TECHNICAL APPENDIX 6
SAN DIEGO REGION INTELLIGENT TRANSPORTATION SYSTEMS (ITS) SYSTEM ARCHITECTURE

Since the completion of the San Diego Region ITS Strategic Deployment Plan, the San Diego region has been working to deploy a series of integrated ITS projects to improve operations of the freeway, arterial, transit, and emergency management systems. The specifics of each of these ITS projects differ, but all seek to apply advanced sensor, computer, electronics, communications technologies, and management strategies to improve the reliability, safety, and efficiency of the regional surface transportation system. Basically, these ITS projects are deployed to deliver a series of transportation network services to managers and users of the transportation system.

Regional System Architecture and Federal Requirements

As part of Section 5206(e), the Transportation Equity Act for the 21st Century (TEA-21), the Federal Highway Administration (FHWA) and the Federal Transportation Administration (FTA) have established rules and policies requiring that all ITS projects funded from the Highway Trust Fund be in compliance with the National ITS Architecture. The National ITS Architecture is to meet "a general framework for planning, defining, and integrating ITS." To meet this requirement, the San Diego region is required to develop a Regional ITS Architecture to ensure technical integration and institutional agreement for ITS projects deployed in the region. SANDAG is the responsible agency for reviewing ITS projects and determining whether or not they conform to the regional architecture and meet the intent of the National ITS Architecture.

This Technical Appendix is meant to highlight the information included in the Regional ITS Architecture and to refer interested parties to the appropriate documentation. The Draft ITS System Architecture can be downloaded from the SANDAG Web site at:

> http://www.sandag.org/programs/transportation/comprehensive_transportation_projects/2030rtp/its_architecture.pdf

The federal guidance requires that the Regional ITS Architecture cover eight information areas as they relate to ITS deployment in the region. Each of the eight areas is listed in Table TA 6.1 along with the documents to which readers should refer for information on these areas.

TABLE TA 6.1—EIGHT INFORMATION AREAS OF REGIONAL ARCHITECTURE AND REFERENCE DOCUMENTS

ARCHITECTURE SECTION	DESCRIBES	REFERENCE DOCUMENTS
Regional Description	Major transportation infrastructure and existing systems in the region	• *MOBILITY 2030* – for transportation infrastructure. • *San Diego Region ITS Strategic Deployment Plan* – for summary of transportation infrastructure and existing systems • San Diego ITS Regional Architecture – Detail Document
Regional Stakeholders	Major stakeholders in ITS deployment and regional transportation operations	• *MOBILITY 2030* • *San Diego Region ITS Strategic Deployment Plan* – for all ITS system areas • *Regional Arterial Management System (RAMS) Implementation Plan* – for interjurisdictional signal coordination • *Regional AVL System Implementation Plan* – for transit and fleet management systems. • *San Diego ITS Regional Architecture Summary* • *San Diego ITS Regional Architecture – Detail Document* – for all major ITS system areas
Operational Concept	Manner in which agencies operate and use the systems	• *San Diego ITS Regional Architecture – Detail Document* – for all major ITS system areas • *San Diego Region ITS Strategic Deployment Plan* – for all ITS system areas
Operations Agreements	Existing and needed agreements to support ITS deployment and operations	• *San Diego ITS Regional Architecture – Detail Document* – for all major ITS system areas • *San Diego Region ITS Strategic Deployment Plan* – for all ITS system areas • *RAMS Implementation Plan* – for interjurisdictional signal coordination • *Regional AVL System Implementation Plan* – for transit and fleet management systems.
Functional Descriptions	Functional capabilities of the major systems	• *San Diego ITS Regional Architecture – Detail Document* – for all ITS system areas • *RAMS User & System Requirements Documents* – for interjurisdictional signal coordination • *Regional AVL User & System Requirements Documents* – for transit and fleet management systems • *San Diego Region ITS Strategic Deployment Plan* – for all ITS system areas
Information Flows & Interface Requirements	Data and functional capabilities that will be shared within and between the systems described in the architecture	• *San Diego ITS Regional Architecture Summary* • *San Diego ITS Regional Architecture – Detail Document* – for all major ITS system areas • *RAMS User & System Requirements Documents* – for interjurisdictional signal coordination

