June 14th, 2005

San Gabriel Valley Traffic Forum

ATMS Improvement Project

Integrated System Conceptual Design

(Deliverable 2.6.4)

Draft

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PUBLIC WORKS

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SAN GABRIEL VALLEY TRAFFIC FORUM

INTEGRATED SYSTEM CONCEPTUAL DESIGN

(Deliverable 2.6.4)

DRAFT

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1. INTRODUCTION

1.1 PROJECT OVERVIEW

The San Gabriel Valley Traffic Forum (SGVTF) is one of the planned Intelligent Transportation Systems (ITS) improvement projects that the Los Angeles County Department of Public Works (County) is developing as part of the Traffic System Management (TSM) program in order to improve traffic flow and enhance arterial capacity in a cost-effective way where roadway widening is not possible. The purpose of the SGVTF Project is to design, develop, and deploy an Advanced Transportation Management System (ATMS) that can be tailored to each Agency's operational needs so that traffic signals can be synchronized and ITS systems integrated across jurisdictional boundaries. The SGVTF Project focuses on the specific needs of each Agency to manage their ATMS and recommends improvements to field infrastructure (e.g., controllers, detection systems, communications, etc.) and centralized Traffic Control Systems (TCSs) and/or Traffic Management Centers (TMCs) to meet those requirements. When the SGVTF is successfully completed, each of the Agencies responsible for traffic signal operations will have full access to an ATMS that monitors and controls the traffic signals within their jurisdiction. In addition, Agencies will be able to synchronize their signals and exchange traffic information in real-time with neighboring Agencies. This will allow the Agencies to respond to recurrent and non-recurrent congestion in a coordinated fashion across jurisdictional boundaries.

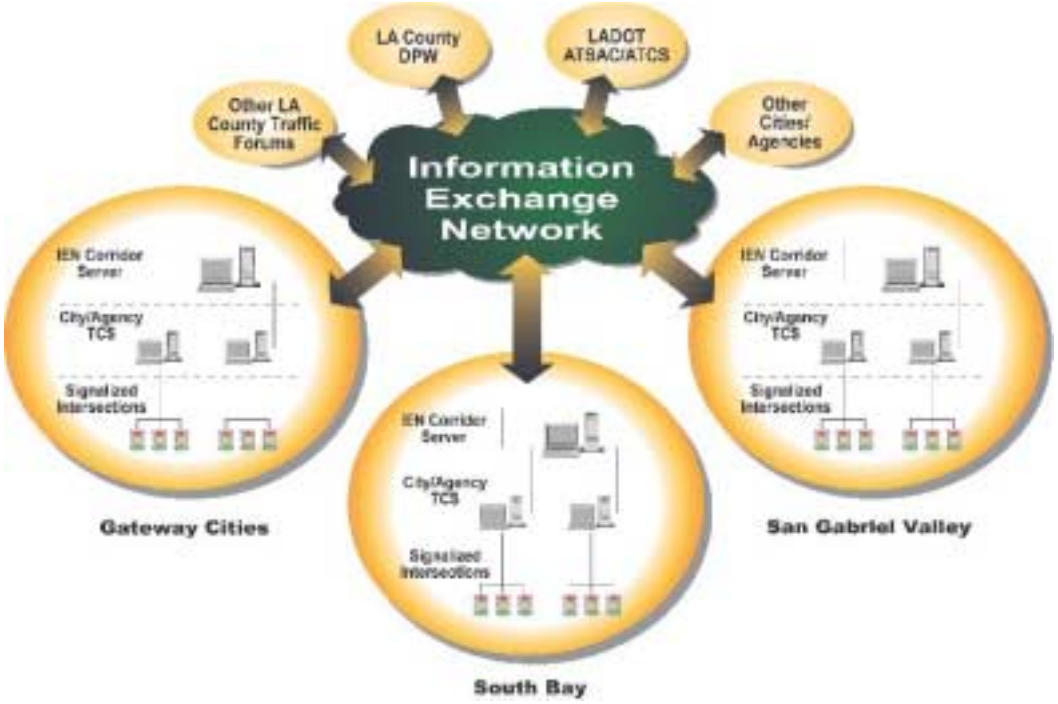
The SGVTF Project area ranges from Cities bordering the California State Route (CA SR) 110 and I-710 freeways to the west, I-210 freeway to the north, CA SR 57 freeway to the east, and the CA SR 60 freeway to the south. It encompasses 24 municipalities as well as unincorporated portions of Los Angeles County. The traffic signals in this Region are operated by many of the individual Agencies, County, and Caltrans District 7.

