.g., ATMS 2005. Figure 2-2 depicts an ICMS with the following five subsystems: System Management Subsystem Life-Cycle Support Subsystem Data Stores Subsystem DSS Subsystem IMTMS Subsystem Figure 2-2's IMTMS subsystem has internal interfaces with 16 subsystems. These are classified as internal subsystems, yet in Figure 2-1 these systems are external to the automation boundaries of the ICMS. The result is a logical inconsistency between Figures 2-1 and 2-2.

[9]This document is available from the Department of Defense at the following link: http://www.acq.osd.mil/sse/guidance.html; the direct link to draft version 1.0 working draft is http://www.acq.osd.mil/sse/ssa/docs/SoS-SE-Guide-v1_0-WORKING-DRAFT.pdf

Item	**4. (cont'd)**
Page	**4**
Section	**2.2 ICMS System Description**
Comment (cont'd)	Figure 2-1 provides a good example of the ICMS' subsystems and external interfaces, e.g. Two-way ICMS interface. While Figure 2-1 is clear and concise, new versus existing external interfaces are not identified. Figure 2-2 is confusing. Three ICMS subsystems: Systemwide IMTMS DSS are depicted in Figure 2-1. However, Figure 2-2 depicts five major subsystems: System Management Subsystem Life-Cycle Support Subsystem Data Stores Subsystem DSS Subsystem IMTMS Subsystem Again, the figures are not consistent. Figure 2-2's IMTMS subsystem has interfaces to CCTV and CMS subsystems; however, these subsystems are not described in Section 2. Figure 2-7 on Page 18 depicts interfaces between the IMTMS, and ATMS 2005 and the QuickNet 5 systems. The ATMS 2005 and QuickNet 5 systems contain CCTV and CMS subsystems. Please provide a reason why the CCTV and CMS subsystems are depicted as separate subsystems in Figure 2-2. It's recommended that the logical inconsistency between Figures 2-1 and 2-2 be reconciled. The ICMS is hard to comprehend due to the logical inconsistency between these important diagrams.
San Diego ICM Pioneer Site Response 3/31/2008	*We have discussed this with the USDOT Team and consequently we have revised Figure 2-2 so that it is now consistent with the Context Diagram (Figure 2-1); the revised text also addresses the issue raised in the comment.*

Item	**5.**
Page	**6**
Section	**Figure 2-2**
Comment	Will the new subsystems identified be deployed as part of the ICM demonstration project?
San Diego ICM Pioneer Site Response 3/31/2008	*The new identified subsystems with the possible exception of HAR will be deployed as part of the ICM demonstration project.*

Item	**6.**
Page	**13**
Section	**2.2.2.3 Congestion Pricing System paragraph 6**
Comment	Please provide the complete name of NTCIP standards specified for this deployment.
San Diego ICM Pioneer Site Response 3/31/2008	*We have addressed this comment in the Final System Requirements document by adding a new Section 3.5 with accompanying Table 3-4 and Figure 3-1.*

Item	**7.**
Page	**22**
Section	**2.2.4.2 Database Management paragraph 4**
Comment	PeMS appears to be an important component for data acquisition; however, PeMS is not depicted on Figure 2-1 or 2-2. Shouldn't PeMS be included in the figures?
San Diego ICM Pioneer Site Response 3/31/2008	*We have addressed this comment and PeMS now does appear in the Context Diagram (Figure 2-1).*

Item	**8.**
Page	**24**
Section	**2.3 ICMS Operational Modes**
Comment	Please consider redefining the operational modes identified in this section. Steady State and Event modes are operational modes of the corridor, not operational modes of the ICMS. Modeling Mode is a capability, i.e.: a function, not a mode of operation. This function could be used when the system was in steady state, or event mode. Failure mode is a valid mode of operation of the ICMS. Please consider adding ICMS modes for normal and degraded operations.
San Diego ICM Pioneer Site Response 3/31/2008	*We have addressed this comment and have revised the operational modes and list them as follows: normal mode, and failure mode. Failure mode has three submodes: degraded operations, complete system failure and maintenance (planned outage of one or more system components). System "states" were also defined as closely paralleling corridor modes.*