ARCHITECTURE SECTION	DESCRIBES	REFERENCE DOCUMENTS
		• *Regional AVL User & System Requirements Documents* – for transit and fleet management systems • *Advanced Traveler Information Management System (ATIMS) User Requirements* – for public sector traveler information systems • *Advanced Transportation Management System - Intermodal (ATMSi) User & System Requirements*– for the freeway management system and intermodal interactions.
Standards	ITS standards that are available, adopted, and/or being considered for adoption for deployment in the region	• *San Diego ITS Regional Architecture Summary* • *San Diego ITS Regional Architecture – Detail Document* – for all major ITS system areas
Project Phasing	Relationships and dependencies for sequencing of major ITS deployments in the region	• *San Diego ITS Regional Architecture – Detail Document* – for all ITS system areas • *RAMS Implementation Plan* – for interjurisdictional signal coordination • *San Diego Region ITS Strategic Deployment Plan* – for all ITS system areas

Regional Systems and High-Level Architecture Diagrams

San Diego Region ITS System Architecture – Detailed Document serves as an important reference for each of the eight information areas required by the federal guidance.

The Regional ITS Architecture defines the systems, physical connections between systems, as well as major data flows and functional interactions between systems. Table TA 6.2 identifies the major regional systems covered in the Regional Architecture. For each system, the table summarizes some of the basic functional services and major types of data from the system and the types of agencies likely to share these functions/data.

Included in this Technical Appendix, for reference purposes, are summary descriptions of each of the systems listed in Table TA 6.2 along with the high-level system interaction diagrams that display what types of information and functionality will be shared within and between the systems. Reference should be made to the documents listed in Table TA 6.1 for additional and/or detailed information on the systems.

TABLE TA 6.2—BRIEF SUMMARY OF ITS SYSTEMS

SYSTEMS	DESCRIPTION	BASIC FUNCTIONAL SERVICES/ DATA TYPES	STAKEHOLDER AGENCIES
IMTMS Network	Regional communications network, including leased and agency-owned communications resources that form the backbone for the exchange of information between ITS systems in the region.	**Services**: System integration, security, communications, regional network management, etc. **Data**: All types of data, including both data exclusive to a particular project and data shared between multiple ITS projects.	All agencies
Freeway Management System	Focused around the Advanced Transportation Management System (ATMS) being deployed by Caltrans District 11, it is the core of freeway management including the use of cameras, changeable message signs, and vehicle detection sensors.	**Services**: Field device (cameras, CMS, vehicle detection stations) control/ mgmt., incident/event mgmt., incident response, resource mgmt., etc. **Data**: Freeway speeds, incidents, video, sign messages, etc.	Caltrans, CHP, Cities, transit, and emergency services
Regional Arterial Management Systems	Focused around the Regional Arterial Management System (RAMS), and comprised of two basic tiers: 1. Interjurisdictional signal coordination/mgmt. 2. Local advanced traffic and event mgmt. In addition, the Mission Valley Advanced Transportation Management & Information System (ATMIS) is viewed as an initial implementation of RAMS Tier 2 for architecture purposes. MV ATMIS functions will be incorporated and expanded on as part of RAMS Tier 2.	**Services**: Signal timing/control, interjurisdictional signal timing, regional timing plan implementation, field device (cameras, CMS, vehicle detection stations) control/ mgmt., incident/event mgmt., incident response, resource mgmt., etc. **Data**: Signal status, timing, local incidents/events, arterial cameras, vehicle sensors, and message signs.	Cities, Caltrans, local law enforcement, and transit agencies
Transit Management Systems	Comprised of several transit management systems in the region for purposes of fleet management, enhanced schedule performance, improved fare payment, and improved interagency coordination.	**Services**: Fleet mgmt., vehicle tracking, emergency alerts, transit schedule & arrival info., transit traveler info., automated fare payment, etc. **Data**: Transit vehicle locations, vehicle status, schedule performance/adherence, real-time info. displays at stops, dispatch/vehicle text messages, etc.	Transit agencies, some local Cities, and emergency services during safety related incidents
Traveler Information Management Systems	The public sector will provide a common interface for private information service providers to obtain selected information from the IMTMS Network.	**Services**: Portal for public sector transportation info on IMTMS Network to private sector info providers, data translation, data filtering, etc. **Data**: Freeway/roadway speeds, incidents, announcements, transit schedule information, and next stop arrival, etc.	Private sector traveler information providers

Intermodal Transportation Management System (IMTMS) & IMTMS Network

The term Intermodal Transportation Management System (IMTMS) refers to the San Diego region's "system of systems." In layman's terms, IMTMS is the "glue" that ties together the management systems of the individual modes and allows for the intermodal sharing of data and functional capabilities. For example, IMTMS is what allows a transit agency to receive information on traffic conditions, and IMTMS is the system that allows cities to share event management information as well as traffic video and camera control, with other cities and Caltrans. IMTMS is the critical system concept in the San Diego Regional ITS Architecture. As a term, IMTMS is used to describe the integrated development and operation of the major modal management systems in the region.