Developed by the County, the Countywide Information Exchange Network (IEN) is the integrated system framework that connects participating Agency ATMSs into a Regional network to support the operational goals identified above. The Countywide IEN supports traffic signal operations at the Local level, Corridor level, and Regional level. The SGVTF assumes the availability of the Countywide IEN at the Corridor and Regional levels. Therefore, the SGVTF Project is focused on the selection of TCSs and the integration of those systems to the Countywide IEN at the Local level. The eventual ATMS design for the SGVTF will take into account the interface to the IEN and its requirements at the Local level and encompass the following six (6) core components:

- ATMS and/or TCS (Individual Agency)
- Detection and Surveillance
- TMC and/or Workstation Layouts (ATMS and/or IEN)
- Communications Network
- SGVTF Participation/Coordination (City-specific and/or SGVTF-Regional integration)
- Operations and Maintenance (O&M)

As depicted in Exhibit 1.1, the Countywide IEN comprises a series of computer servers, communication networks, and software applications that integrates these components for the collection and transfer of data to support Corridor and Regional functions throughout Los Angeles County.

Exhibit 1.1 – Countywide Information Exchange Network (IEN)



1.2 AGENCY LEVEL DEFINITIONS

Four (4) Agency roles or "Levels" have been defined as well as a planning-related Level (Region Coordinator) for the implementation of the ATMS based upon the level of interaction an Agency will have in managing its traffic operations:

- **Level 1**
  - Agency does NOT operate its traffic signals
    - Agency wants to be "Agency B" on another Agency's ATMS
    - Another Agency operates its traffic signals (e.g., LA County DPW)
  - Provided with an IEN W/S to monitor traffic signals & incident management activities
  - No separate ATMS W/S provided
- **Level 2A**
  - Agency passively manages its traffic signals
    - Establish initial signal timings, monitor system status daily, etc.
    - May operate on an exception/as-needed basis
    - Monitor mainly for alarms & malfunctions
  - Agency wants to be "Agency B" on another Agency's ATMS
  - Provided with an IEN W/S to monitor traffic signals & incident management activities [Regional view]
  - Maintains a separate ATMS W/S connected to "host" Agency's ATMS [Local view]

- **Level 2B**
  - Agency actively manages & operates its own ATMS
    - Actively manages ATMS during exceptions
    - Passively manages ATMS during AM & PM peak periods
  - Agency may operate some other ITS devices (small amount)
  - Agency may operate other Agencies' traffic signals (Level 1)
  - Agency may "host" other Agencies' traffic signals (Level 2A)
  - Maintains an LCCS facility to manage traffic signals & incident management activities
    - IEN W/S [Regional view]
    - ATMS W/S [Local view]
    - CDI between the ATMS & IEN
- **Level 3**
  - Agency actively manages its own ATMS & other ITS devices (large amount)
    - Typically AM & PM peak period traffic operations & incidents
    - May support 24/7 operations
  - Agency may operate other Agencies' traffic signals (Level 1)
  - Agency may "host" other Agencies' traffic signals (Level 2A)
  - Agency will have a TMC from which to operate its ATMS, the IEN, & other ITS devices
  - Maintains an TMC/LCCS facility to manage ATMS & incident management activities
    - IEN W/S (Regional view)
    - ATMS W/S (Local view)
    - CDI between the ATMS & IEN

Each Agency has been mapped to one of these Levels based upon the types of traffic and incident management functions and operations the Agency is proposed to be performing following the ATMS implementation and not what is being done today. Exhibit 1.2 presents the Agency/Level mapping for the SGVTF.