Item	**9.**
Page	**25**
Section	**Table 2-3**
Comment	In the Section 2.4 text, please explain the purpose of including the System Mode(s) column/information in Table 2-3.
San Diego ICM Pioneer Site Response 3/31/2008	*We have reviewed the need for having this information in the table, and in the Final System Requirements document, have removed the "System Mode(s)" column from Table 2-3.*

Item	**10.**
Page	**34**
Section	**Table 3.2 – Definition of incorporate and provide**
Comment	It seems odd to include "human actions" in the definition of "incorporate" and "provide" as a means of satisfying a system function.
San Diego ICM Pioneer Site Response 3/31/2008	*We have discussed this item with the USDOT Team and have received agreement that "human action" is, indeed, called for, in the definition of "Provide" and "Incorporate", in certain circumstances.*

4.2 Specific System Requirements Comments

This section provides specific comments on the requirements contained in the SyRS—i.e., the SyRS must contain well-formed requirements, requirements with appropriate characteristics (i.e., abstract, unambiguous, traceable, and validatable), and requirements of at least the following types: functional, performance, security, data, reliability, and interface. The specific comments below request clarification of some items.

Item	**1.**
Page	**29**
Section	**3.1 Requirements Framework paragraph 3**
Comment	**Please see comment eight in Section 4.1 Specific Description System Description Comments.**
San Diego ICM Pioneer Site Response 3/31/2008	*We have revised the text in Section 3.1 Requirements Framework paragraph 3 dealing with operational modes so it is now consistent with our revised set of operational modes: normal and failure.*

Item	**2.**
Page	**29**
Section	**3.1 Requirements Framework paragraph 5**
Comment	It appears that this text refers to Figure 3-1. If this is the case, please provide a reference to Figure 3-1 on Page 38.
San Diego ICM Pioneer Site Response 3/31/2008	*The indicated text does refer to both Figure 3-2 (revised from Figure 3-1 due to addition of a new figure preceding), the overview of the 17 functional areas for the ICMS as well as the set of 17 User Needs, both of which appear later in the text. We cite each one with a reference in the text.*

Item	**3.**
Page	**29-30**
Section	**3.1 Requirements Framework paragraph 5**
Comment	"The team then partitioned the 17 functional areas two additional times according to (1) the current implementation state of the ICMS subsystems (operational or awaiting development and implementation) and (2) the context of the ICMS subsystems (internal or external to the ICMS)." Please provide documentation that describes the partitioning referenced above.
San Diego ICM Pioneer Site Response 3/31/2008	*We have indicated in the text that our partitioning scheme was based on our Concept of Operations as well as Figure 2-1 of the System Requirements document.*

Item	**4.**
Page	**30**
Section	**Table 3-1 Agency Data Server**
Comment	**Please provide the complete name of the ITS Standards implemented currently or planned as part of the demonstration project.**
San Diego ICM Pioneer Site Response 3/31/2008	*We have addressed this comment in the Final System Requirements document. (See new Section 3.5).*

Item	**5.**
Page	**31**
Section	**Table 3-1, Level 1 Agency**
Comment	The following text appears in the definition for a Level 1 Agency, "Level 1 Agencies are expected to be recipients of IMTMS real-time data via either an XML data stream or a browser-based Regional Integrated Workstation (RIWS)." The aforementioned text appears to be in contradiction with the definition of a bridge. The bridge definition implies that workstations are not considered to be a host system. Can you please clarify?
San Diego ICM Pioneer Site Response 3/31/2008	*We have discussed this item with the USDOT Team. While the information in the definitions is correct, the concepts of ADS and RIWS will be clarified in the text of the Final System Requirements document.*

Item	**6.**
Page	**32**
Section	**Table 3-1, Regional Integrated Workstation**
Comment	Please explain what "when available" means.
San Diego ICM Pioneer Site Response 3/31/2008	*We have addressed this comment in the Final System Requirements document in a footnote. Basically, "when available" refers to the fact that arterial data is not currently collected but that data collection on the three primary I-15 Corridor arterials (Centre City Parkway, Pomerado Road, Kearny Villa/Black Mountain Road) will occur as part of the initial deployment of Arterial-PeMS (A-PeMS) in July 2008. Arterial congestion data will then be available.*