The IMTMS Network refers both to the communications network across which each of the individual management systems communicates to share information and functional services as well as the interfaces, equipment, and software that allow this communication to occur. Figure TA 6.1 displays, at a general level, the various management systems and operations centers that comprise the IMTMS Network, and it also indicates the basic types of information being shared across the network. Figure TA 6.2 displays at a more specific level, some of the physical systems and links between systems that are currently being deployed as part of the IMTMS Network.

Communications across the IMTMS Network occurs at two basic levels:

1. Communications between agencies within a system – The IMTMS Network is utilized to link together various agencies utilizing a single system. For example, several cities will utilize the IMTMS Network for communicating information internal to the Regional Arterial Management System (RAMS). A specific example is when one agency is sharing signal timing coordination data with another agency. This coordination data travels between the agencies in a format specific to RAMS, and is not available to the broader users of the IMTMS Network. At this level, the IMTMS Network lets agencies throughout the region make use of a common integrated management system.

2. Communications between different modal management systems – The IMTMS Network is utilized to communicate information and share functionality between modal management systems. For example, information may travel from the Transit Management System to the Freeway Management System or vice versa. Data at this level utilizes the standards set in the Southern California SHOWCASE development effort. This means that systems in the region can share information and functionality with other management systems in Southern California. The IMTMS Network also provides data to a common public/private sector information "portal" known as the Advanced Traveler Information Management System (ATIMS). Private sector providers of traveler information can access information such as freeway speeds, lane closures, transit schedules, bus arrival times, and a great deal of other data through ATIMS.

The IMTMS Network is comprised of:

- **Physical Communications** – This includes the Caltrans District 11 Traffic Operations System Network, or TOSNET, consisting of phased fiber optic projects being deployed across the San Diego region; fiber and other high capacity communications being deployed by cities and transit agencies; and leased communications used to reach locations where agency owned communications are not practical or available. Over time, it is anticipated that the balance of connections that comprise the IMTMS Network will shift from largely leased communications to more agency-owned communications.

- **Integration/Management Software & Systems** – This includes the San Diego regional intertie software which provides network management and security services, the various "seeds" and clients that allow the individual management systems to communicate across the network, and supporting software and equipment for operations of the network.

FIGURE TA 6.1—IMTMS LOGICAL ARCHITECTURE (HIGH LEVEL DATA FLOWS SUMMARY)

