LADOTD

Department of Public Works

August 31st, 2007

INFORMATION EXCHANGE NETWORK (IEN)

IEN System Overview Manual

Final, Revision 2

Prepared by:

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LOS ANGELES COUNTYWIDE

INFORMATION EXCHANGE NETWORK

SYSTEM OVERVIEW MANUAL

FINAL, REVISION 2

Prepared for:

Los Angeles County
Department of Public Works

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REVISION HISTORY

VERSION	DATE	DESCRIPTION	REVIEWED BY
Draft	1/23/2004	Initial Draft	Kris Johnson
Final	3/24/2005	COTS Migration updates	Michael Bayer
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1. INTRODUCTION

1.1 PURPOSE

This document describes the project goals, system capabilities, and concepts of operations of the Los Angeles County Information Exchange Network (IEN). It is intended to be an introduction to the IEN.

Please refer to the following documents for more detailed information about the IEN:

- *IEN System Operators Manual*
- *IEN System Administrators Manual*
- *IEN System Technical Reference Manual*
- *IEN Detailed Design Document (DDD)*

1.2 AUDIENCE

The *IEN System Overview Manual* is targeted towards new users who will be responsible for operating and administering the system. This document would also be useful to representatives of agencies who are interested in connecting to the IEN.

2. OVERVIEW

In 1999, TransCore was selected by the Department of Public Works to establish a coordinated network for sharing information and control of the various traffic control systems along the I-210/Foothill Freeway using a common network backbone based on the Common Object Request Broker Architecture (CORBA). Sharing information and control along the I-210 Corridor is intended to improve coordination between member Agency traffic control systems as well as improve incident response and management activities. TransCore has overall technical responsibility to design, develop, and implement the Information Exchange Network (IEN). What is unique to the IEN is the fact that the primary focus of the system is intersection traffic control as opposed to freeway management. Key components of the IEN include:

- Establishing a common system interface (IDL) which allows the connection of heterogeneous traffic control systems onto the IEN backbone.
- Sharing second-by-second intersection data to support real-time workstation, intersection, and section displays, arterial coordination, and incident response management.
- Allowing smaller Agencies to share control and monitoring for off-hours support and maintenance (thus, a single Agency can serve as the after hours coordination center for all of the traffic control systems in the region).
- Pop-up control windows that allow operators to change the plan/mode of any intersection.
- Incident and planned event tracking system which allows the Agencies to share incident, planned event, and construction activities.
- Scenario manager, which allows the member Agencies to establish multi-agency incident response/mitigation plan.

This document describes the IEN project goals (see Section 3), system capabilities (see Section 5), and the concept of operations (see Section 6). Readers can also find information on how to connect to the IEN (see Section 7).

3. PROJECT GOALS

3.1 USE AN OPEN ARCHITECTURE

The purpose of the IEN project is to establish a network for sharing information and control of the various traffic control systems in the region using a common network backbone based on the Common Object Request Broker Architecture (CORBA). What is unique to the IEN is the fact that the primary focus of the system is Intersection Traffic Control as opposed to freeway management. The system establishes a common system interface definition language (IDL), so that any traffic control system can connect to the IEN.

3.2 SHARE REAL-TIME DATA

The IEN is also unique because it shares second-by-second real-time intersection data; most other regional systems deal with slowly changing freeway data and Dynamic Message Signs, while the IEN was specifically designed to share real-time data to support real-time intersection displays, section displays, and arterial coordination. Sharing information and control along the corridor is intended to improve coordination between systems along the arterials and improve response management in the event of a problem with special events or incidents along the freeway or surface streets in the corridor.

3.3 SHARE CONTROL AND MONITORING

The system also allows smaller agencies to share limited control of their traffic control system to another agency for off-hours support. Thus, a single agency can serve as the after hours coordination center for neighboring agencies.

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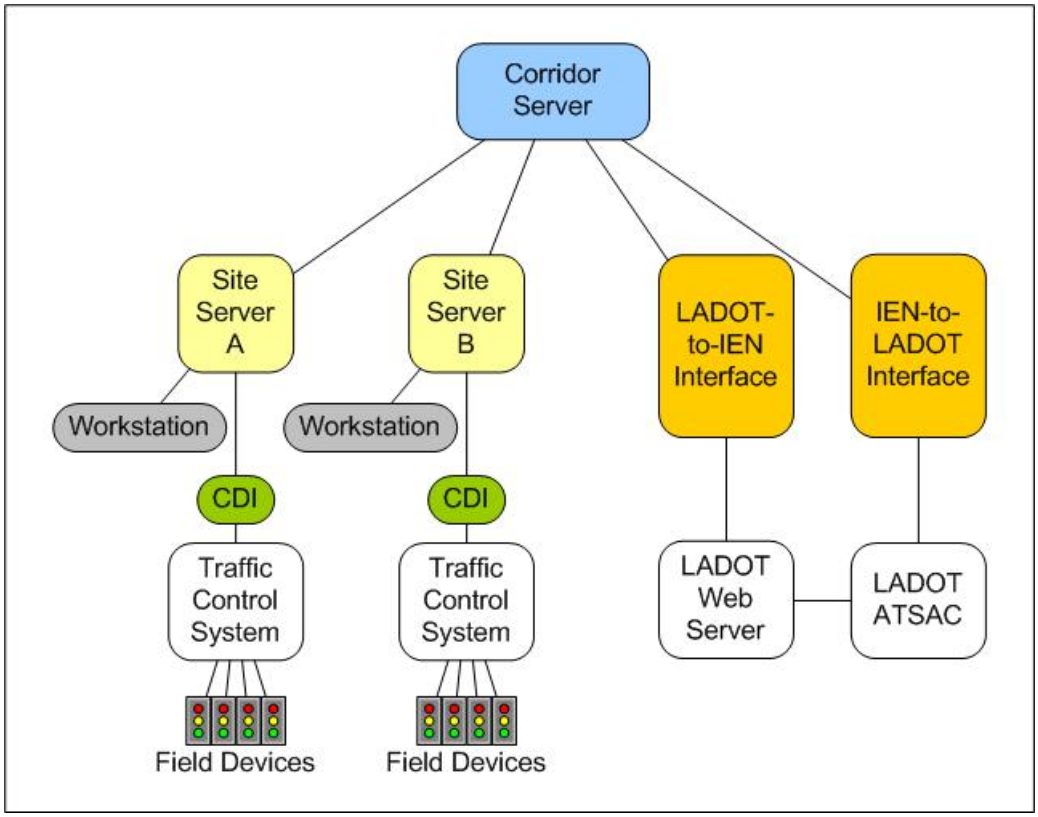
4. SYSTEM ARCHITECTURE