Item	**7.**
Page	**33**
Section	**Table 3-1, Well-Defined Protocol Formats, Well-Defined Message Formats**
Comment	Please provide the complete name for the ITS Standards currently implemented or planned for the demonstration project.
San Diego ICM Pioneer Site Response 3/31/2008	*We agree with this comment and the requested information has been specified in the Final System Requirements document. See Item 4. Above and new Section 3.5 in the System Requirements.*

Item	**8.**
Page	**33**
Section	**Table 3-1, Acquire**
Comment	Please explain the difference between the terms Acquire and Remotely Access.
San Diego ICM Pioneer Site Response 3/31/2008	*We agree with this comment and these terms have been redefined and the difference between them explained; both terms will be kept.*

Item	**9.**
Page	**39**
Section	**3.6 ICMS Requirements**
Comment	Please provide a legend for the type of requirements identified in Section 3.6. Based on text contained in the narrative of 3.6 it's assumed that requirements that begin with the letter "D" refer to data requirements and that requirements that begin with the letter "I" refer to interface requirements.
San Diego ICM Pioneer Site Response 3/31/2008	*We have provided a legend that explains how we coded each of the requirements. This legend appears in Section 3.8.*

Item	**10.**
Page	**39**
Section	**3.6. ICMS Requirements**
Comment	Please note, verification that requirements contained in Section 3.6 satisfy user needs can not be accomplished until traceability is provided in the "ConOps Trace" column.
San Diego ICM Pioneer Site Response 3/31/2008	*We agree and have provided traceability in the "ConOps Trace" column. By design, our 17 User Needs have a 1:1 correspondence with the 17 functional areas that form the foundation of the system requirements.*

Item	**11.**
Page	**39**
Section	**3.6.1 ICMS Configuration Data Store**
Comment	This sections maps to the Store Configuration Data function contained in Figure 3-1, ICMS Requirements Overview. The content identified in Figure 3-1 and the requirements in Section 3.6.1 are not consistent. For example, requirement D1.1.1 does not correlate with any of the subheadings contained in Figure 3-1, Store Configuration Data. Requirement D1.1.2 doesn't correlate with any of the subheadings contained Figure 3-1, Store Configuration Data. Due to the systemic nature of this issue, it would be prudent for the team to review all 17 functions identified in Figure 3-1 for consistency with requirements contained in Section 3.6 on Pages 39 thru 132 of the I-15 ICM Systems Requirements document. If the lack of completeness is by design, please provide an explanation.
San Diego ICM Pioneer Site Response 3/31/2008	*We agree with the comment made in this item and we have modified (new) Figure 3-2 with respect to each of the 17 functional areas to make it consistent with our system requirements.*

Item	**12.**
Page	**39**
Section	**3.6.1 ICMS Configuration Data Store**
Comment	A number of the requirements contained in this section use the following phrases: maintain local data stores maintain a database table maintain a Smart Parking System Facility table maintain a data store Are the terms to the right of the word "maintain" referencing the same thing? Is there a difference in the definition of a "local data stores," "database table," or "a data store." If there is, please define the terms in the glossary. If there isn't, please consider revising the terms used above. Due to the systemic nature of this issue, it would be prudent for the team to review all requirements in Section 3.6 on Pages 39 thru 132 of the I-15 ICM Systems Requirements document for this type of issue.
San Diego ICM Pioneer Site Response 3/31/2008	*We have revised the wording of the terms for this set of requirements to remove the ambiguity and have checked for the presence of this issue throughout each set of requirements associated with each of the 17 functional areas. In general we reference "database" as the encompassing element and "database tables" as the atomic elements. "Data Stores" is used to refer to the database management Subsystem under ICMS System Services.*

Item	**13.**
Page	**41**
Section	**3.6.2 Data Collection and Processing**
Comment	The first sentence of this section refers to "existing or planned modal management…" For the purposes of this effort, it's important to know what systems and functionality of said systems will be operational for the demonstration project. If any of the systems or an important set of functionality needed to realize the ICM operational concept will not be ready for the demonstration project, please specify/advise.
San Diego ICM Pioneer Site Response 3/31/2008	*In the Final System Requirements, we have replaced the phrase "existing or planned" with "deployed" and have included deployment dates for each of the modal management systems listed in (new) Section 3.8.2. More generally, we have provided a new timeline-schedule table in Section 2.7.6 that provides the reader with deployment dates for these as well as additional items.*

Item	**14.**
Page	**42**
Section	**3.6.2 Data Collection and Processing**
Comment	The second sentence on this page states, "ATMS 2005 computes travel times from CMS signs…" Is this a correct statement?
San Diego ICM Pioneer Site Response 3/31/2008	We have reworded the text to make this statement clear and unambiguous.