Exhibit 1.2 - SGVTF Agency/Level Mapping

Level 1	Level 2A	Level 2B	Level 3
Duarte La Puente San Marino South El Monte South Pasadena Temple City	Azusa Baldwin Park El Monte Glendora Monrovia Montebello Monterrey Park San Gabriel	Alhambra Arcadia Covina Irwindale Rosemead San Dimas West Covina	Caltrans LA County DPW Pasadena

1.3 PURPOSE OF DOCUMENT

This document is Deliverable 2.6.4 – Integrated System Conceptual Design. This document describes how the IEN and its components will be utilized to enable the integration of systems for the SGVTF.

1.4 REPORT ORGANIZATION

Following this introduction, the report is broken into the following sections:

- Integrated Systems Architecture
- Command/Data Interface (CDI)

1.5 REFERENCED DOCUMENTS

The following documents have been used as reference material in the preparation of this report:

- SGVTF Integrated System Requirements Analyses (Draft) (Deliverables 2.3.6.1 & 2.3.7.1)
- SGVTF ATMS Alternatives Analysis Document (Draft) (Deliverable 2.5.1.1)
- SGVTF Local City Control Site and Computer Systems Alternatives Analysis Report (Draft) (Deliverable 2.5.3.1)
- SGVTF System Recommendations (Draft) (Deliverable 2.5.4.1)
- SGVTF Communications Conceptual Design (Draft) (Deliverable 2.6.2)
- SGVTF Local City Control Site Conceptual Design (Draft) (Deliverable 2.6.3)
- Gateway Cities Conceptual Design – Final Report (Version 1, January 2004)
- SGVPP Information Exchange Network Recommendations for the Implementation of New TCS CDI Programs (Final, Revision 3)
- IEN Program Overview (November 14th, 2002)
- IEN System Technical Reference Manual (Draft Version 2)

2. INTEGRATED SYSTEMS ARCHITECTURE

2.1 IEN OVERVIEW

As discussed earlier, the Countywide IEN is the system/framework integrating participating SGVTF Agencies' (and Agencies in other TFs) traffic and incident management systems and processes.

The IEN is comprised of several components. Wherever feasible, commercial off-the-shelf (COTS) software and tools are used in the development of the IEN and its components. For example, the IEN servers and workstations use the appropriate Microsoft Windows operating system, database services are provided by an Oracle RDBMS, IEN Servers and Workstations run on standard configuration commodity equipment, etc.

Please see the appropriate requirements documents for detailed functionality of the IEN components summarized below.

2.1.1 IEN Workstation

The IEN Workstation provides the tools that facilitate Corridor and Regional traffic signal and incident management for participating SGVTF Agencies. An IEN Workstation includes map presentation, traffic management, and incident/event coordination tools. The IEN Workstation is the primary local traffic and incident management tool for Level 1 Agencies (an ATMS Workstation is the primary tool for other Agency levels). Compared to an ATMS Workstation, an IEN Workstation provides a subset of the available local traffic signal capabilities/operations. All SGVTF Agencies will have an IEN Workstation. Please refer to the SGVTF LCCS Conceptual Design for the minimal technical specifications for an IEN Workstation.

2.1.2 IEN Site Server

The IEN Site Server is software that distributes data between the site (local IEN Workstations and up to one TCS) and Corridor-level components (i.e., IEN Corridor Server). An IEN Site Server is required for IEN Workstation communications as well as for CDI communications, however only one (1) IEN Site Server should be needed for an Agency in most cases. While every Agency will have one, the IEN Site Server software will normally reside on an Agency's IEN Workstation PC or the TCS Server (i.e., a stand-alone IEN Site Server PC is not normally required).

2.1.3 IEN Command/Data Interface (CDI)

The IEN CDI performs translation between a Level 2B or Level 3 Agency's TCS and the IEN (via the local IEN Site Server). Each Vendor's TCS requires that a CDI be developed for it, but once developed, it can be utilized by any Agency operating that type of TCS. An Agency's CDI will normally reside on a separate PC/server, but could also reside on an Agency's ATMS Server instead. Section 3 discusses the types of data that the CDI must be able to process.

In addition to the CDI, each Level 2B and Level 3 Agency will also have one or more ATMS Servers and ATMS Workstations. Level 2A Agencies will have one or more ATMS Workstations connected to LACO DPW's TCS. While these items are not part of the IEN, they are required for local traffic signal operations and as a data source for the IEN (via the CDI). Exhibit 2.1 presents the minimum technical specifications for a CDI system.