The LA County IEN is a multi-tiered, hierarchical system with site, corridor and regional components.

Exhibit 4.1: LA County IEN System Architecture



4.1 SITE COMPONENTS

IEN site components are installed at each participating agency. Site components include the following:

- Site Server: Manages the distribution of data between site components and with the Corridor Server
- Workstation: Hosts the IEN User Interfaces
- Command/Data Interface (CDI): Interconnects an IEN Site Server and a Traffic Control System (TCS)

See Section 7 for more information on the site components.

4.2 CORRIDOR COMPONENTS

An IEN Corridor Server coordinates communications between sites within the Corridor. Each Corridor Server can support up to nine site connections. The server also hosts a central database to maintain static system configuration data and the dynamic data archives.

4.3 REGIONAL COMPONENTS

Regional IEN components (not depicted in Exhibit 4.1 above) are responsible for coordinating communications between the IEN corridors and coordinating communications between the IEN and external agencies.

The project to develop the regional components started in 2006.

4.4 EXTERNAL SYSTEM INTERFACES

In some cases, customized interfaces are used to connect external systems to the IEN. The following external system interfaces have been developed for the IEN:

- LADOT-to-IEN Interface: Pulls LADOT intersection, system detector, and planned event data from LADOT's Web Server into the IEN.
- IEN-to-LADOT Interface: Pulls IEN intersection, system detector, and event data into LADOT's ATSAC system.

4.5 CORBA

CORBA, or the Common Object Request Broker Architecture, is used to transport dynamic real-time data and static data throughout the IEN. CORBA is required to support the large amount of real-time data generated by the system every second with the relatively low bandwidth of the IEN's wide-area network.

4.6 DATABASE SERVICES

All static configuration data for the IEN is maintained in a relational database on each Corridor Server. This configuration data consists of the following:

- Security attributes for users and resources
- The set of TCS objects known to the system
- Alarm notification configuration
- Locations and attributes of network resources
- Scenario response plans

In addition to the static configuration data, the Corridor Server relational database system stores IEN system event logs and archived real-time data.

5. SYSTEM CAPABILITIES

The IEN Workstation Software includes a suite of User Interfaces, some of which were developed specifically for the IEN and some of which are components of TransCore's TransSuite ATMS product family. LA County has licensed these TransSuite applications for use within the LA County IEN.

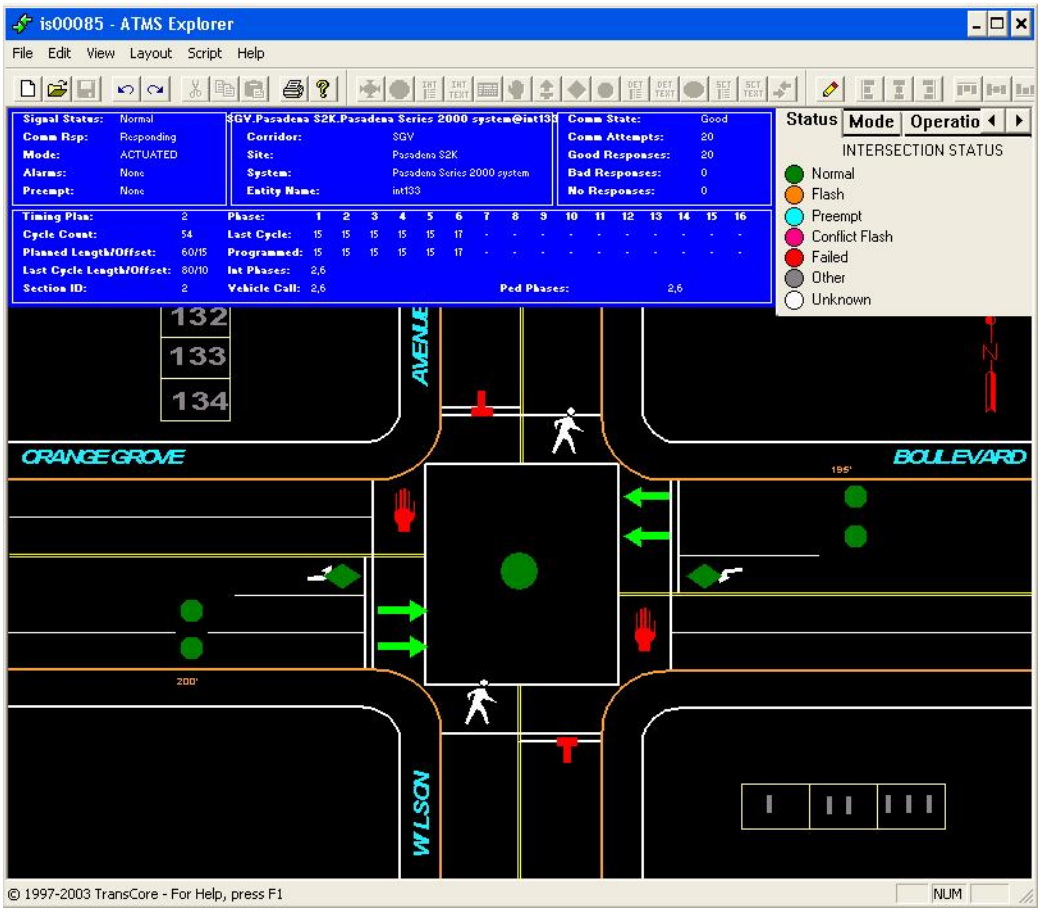
The IEN User Interfaces include:

- ATMS Explorer
- ATMS Map
- ATMS System Log Viewer
- IEN Alarm Viewer
- IEN Scenario Manager
- IEN System Configuration Manager
- Incident Tracking and Management System

5.1 ATMS EXPLORER

ATMS Explorer is a powerful diagramming platform that can be used to create and display custom views of traffic management equipment such as a diagram that shows the layout, status, and operation of an intersection or a diagram that shows how several intersections along an arterial are interacting.

Exhibit 5.1: ATMS Explorer



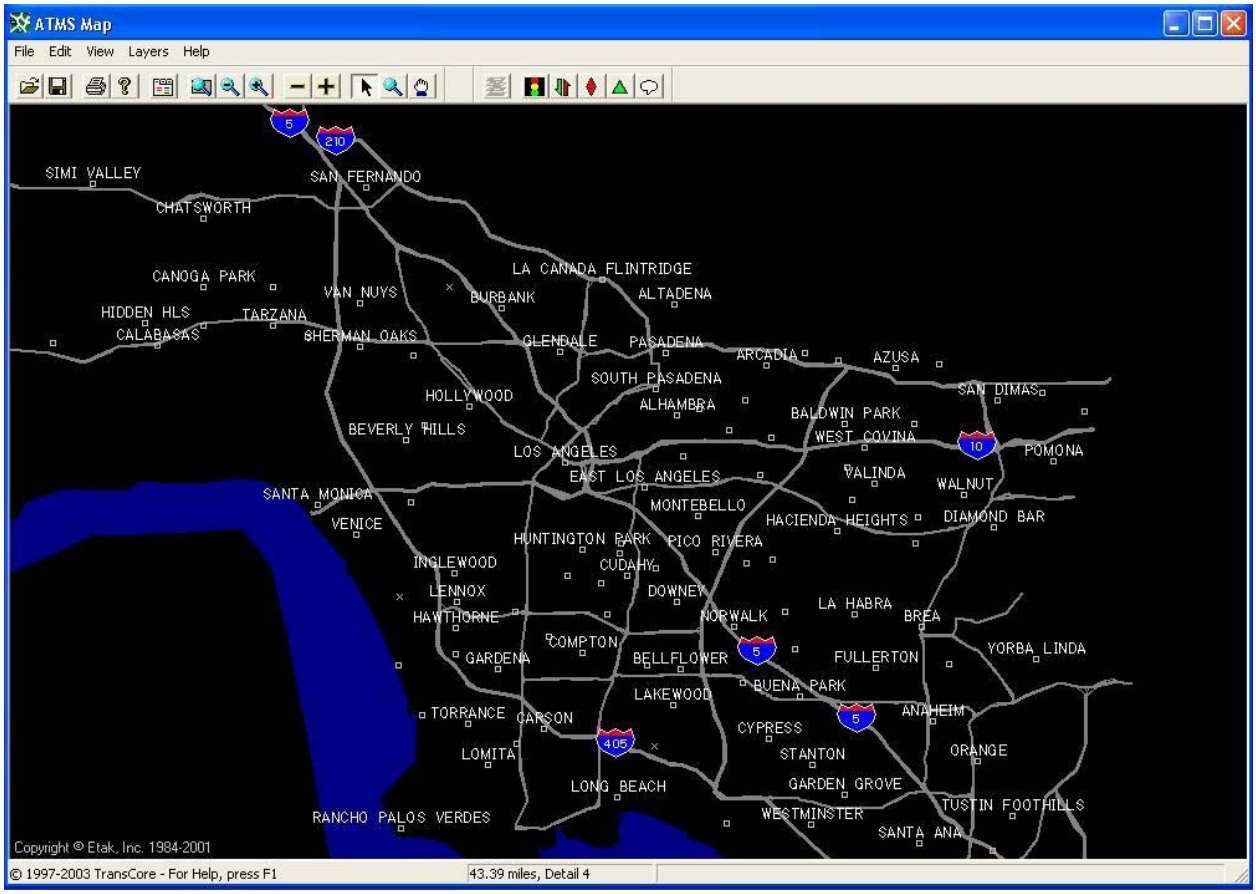
An ATMS Explorer diagram consists of a set of icons drawn on top of a static background. These "icons" can be controls or other types of embeddable objects, such as CorelDraw drawings or Excel spreadsheets. ATMS Explorer includes special support for the following:

- Custom ATMS controls (such as intersection controller icons, green arrow icons, pedestrian icons, and many more)
- Linking diagrams together to allow users to navigate from intersection to intersection even across jurisdictional boundaries
- Integration with other IEN applications

5.2 ATMS MAP

ATMS Map is a geographically accurate display of Los Angeles County roadways with overlying layers of dynamic icons that represent various types of devices, congestion links, and incidents within the IEN.

Exhibit 5.2: ATMS Map



Operators can pan and zoom the map to quickly navigate throughout the roadway network and activate or deactivate the individual layers according to their needs. Operators can interact with the icons to see more detailed information, to update the location or status of an incident, and to issue commands to devices in the field.

The IEN map layers include:

Intersection Layer: Contains icons that represent intersection controllers at their geographic positions. Intersection icons can display various types of operational and timing status and provide command options for authorized users.

Congestion Link Layer: Displays aggregate volume, occupancy, V+kO, and speed measurements from detectors along arterial segments.