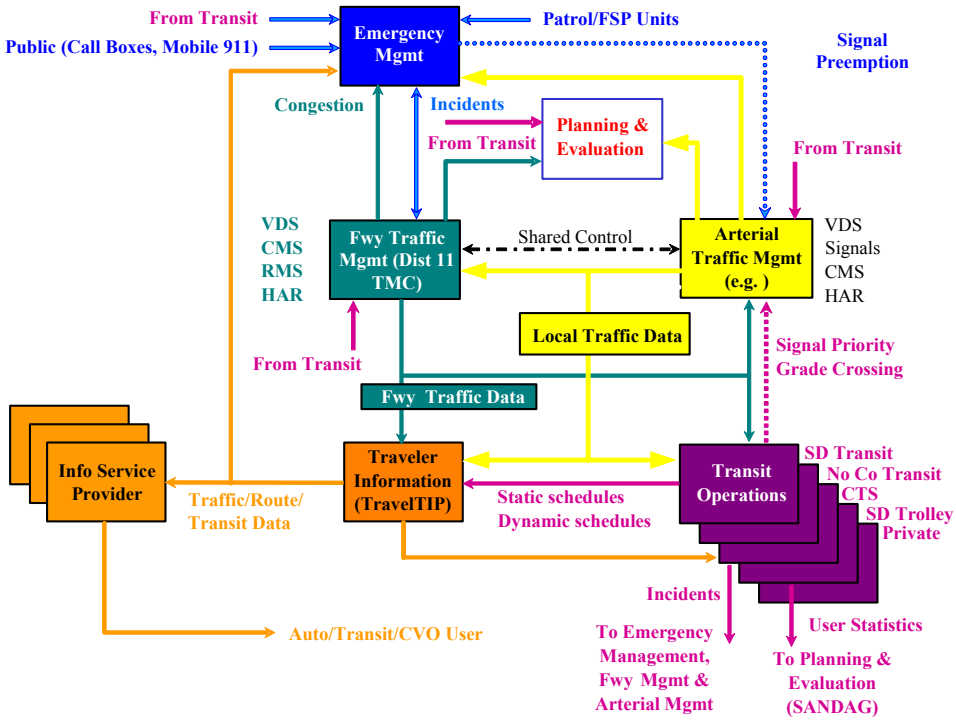
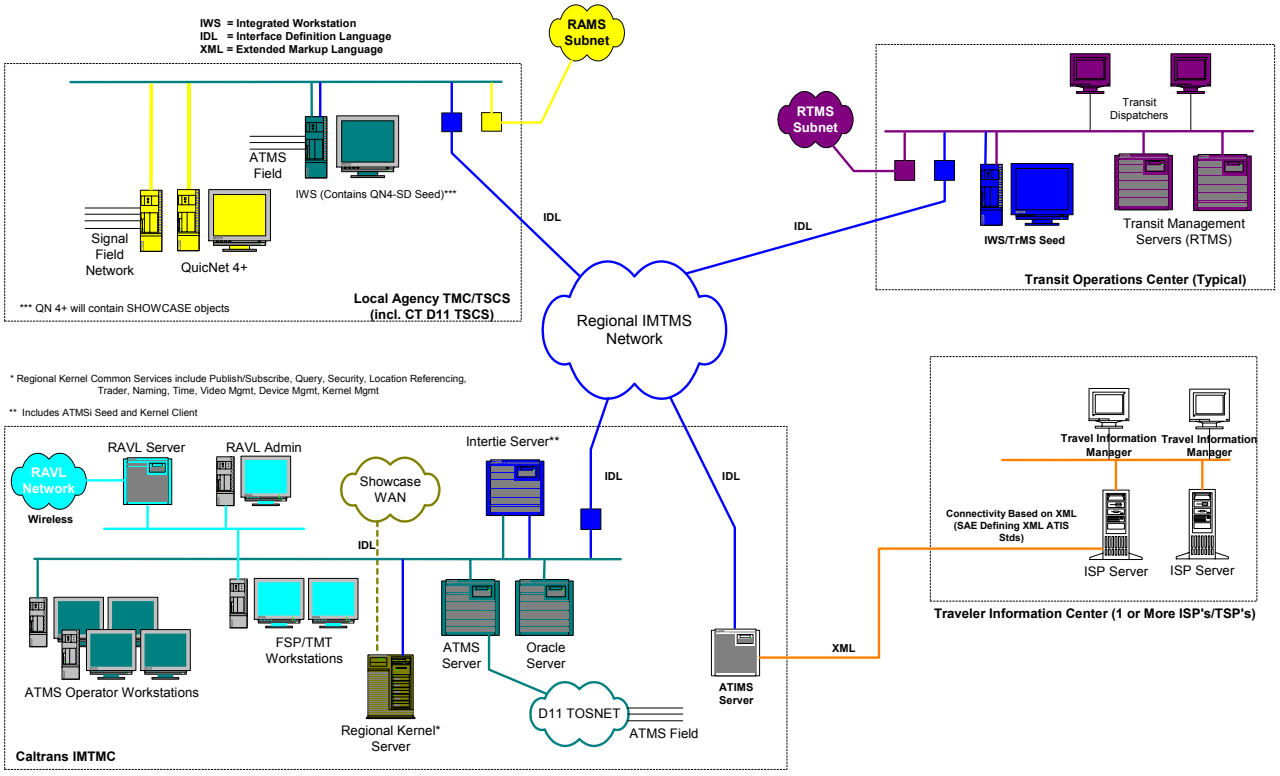


FIGURE TA 6.2— REGIONAL IMTMS PHYSICAL ARCHITECTURE (GENERALIZED)



Freeway Management System

There are four key regional systems that taken together comprise Caltrans District 11's freeway management system:

- Advanced Transportation Management System (ATMS) – ATMS Version 2.0 is currently being deployed in the San Diego region. This will bring Caltrans District 11 up to the current state standard for ATMS. In addition, Caltrans District 11 will deploy intermodal functionality for the ATMS which is referred to as the ATMSi. This intermodal functionality accomplishes three primary objectives: (1) it facilitates Caltrans and local transportation agency data sharing and shared control over the IMTMS Network; (2) it provides local agencies a real-time view of freeway congestion and incidents; and (3) it brings information from other modes and agencies into Caltrans providing a more comprehensive picture of surface transportation management in the San Diego region.

- Ramp Metering Information System (RMIS) – RMIS has already been deployed to provide centralized management of the District's ramp metering system. RMIS provides real-time congestion data to the ATMS, to a data analysis application at UC Berkeley and to the legacy SDRMS computers. Data polling and ramp meter control are exercised through a Front End Processor.