Exhibit 2.1 – CDI PC Technical Specifications

Component	Specifications (Minimum)
CPU	800 Mhz Pentium III
Hard Disk Drive	10Gb
RAM	256Mb RIMM
LAN	Two (2) 10Mbs Ethernet cards/connections
Software	• MS Windows 2003 Server • Oracle 10g Client
Estimated Cost (Oracle licensing is to be handled by LACO and is not included in the estimate)	$2,000

2.1.4 IEN Corridor Server

The IEN Corridor Server (also known as a Sub-Regional Server) is the focus of IEN activity for a Traffic Forum. The IEN Corridor Server provides the means for Sub-Regional (Traffic Forum-wide) traffic signal collaboration and coordinated incident management.

The IEN Corridor Server stores certain types of traffic data from Level 2B and Level 3 Agencies (via their TCS CDIs) and incident management data as entered from Agency IEN Workstations. The IEN Corridor Server also supplies these data to requesting IEN Workstations in the Traffic Forum and to Agencies outside of the TF (via the IEN Regional Server).

The SGVTF IEN Corridor Server will be located at the SGVTF Sub-Regional TMC at the LACO DPW TMC. The technical specifications for the IEN Corridor Server are detailed in the IEN System Technical Reference Manual (Draft Version 2) and are summarized in the table below.

Exhibit 2.2 – SGVTF IEN Corridor Server Technical Specifications

Component	Specifications (Minimum)
CPU	Two (2) 733Mhz Pentium III configured as a cluster server with shared disk storage
Hard Disk Drive	18Gb SCSI (each system)
RAM	1Gb RIMM (each system)
Shared Disk Storage	Five (5) 18Gb SCSI
LAN	• 10Mb/s to local IEN Workstations • 384Kb/s to the various TCS CDIs
Server Software	• MS Windows 2003 Advanced Server • Oracle 10g

Component	Specifications (Minimum)
Estimated Cost (Oracle licensing is to be handled by LACO and is not included in the estimate)	$ 27,000

2.1.5 IEN Regional Server

The IEN Regional Server (not a part of the SGVTF) is the server that integrates the various IEN Corridor Servers and provides the means for Regional traffic and incident management for Agencies throughout the County. The IEN Regional Server also manages integration with non-Traffic Forum Agencies, such as Caltrans and LADOT.

The technical specifications and cost estimates for the IEN Regional Server will be developed as part of another project but should be similar to the IEN Corridor Server as discussed in Exhibit 2.2.

2.1.6 IEN Communications Network

The IEN communications network (IEN network) is the glue that enables all of the aforementioned components to work together. The IEN network is a private network and will not be directly linked to any Agency's local LAN/WAN nor to the Internet. There will be a communications link between every SGVTF Agency to the Sub-Regional TMC (at the LACO DPW TMC).

The IEN network connectivity to each Agency is proposed to operate over leased 1.544 MBPS DSL circuits and is described in more detail in the SGVTF Communications Conceptual Design and the SGVTF Communications Alternatives Analysis documents. The networking equipment that each Agency will need for their Center-to-Center (i.e., Agency LCCS to the Sub-Regional TMC) communications is shown in Exhibit 2.3.

Exhibit 2.3 – SGVTF Agency IEN Networking Equipment

Component	Specifications (Minimum)
Ethernet Switch	• 8 dual speed ports (min)
DSL Modem	• RJ-11, RJ-45 and USB interfaces • 10Mb/s & 100Mb/s • Support for SBC and Verizon networks
Estimated Cost	$ 150

2.2 SYSTEM INTEGRATION ARCHITECTURE

The actual IEN components deployed at each Agency are dependent upon that Agency's traffic signal operating level. The following sections present various views of the IEN systems architecture and SGVTF systems integration.

2.2.1 System Architecture

The following diagrams depict the conceptual system architecture for each Agency Level. The diagrams show the connectivity of the Agency's field equipment (to their TCS or to the County's

TCS) and the primary traffic control/management system components (IEN and ATMS) each Agency level will operate. Of particular note is the dual network connectivity of the CDI (at LACO and Level 2B & Level 3 Agencies). This is required to allow the CDI to communicate with both the TCS and the IEN. The specifics for each Agency (ATMS, LCCS, and communications) are presented in the respective SGVTF conceptual design documents.