Incidents Layer: Shows the location of incidents throughout the County, allowing users to monitor and manage the affect on traffic flow.

Planned Event: Shows the location of pre-planned events that affect traffic flow and can include alternate route notations and other mitigating information.

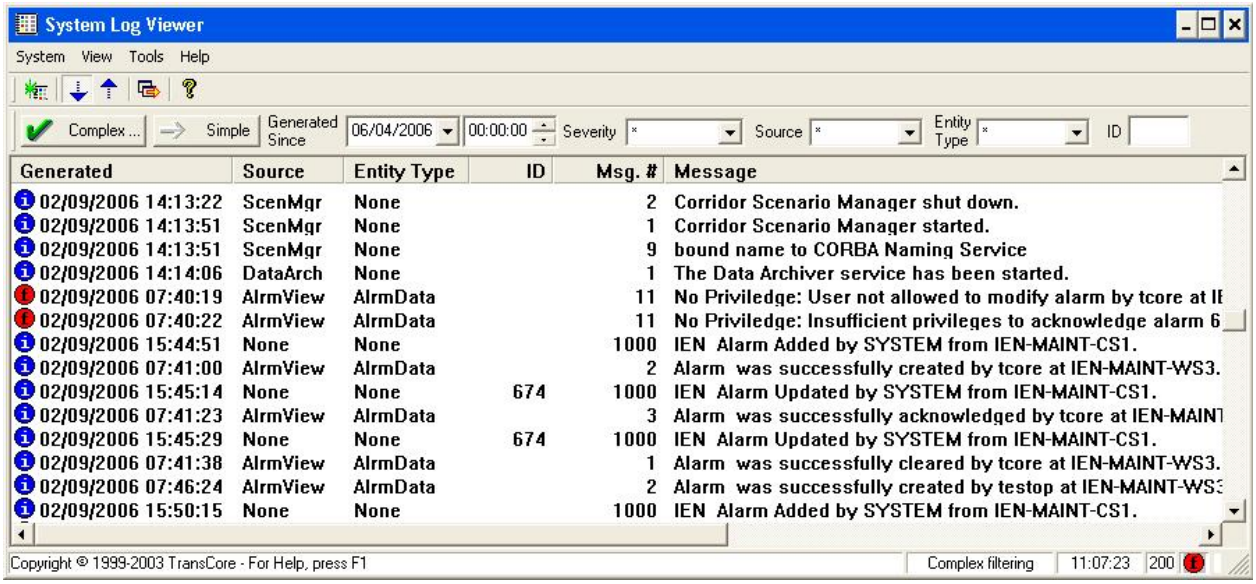
Informational Layer: Displays user-created textual and graphical annotations on the map.

Additional layers can be added to support new types of devices as the IEN expands.

5.3 ATMS SYSTEM LOG VIEWER

The ATMS System Log Viewer displays event messages that have been generated by the ATMS applications. Log entries are created for all activities that change the operation of the ATMS or that affect the operation of connected systems. These include operator login, starting and stopping of services and applications, and sending commands to devices. The ATMS System Log also contains error messages and other information useful for diagnosing problems.

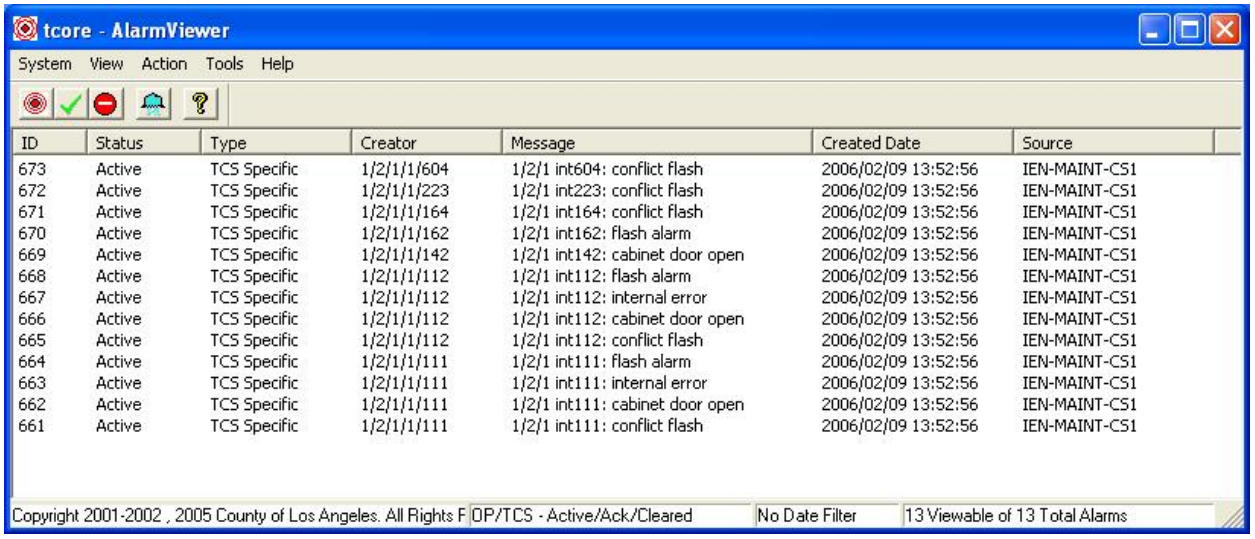
Exhibit 5.3: ATMS System Log Viewer



5.4 IEN ALARM VIEWER

The IEN Alarm Viewer displays device and operator alarms. The IEN automatically generates a device alarm whenever an intersection controller reports a door open, flash, conflict flash, preempt, or internal error condition. Operator alarms are manually generated.