- I-15 Reversible Lane Control System (RLCS) – RLCS manages and controls the reversible High Occupancy Vehicle/FasTrak lanes on I-15. An updated RLCS is in the process of being designed and deployed. RLCS will provide information to the ATMS on the status of the HOV lanes, including whether they are open and in which direction.

- Freeway Service Patrol and Traffic Management Team Automatic Vehicle Location System (FSP/TMT AVL) – The AVL system will track FSP and TMT units in real-time to allow improved incident management on the regional freeway system. A management capability will be provided that allows data collection and analysis to replace the current manual methods.

ATMS and RMIS are both capable of handling expanded regionwide deployment of field devices such as ramp meters, CCTV cameras, changeable message signs (CMS), etc. The only new management system which is likely to come into play within the foreseeable future is the Managed Lanes Control System (MLCS) which would control the managed lanes along I-15 from SR 56 to SR 78 and along other facilities as necessary in the future. Similar to the RLCS, the MLCS would provide status information to the ATMSi and the Regional IMTMS Network regarding status of the ITS managed lanes.

The ATMSi is the core system that connects the freeway management systems and field devices to the IMTMS Network, and therefore to the other systems in the region. Figure TA 6.3 displays the freeway management functions and architectural flows that are, or will be implemented in the region. This figure also shows the coordination between freeway and arterial traffic management operations. Caltrans will input freeway related incidents and events in ATMSi, and this data will be available to local agencies. In addition, it is envisioned that Caltrans, using ATMSi, and local agencies, using a Regional Integrated Workstation, will work together towards managing the surface transportation network. The FSP/TMT AVL system will improve incident management activities in the region by displaying the location and status of these valuable freeway management resources to Caltrans and CHP TMC operators. Figure TA 6.4 depicts the architectural flows that will support regional incident management across all modes of transportation.