Item	**15.**
Page	**42**
Section	**3.6.2 Requirement I2.1**
Comment	Verification of "planned IMTMS" subsystems doesn't appear to be feasible. It's suggested that the word planned be removed from the requirement.
San Diego ICM Pioneer Site Response 3/31/2008	*The word "planned" has been removed from System Requirement I2.1*

Item	**16.**
Page	**46 and 47**
Section	**3.6.2 Data Collection and Processing**
Comment	The requirements contained on Pages 46 and 47 appear to be at a level of abstraction that is too low. For example, Requirement I2.1.9's localization is the REMS external system identified in Figure 2-1. The ICMS should acquire specified data from REMS for all local systems interfaced with REMS. The ICMS will not interface directly with the systems identified in the detailed requirements. Identifying each system in the requirements and not creating an abstraction will affect *scalability* and *extensibility* of the ICMS for this set of requirements. Due to the systemic nature of this issue, it would be prudent for the team to review all requirements in Section 3.6 on Pages 39 thru 132 of the I-15 ICM Systems Requirements document for this type of issue.
San Diego ICM Pioneer Site Response 3/31/2008	*We have addressed this issue and revised the set of requirements dealing with the Regional Event Management Systems; moreover, we have reviewed all requirements for the appearance of this same issue.*

Item	**17.**
Page	**48**
Section	**3.6.2 Data Collection and Processing, Requirements F2.3 and F2.4**
Comment	The aforementioned requirements are confusing and would not be understandable to a system designer. How will the ICMS compute travel times from CMS? Please revise.
San Diego ICM Pioneer Site Response 3/31/2008	*We have reworded the text of system requirements F2.3 and F2.4 and made each of them clear and unambiguous.*

Item	**18.**
Page	**48-49**
Section	**3.6.2 Data Collection and Processing**
Comment	Many of the "P" type requirements contained on these pages contain the phrase "within the interval." The phrase should not be used. A quantifiable constraint value should be used.
San Diego ICM Pioneer Site Response 3/31/2008	*In the Final System Requirements document, we have inserted the specific interval data into the affected "P" type requirements and have thus addressed this comment.*

Item	**19.**
Page	**48, 63**
Section	**F2.2, I4.3**
Comment	The phrase "well-defined" is ambiguous.
San Diego ICM Pioneer Site Response 3/31/2008	*We have removed definitions for "Well-defined protocols" and "Well-defined message formats". In requirements F2.2 and I4.3, "well-defined" has been replaced with specific sited standards, consistent with the new information provided in Section 3.5.*

Item	**20.**
Page	**56**
Section	**3.6.4 Information Publishing (Corridor Managers) Requirement I4.1.1.1**
Comment	A search was performed on the document to determine if requirements for acquiring arterial video imagery existed, none were found. Please confirm this finding or provide the requirement's location in the document. Due to the systemic nature of this issue, it would be prudent for the team to review all requirements in Section 3.6 on Pages 39 thru 132 of the I-15 ICM Systems Requirements document for this type of issue.
San Diego ICM Pioneer Site Response 3/31/2008	*We have corrected for this oversight and have inserted the appropriate requirements dealing with acquiring arterial video imagery in functional area #2 that deals with Data Collection and Processing. We have also reviewed the requirements for other appearances of this type of issue; where other such appearances have occurred, we have made the appropriate revisions.*