Exhibit 5.4: IEN Alarm Viewer

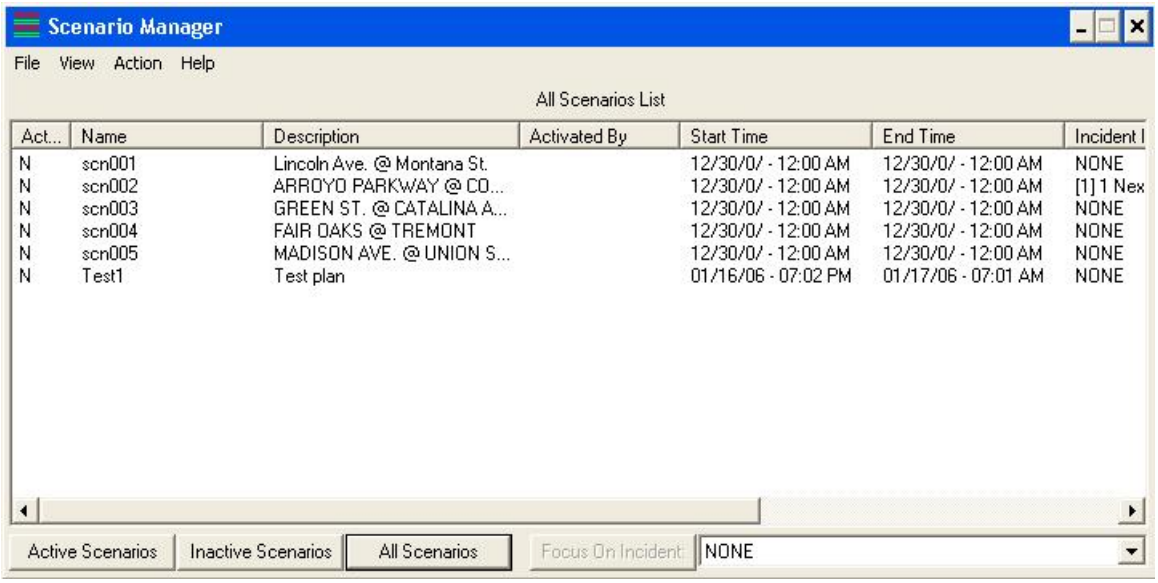


A device alarm is only made visible to operators that hold the View privilege for the generating device. Operator alarms are visible to all other operators. Authorized operators can acknowledge an alarm to indicate that action is being taken to investigate and correct the problem. Alarms are cleared when the alarm condition ends (automatically) or at operator direction (manually).

5.5 IEN SCENARIO MANAGER

The IEN Scenario Manager enables operators to monitor and manage scenario plans. A scenario plan is a pre-planned set of device commands that are executed together. For example, a "Stadium Exit" scenario plan could include a set of commands that prioritize traffic flowing away from the stadium at the end of an event. IEN scenario plans may include devices from different jurisdictions.

Exhibit 5.5: Scenario Manager



Operators are able to search the database for a plan that meets their needs and then activate the plan if they are authorized to do so. The Scenario Manager reports the status of the each action within a plan. Scenario plans will either timeout when their duration expires or they can be deactivated manually.