FIGURE TA 6.3— FREEWAY & ARTERIAL TRAFFIC MANAGEMENT ARCHITECTURE

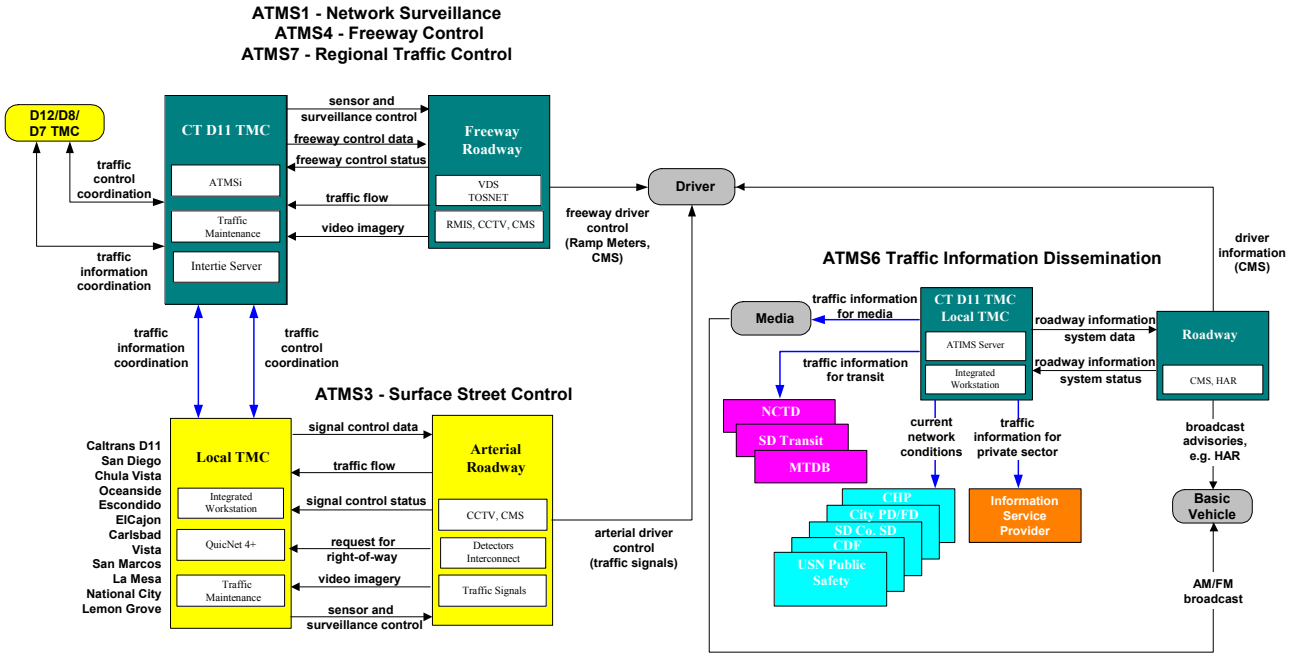
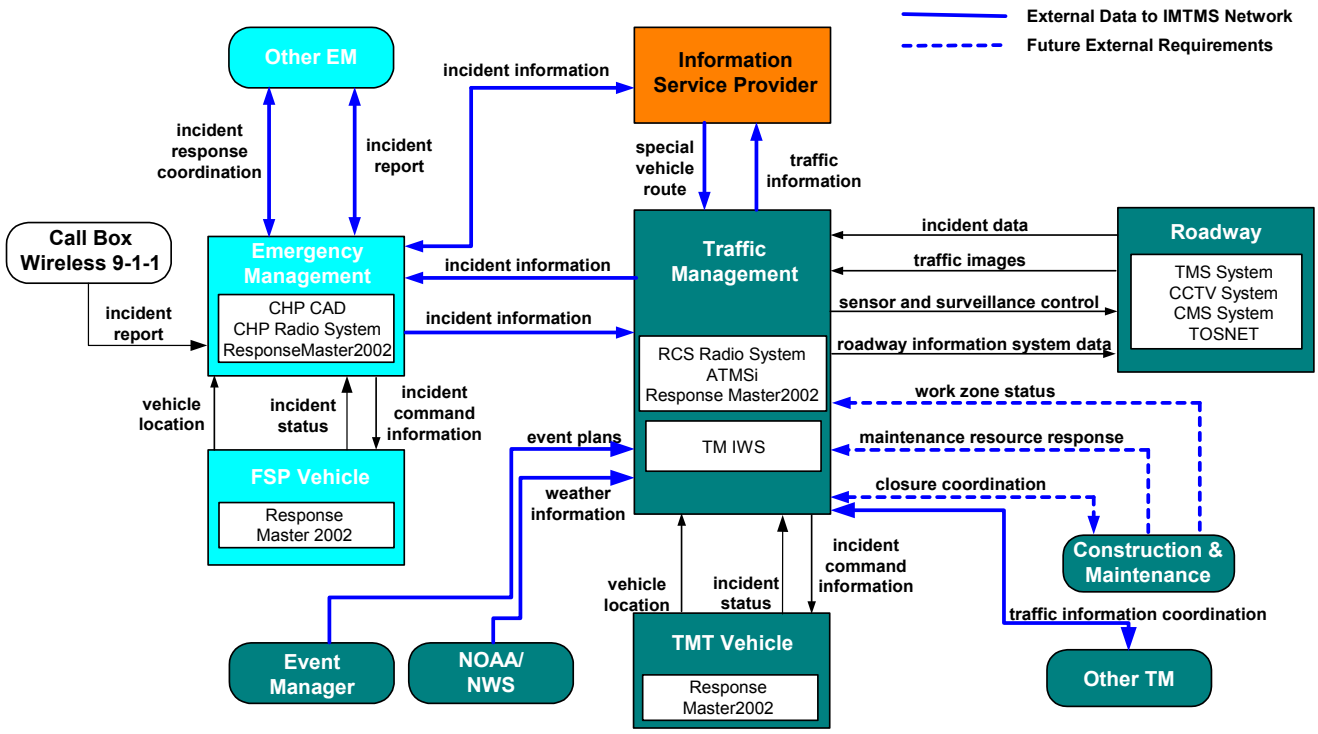


FIGURE TA 6.4—IMTMS FSP/TMT & INCIDENT MANAGEMENT DATA FLOWS



Regional Arterial Management System

The San Diego region has undertaken a cooperative effort to establish a common Regional Arterial Management System (RAMS). RAMS is being deployed as a regional effort with direct involvement from the City of San Diego, Caltrans District 11, and the Cities of El Cajon, Escondido, Oceanside, and Chula Vista. These agencies have been sharing information with other cities about the requirement and development progress of RAMS. Figure TA 6.3 (previously shown) displays the architectural relationship between RAMS, the freeway management system, and other supporting systems in the region. RAMS is comprised of two interrelated yet separate deployment efforts:

- Tier 1 – Regional Interjurisdictional Signal Coordination – Includes the deployment of the QuicNet 4+ software to state, County, and local city agencies to provide managed and enhanced interjurisdictional signal coordination functions. In a secured network environment, agencies will be able to view signal status, controlled time, timing/coordination information, and implement previously input regional timing plans both for their own signals and for preselected signals from neighboring agencies. The deployment of Tier 1 will greatly simplify interjurisdictional signal coordination along major corridors.