Item	**21.**
Page	**57**
Section	**3.6.4 Information Publishing (Corridor Managers) Requirement I4.1.1.4.1**
Comment	A search was performed on the document to determine if requirements for acquiring arterial event data existed, none were found. Please confirm this finding or provide the requirements' location in the document. Due to the systemic nature of this issue, it would be prudent for the team to review all requirements in Section 3.6 on Pages 39 thru 132 of the I-15 ICM Systems Requirements document for this type of issue.
San Diego ICM Pioneer Site Response 3/31/2008	*We have corrected for this oversight and have inserted the appropriate requirements dealing with acquiring arterial event data in functional area #2 that deals with Data Collection and Processing. We have also reviewed the requirements for other appearances of this type of issue; where other such appearances have occurred, we have made the appropriate revisions.*

Item	**22.**
Page	**66**
Section	
Comment	Two requirements do not have an ID.
San Diego ICM Pioneer Site Response 3/31/2008	*We have made the appropriate corrections and provided unique requirement IDs for these two requirements. We have also made sure that any subsequent requirements' IDs for this set of requirements (Functional Area #6) are changed as necessary.*

Item	**23.**
Page	**72**
Section	**F7.11.1**
Comment	Prior to this requirement, there are requirements to classify incidents as CONFIRMED or UNCONFIRMED but not Active. How does an incident get on the "Active Incident List"?
San Diego ICM Pioneer Site Response 3/31/2008	*We have addressed this comment in the Final System Requirements document by adding requirements describing the "Active Incident List".*

Item	**24.**
Page	**82-83**
Section	**I10.6, I10.6.1-I10.6.4**
Comment	The intent of these requirements is unclear.
San Diego ICM Pioneer Site Response 3/31/2008	*We have discussed this item with the USDOT Team. The stated requirements were reworded to indicate that these "Action Plan" interface requirements would be included in existing (or planned) ICD's. The ICD's themselves are referred to in Section 3.8.17 Life Cycle Management.*

Item	**25.**
Page	**83**
Section	**F11.1**
Comment	The intent of this requirement is unclear. How does the ICMS incorporate an entity that is external? The words "incorporate" and "external" are in conflict.
San Diego ICM Pioneer Site Response 3/31/2008	*The modeling subsystem is now an internal subsystem of the ICMS DSS as shown in Figures 2-1 and 2-1; requirements listed under functional area 11 (Impact Assessment) are now consistent with this architectural shift.*

Item	**26.**
Page	**86**
Section	**I12.2, I12.3**
Comment	These requirements identify the publishing of travel times to CMS locations, but fall within the category of publishing travel times to the ISP server. If the publishing location is correct, should additional information such as priority be addressed?
San Diego ICM Pioneer Site Response 3/31/2008	*We agree with the suggestion made and have addressed this comment in the Final System Requirements document by rewording the lead-in paragraph of Section 3.8.12 and removing requirements related to publishing travel times to CMS signs.*

Item	**27.**
Page	**119**
Section	**F13.2.5**
Comment	Requirements need to have unique numbers.
San Diego ICM Pioneer Site Response 3/31/2008	*There were two requirements with IDs "F13.2.5". This has been corrected and we have also made all necessary changes in requirements' IDs subsequent to F13.2.5 for "F13" type requirements.*

Item	**28.**
Page	**120**
Section	**3.6.14**
Comment	It is unclear what the reference "see 3.2 above" is referring to because Section 3.2 is "Definitions".
San Diego ICM Pioneer Site Response 3/31/2008	*We have corrected this and now the parenthetical remark states "see Section 3.8.13 above". The reference is to performance measurement and what is now Section 3.8.13 appeared in a previous version of this document as section 3.2*

Item	**29.**
Page	**125**
Section	**F16.5.3**
Comment	What constitutes a "hung" process?
San Diego ICM Pioneer Site Response 3/31/2008	*We have addressed this comment by rewording the requirement to use the term "terminate abnormally" instead of "hung process".*

Item	**30.**
Page	**131**
Section	**F17.12; F17.12.1-F17.12.15**
Comment	Wording needs to be added to include reference to appropriate Interface Control Document. For example, "The ICMS system shall provide physical and logical interfaces for connected subsystems according to each subsystem's Interface Control Document".
San Diego ICM Pioneer Site Response 3/31/2008	*We agree with the comment and have modified the affected requirements accordingly.*