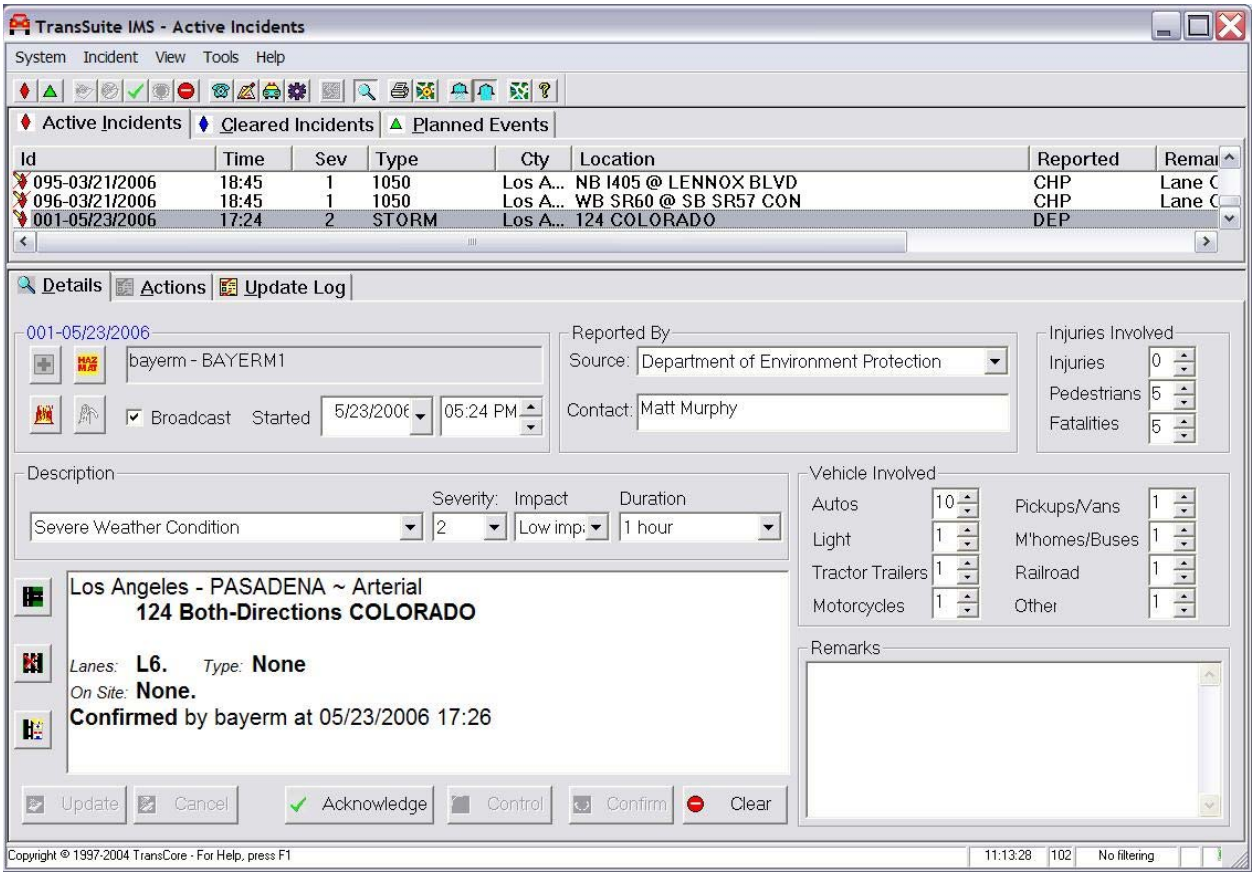
5.6 IEN SYSTEM CONFIGURATION MANAGER

The IEN System Configuration Manager is used to view and modify IEN configuration data. The application permits administrative users to generate printed database reports, create or modify scenario plans, define system devices, and configure user access privileges.

5.7 INCIDENT MANAGEMENT SYSTEM

The TransSuite Incident Management System, or IMS, enables users to view, respond to, and track the incidents and planned events that occur within their roadway network. IMS is a particularly powerful tool when used in multi-jurisdictional systems such as the IEN, allowing multiple agencies to collaborate and coordinate their response efforts.

Exhibit 5.6: TransSuite IMS



IMS automatically plots the geographical location of an event and accepts internal and external input. Operators can quickly navigate between event details in IMS and the event location in an ATMS Map display.

- Operators can view and maintain detailed information for each incident and event such as the following:
- Operator communications
- Communications between agencies
- Arrivals and departures of on-site responders (e.g., police, fire, ambulance, etc.)

IMS maintains customizable contact information for participating agencies and officials. It also logs all actions and changes for each incident. Printed database reports are available to show various types of event metrics over user-selectable time periods.

IMS supports integrated scenario management. Authorized operators can activate pre-defined scenario plans in response to an event and link the plans to the events so they can be managed together.

6. CONCEPT-OF-OPERATIONS

The cities throughout Los Angeles County all manage their traffic signal systems differently. Generally, larger Agencies manage their traffic signal systems daily in a more hands-on manner, while smaller Agencies do not. Likewise, the IEN will be used differently by different Agencies.

Every participating Los Angeles County Agency will get an IEN workstation. In most cases, the IEN workstation will be installed in an Agency's Local City Control Site (LCCS). The location of the LCCS will vary by Agency. For large Agencies the LCCS may be an actual Traffic Management Center (TMC), but the LCCS is oftentimes the traffic engineer's office.

The IEN will be utilized in two distinct operational modes: locally and regionally. In local mode, the IEN workstation is one means for an Agency to observe the operation of their traffic signal system (and potentially other ITS devices). There is also a limited control capacity via the local operational mode. In general, control of a traffic signal system and other devices will be done via a traffic control system operated by the County (with authorization of the local Agency) or by the Agency itself.

The Regional operational mode is where the power and benefits of the IEN can be realized. When used in this mode, Agencies can monitor traffic signal operations and coordinate incident management activities with adjacent jurisdictions. In addition, effected Agencies can be notified in advance of planned events (road work, parades, etc.).

Some of the more common tasks that Agencies will perform while utilizing the IEN include:

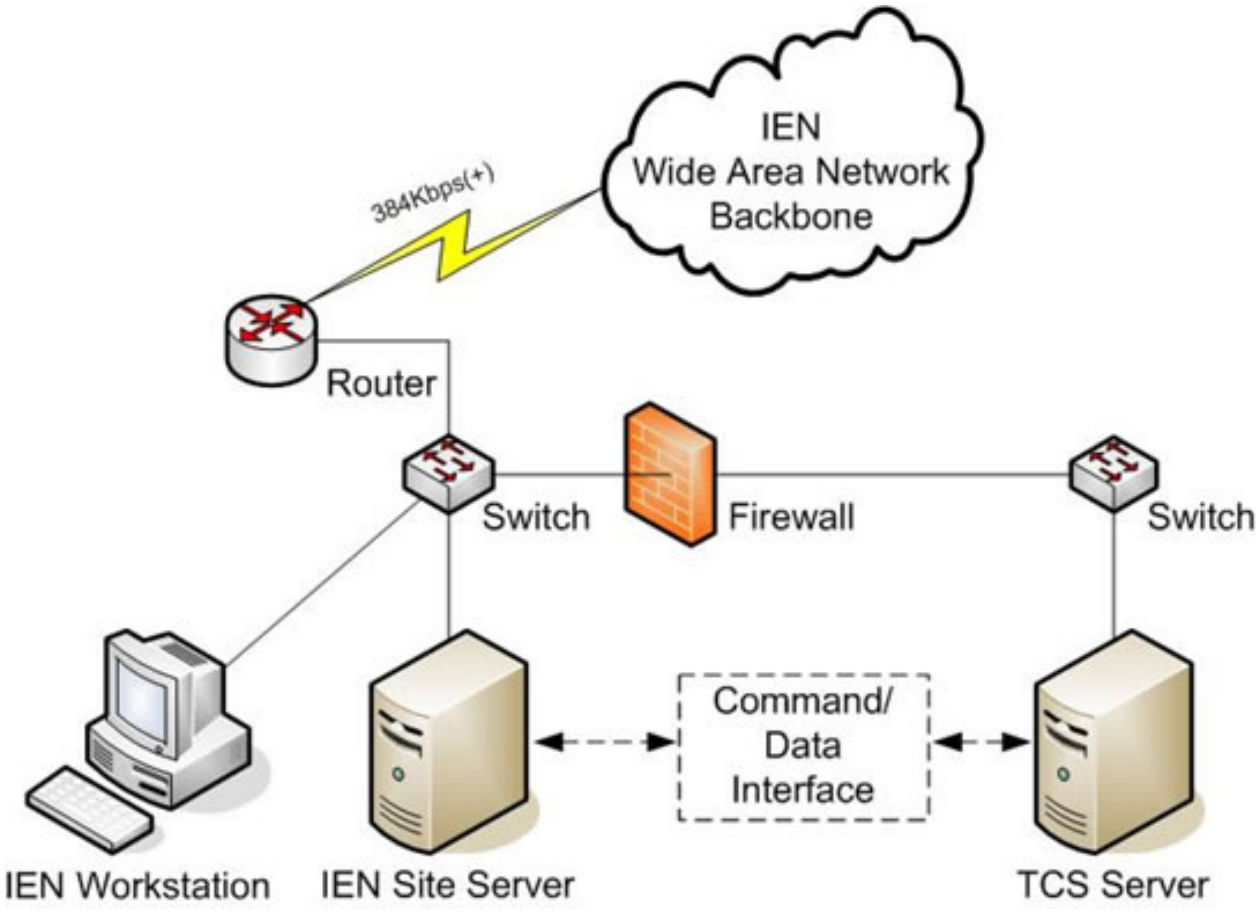
- Monitor IEN workstation performance (e.g., workstation operating and presenting live data, etc.), contacting the County if problems are noted.
- Ensure that the IEN is updated to reflect the real-world implementation.
- Check that field components (controllers, detectors, etc.) are communicating with the IEN and are functioning properly, taking corrective actions as needed.
- Monitor traffic operations as needed/desired using the IEN workstation (if there is not a local TCS workstation).
- Notify other Agencies and/or the County of any upcoming planned events that may affect them.
- Work with other Agencies to develop coordinated incident management plans and implement, as needed.