- Tier 2 – Local Advanced Transportation Management Systems – Provides a map based "windows" style interface as part of the Integrated Workstation (IWS). The IWS allows agencies to control/view video, message signs, vehicle sensors, and incident/special event information. Agencies also can establish shared control and viewing of field device information. The IWS serves as the local simplified version of Caltrans District 11 freeway management system and allows agencies to view traffic information for arterials and freeways throughout the region. The IWS also offers intermodal information such as transit schedules, status, and arrival information. A combination of local traffic and police departments are expected to utilize the IWS in their daily operations. Transit operators will receive IWSs to provide them with traffic and road conditions information. Finally, the IWS serves as a critical communications link and shared resource between transportation agencies in the region should a major emergency event occur.

Transit Management System

Transit management systems in the San Diego region will be comprised of several independent management systems integrated together:

- Regional Automatic Vehicle Location (RAVL) Transit Demonstration – This ITS project will test several capabilities of a transit management and vehicle tracking system, as well as establish the transit interfaces for the Regional IMTMS Network. The RAVL system will demonstrate the capability of providing transit vehicle status, incident, schedule, arrival time, and similar information to the IMTMS Network.

- Regional Transit Management System (RTMS) – The largest transit management system deployment effort in the Region, RTMS will deploy fleet management, vehicle tracking, computer aided dispatch, transit information, and related functions on all fixed route buses being operated by San Diego Transit and North San Diego County Transit Development Board (NCTD) agencies. In the future, RTMS will be expanded to include further enhanced functionality, as well as a majority of transit vehicles in the region. Similar to the RAVL demonstration, RTMS will provide transit vehicle status, schedule, schedule adherence, and emergency incident information to the Regional IMTMS Network.

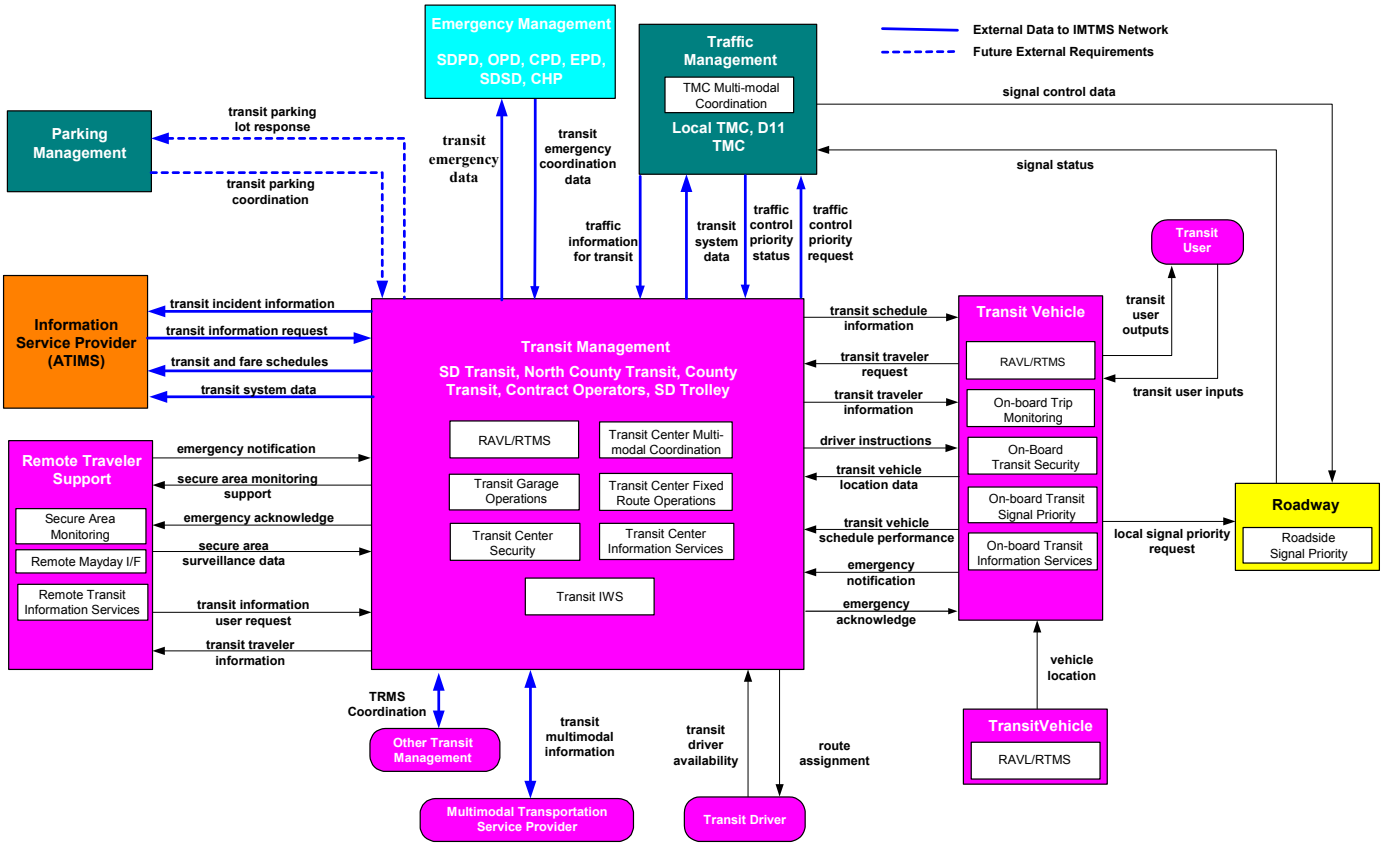
- Smart Card System – The development and deployment of the Smart Card System will simplify fare payment for transit patrons. It will speed boardings and may eventually incorporate more advanced