As stated previously, the level of effort that each Agency spends performing these tasks will vary and range anywhere from an hour or two per week for smaller Agencies that have the County operating their traffic signal operations to one or more full-time staff for Agencies that operate a full traffic control system (where the IEN is a tool in their daily activities).

7. CONNECTION REQUIREMENTS

Agencies that connect to the IEN to share their traffic control data are called IEN Sites. Becoming an IEN Site involves connecting to the IEN network backbone, installing IEN Site Server and Workstation software on systems located at the Agency, and procuring Command/Data Interface software to allow the IEN to communicate with the local Traffic Control System.

Exhibit 7.1: Components of an IEN Site



7.1 CONNECTING TO THE IEN WIDE AREA NETWORK BACKBONE

Each Agency will be assigned to a Corridor within the IEN system hierarchy. Agencies will need to install a communication line between their offices and the location of this Corridor Server. This communication line must have a Committed Information Rate (CIR) of 384Kbps or better.

7.2 IEN WORKSTATION

An IEN Workstation is a system on which the IEN User Interfaces are run. Workstations must be joined to the IEN Domain and need network connectivity to the local IEN Site Server and to their Corridor Server.

7.2.1 Hardware Specifications

IEN Workstations have the following minimum hardware specifications:

- 3 GHz CPU
- 1 GB of available hard disk space
- 512 MB of RAM
- Network interface

7.2.2 Network Specifications

IEN Workstations require the following network connectivity:

- 10Mbps or greater connection to the local IEN Site Server
- 384Kbps or greater connection to the Corridor Server
- A connection to the IEN domain controller

7.2.3 Software Specifications

The following COTS software is used in the IEN Workstation configuration:

- Microsoft Windows XP Professional
- Microsoft Office 2003 Professional
- Oracle 10g Client (with patch set 10.1.0.3.0)
- NTP Client 4.1.7.2
- Microsoft Data Access Components 2.8
- Microsoft .NET Framework 1.1
- Microsoft Visio Professional (or similar graphics editing software)

7.3 IEN SITE SERVER

An IEN Site Server manages real-time status data and commands at a Site. It collects data from the local Traffic Control System and sends that data to both local IEN Workstations and to its Corridor Server for redistribution to other Sites. A Site Server is also responsible for distributing remote TCS data to local workstations and sending IEN commands to a connected Traffic Control System.

Each Agency will need to host an IEN Site Server at their location to support local workstations even if no Traffic Control System will be connected to that Site Server. Each Site Server can support a single Traffic Control System connection.

Site Servers need network connectivity to the Corridor Server, all local IEN Workstations, and the system on which Command/Data Interface software is run (if the Site Server is being connected to a Traffic Control System).

7.3.1 Hardware Specifications

IEN Site Servers have the following minimum hardware specifications:

- 3 GHz CPU
- 1 GB of available hard disk space
- 1 GB of RAM
- Network interface(s)

7.3.2 Network Specifications

IEN Site Servers require the following network connectivity:

- 10Mbps or greater connection to the local TCS Command/Data Interface Server
- 10Mbps or greater connection to local IEN Workstations
- 384Kbps or greater connection to the SGV Corridor Server
- A connection to IEN domain controller

7.3.3 Software Specifications

The following COTS software is used in the IEN Site Server configuration:

- Microsoft Windows 2003 Standard
- Microsoft Data Access Components 2.8
- Oracle 10g Client (with patch set 10.1.0.3.0)
- Microsoft .NET Framework 1.1

7.4 COMMAND/DATA INTERFACE

The Command/Data Interface, or CDI, is the software component that connects an IEN Site Server to a Traffic Control System. Each CDI is designed to interface with a particular type of Traffic Control System. For example, the Series 2000 CDI software in use at the City of Pasadena can be used by any Agency that has TransCore's Series 2000 Traffic Control System; however, it would not support other types of Traffic Control Systems. Similarly, BI Trans has developed CDI software for their QuicNet/4 system.

Agencies will need to develop or procure CDI software that supports their Traffic Control System. CDI specifications will be provided upon request.

7.5 MISCELLANEOUS NETWORKING COMPONENTS

An IEN Site will need various types of commercially available networking equipment, such as routers, switches, and cables, to interconnect the IEN Site components. Agencies are asked to isolate the IEN components from local Agency networks with the use of firewalls and other secure network practices.

8. STANDARDS COMPLIANCE

Standards are designed to facilitate the integration of system components by providing a predefined and public (open) interface that vendors/developers can design and build their products around. Ideally, when standards are implemented by different developers (software or hardware), their products will work together seamlessly. Some simple but ubiquitous examples of standards in action are the 120V electrical plug, RJ-45 cable connector, and CD-ROM. It is just assumed that you can take one of these items to the appropriate device/receptacle and it will work.

The USDOT's Joint Program Office is supporting the development and maintenance of a number of transportation-related standards as part of the National Intelligent Transportation Systems Architecture framework. These standards are being developed by a number of organizations and are in a various stages of development and acceptance. Even so, use of standards can greatly assist in the decision-making process by reducing the ever-present question of component interoperability ("Will this new device from Vendor X work with that one from Vendor Y?").

An important goal of the LA County IEN system design is adherence to open industry standards. The following standards are used in the IEN:

8.1 COMPONENT MODEL

The IEN is designed using a component-based methodology. Each "component" is a software object that communicates with other components using a standard interface framework. In general, each component corresponds to an application program or a dynamic link library. The IEN's use of the CORBA (Common Object Request Broker Architecture) and COM (Component Object Model) component model standards is described below.

CORBA: CORBA is an open standard for implementing distributed object-oriented systems. For more information, visit www.omg.org. Most inter-process communications between IEN software components running on different machines is accomplished using CORBA-compliant interfaces. The standard CORBA Naming Service is used by components to locate other components on the network. The standard CORBA Event Service is used to distribute dynamic data updates throughout the IEN.

COM: Microsoft's Component Object Model (COM) is used by several workstation components that run under the Windows operating system. COM is used for communications between components running on the same workstation.

8.2 TCP/IP

All communications protocols used by the IEN are based upon the standard Transmission Control Protocol/Internet Protocol (TCP/IP) family of internetworking protocols. TCP/IP-based protocols used within the IEN include SNMP, SMTP, HTTP, and IIOP.

8.3 TMDD

Many IEN data elements are based upon elements defined in the standardized Traffic Management Data Dictionary (TMDD) jointly developed by ITE, FHWA, and AASHTO. The

TMDD definitions do not map directly to any programming language, and are not intended for object-oriented programming. Therefore, its concepts have been adapted as appropriate for the IEN system design. The following TMDD-derived conventions are used throughout the design of IEN data elements:

Most objects have a unique "identifier" attribute (text string of up to 32 alphanumeric characters) and a "name" attribute (text string of up to 128 alphanumeric characters). The "identifier" is used internally by the IEN system to keep track of objects, whereas the "name" is something meaningful to system operators.

Geographic coordinates are specified in micro-degrees of latitude and longitude.

Textual data elements have a maximum length specified that matches that of the corresponding TMDD element.

8.4 NTCIP CENTER-TO-CENTER STANDARDS

An NTCIP committee is in the process of developing CORBA-based Center-to-Center communications standards. However, at the time of this writing, those standards have not been elaborated to the point that they are useful for system design. The IEN does use a set of real-time data distribution interfaces that are based upon one of the proposals for the NTCIP Center-to-Center CORBA Near-Real-Time Data Service (NRTDS).

8.5 SAE LRMS

Location-referencing data elements are based upon the message profiles specified in the Society of Automotive Engineers (SAE) Location Referencing Message Specification. The data elements have been adapted as necessary for use in a CORBA-based design.

8.6 SOUTHERN CALIFORNIA PRIORITY CORRIDOR INTERFACES

The IEN uses the following CORBA Interface Definition Language (IDL) files developed for the Southern California Priority Corridor Showcase projects:

- date_time.idl
- location.idl
- scbridge.idl
- sckernel.idl
- sclog.idl
- sctypes.idl
- security_service.idl

8.7 DATABASE CONNECTIVITY

Several IEN components make use of a central relational database to store persistent data. All database access is performed using the industry-standard ODBC (Open Database Connectivity)

and OLE (Object Linking and Embedding) DB interface standards. Proprietary database protocols are not used by any applications.

9. GLOSSARY

TERM	DESCRIPTION
AASHTO	American Association of State Highway and Transportation Officials
ATSAC	Automated Traffic Surveillance and Control, LADOT's Traffic Control System
ATMS	Advanced Transportation Management System
CCTV	Closed-Circuit Television
CDI	Command/Data Interface
COM	Component Object Model
CORBA	Common Object Request Broker Architecture
COTS	Commercial-Off-The-Shelf (Software)
DDD	Detailed Design Document
DMS	Dynamic Message Sign
DPW	Department of Public Works
FHWA	Federal Highway Administration
GUI	Graphical User Interface
HAR	Highway Advisory Radio
HTTP	Hyper-Text Transfer Protocol
IDL	Interface Definition Language
IEN	Information Exchange Network
IIOP	Internet Inter-ORB Protocol
IMS	Incident Management System
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation Systems
NRTDS	Near-Real-Time Data Service
NTCIP	National Transportation Communications for ITS Protocol
ODBC	Open Database Connectivity
OLE	Object Linking and Embedding
ORB	Object Request Broker
SAE	Society of Automotive Engineers
SGVPP	San Gabriel Valley Pilot Project
SLV	System Log Viewer
SMTP	Simple Mail Transfer Protocol
SNMP	Simple Network Management Protocol
TCP/IP	Transmission Control Protocol/Internet Protocol

TERM	DESCRIPTION
TCS	Traffic Control System
TIMS	TransCore's TransSuite Incident Management System
TMDD	Traffic Management Data Dictionary
WAN	Wide Area Network