payment options and integration with other financial services. The Smart Card System may eventually interact with the RTMS.

Additional transit management and information systems are being considered for deployment in the region, including on-board transit information, enhanced fare payment/financial integration, and various options for transit signal priority. The intermodal integration of the transit fleet management systems, traveler information systems, and freeway/arterial management systems will allow transit agencies to get the full picture of the conditions on the roadway network in order to better manage their resources. Intermodal integration is also seen as crucial to effective event management, and improved emergency response to transit security or safety situations. Figure TA 6.5 displays the basic architecture relationships and data flows between transit management systems and other systems in the region.

Currently, the plan for interfacing transit management systems to the IMTMS Network centers around providing information to a common regional transit database. This database will be integrated with the Regional IMTMS Network through a translation "seed" that packages transit data into commonly defined data objects. These objects will be understandable to other modal systems on the IMTMS Network. In addition, many transit agencies will be utilizing common systems, and internal systems communications will occur over the IMTMS Network.

FIGURE TA 6.5— IMTMS CONSOLIDATED TRANSIT DATA FLOWS



Traveler Information Management System

The San Diego region, in terms of the Regional ITS Architecture, has made a distinction between public agency management systems and private sector traveler information systems. All of the major public agency management systems in the region will make information available to the IMTMS Network. A public/private information "portal," known as the Advanced Traveler Information Management System (ATIMS) will be established on the IMTMS Network. This portal will be the conduit for the private sector to receive information from the IMTMS Network that is useful for traveler information purposes. Therefore, ATIMS will act as a "translator" between the Common Object Request Broker (CORBA) object based standards used on the IMTMS Network and eXtensible Markup Language (XML) which may be used by the private sector. ATIMS will also act as an additional security layer. Security is already established on the IMTMS Network using SHOWCASE procedures, ensuring that any sensitive information is not released uncontrolled. Figure TA 6.6 displays ATIMS data flows and relationship with other regional management systems.

In addition to providing information from the IMTMS Network, ATIMS will allow value added private sector information to be returned to public agencies. The private sector data would be converted back to the CORBA object standards and made available on the IMTMS Network.

Overall, ATIMS is meant to allow some IMTMS information to be provided to private sector traveler information service providers without generating the institutional, security, and configuration problems that could occur by placing private sector entities directly onto the IMTMS Network. ATIMS is not necessarily meant to be the only outlet from public agency management systems to the private sector. For example, Caltrans District 11's ramp metering system provides freeway speed information to an openly available web page. Those agencies desiring to maintain separate interfaces from their individual systems may do so at their own discretion. However, the single interface from the IMTMS Network to the private sector will be ATIMS.

For regional systems architecture purposes, the San Diego region has determined that commercial vehicle operations (CVO) systems will be dealt with as specialized aspects of traveler information. This means that while the region will endeavor to provide traffic conditions and related information for CVO purposes, the regional architecture will not attempt to address systems dealing with CVO credentialing, enforcement, etc. The region feels that the architectural development of these systems is best left to the state and federal agencies responsible for CVO.

FIGURE TA 6.6—TRANSIT TRAVELER INFORMATION & BASIC ATIS MARKET PACKAGES