Exhibit 2.4 - SGVTF Level 1 Agency Systems Architecture

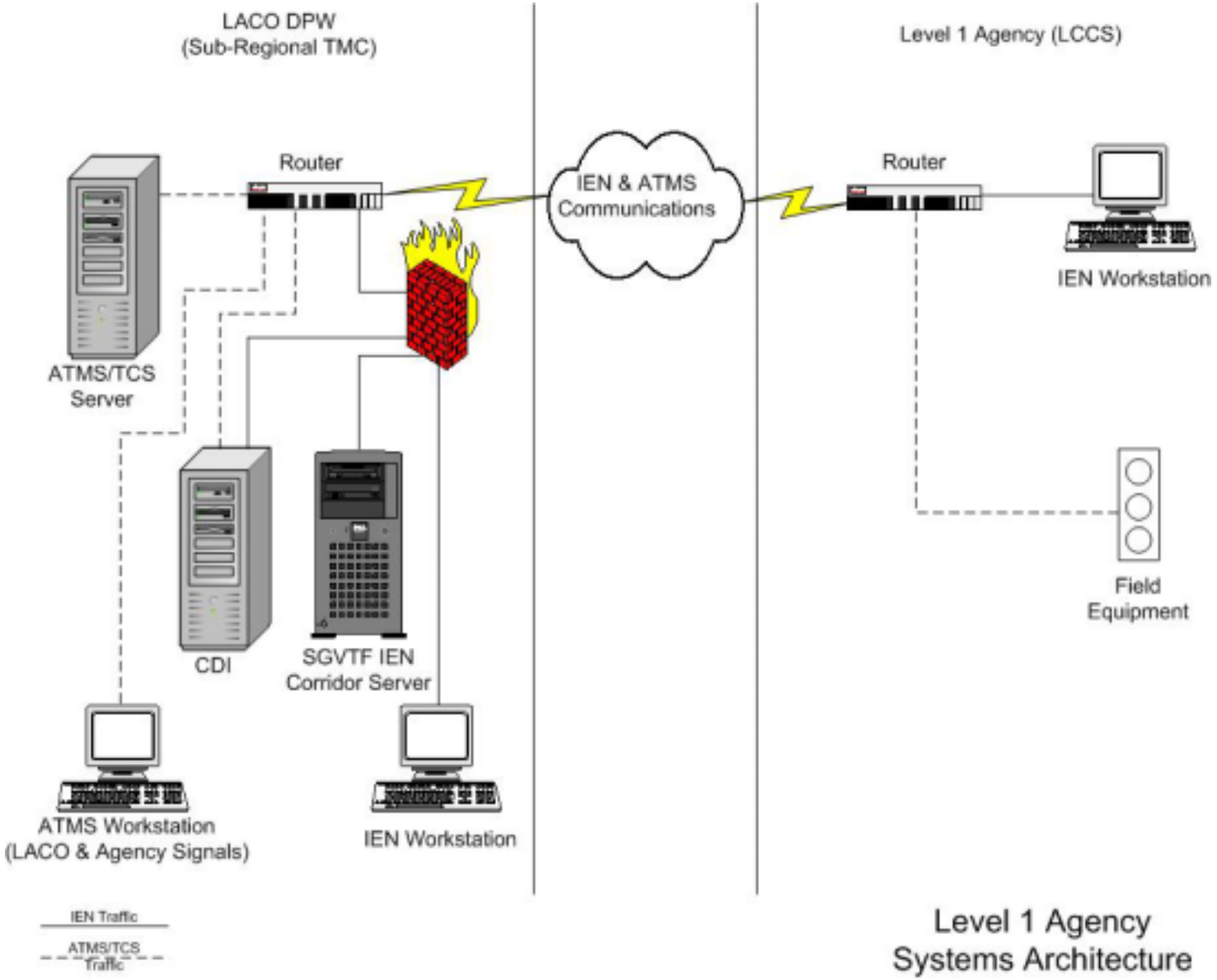


Exhibit 2.5 - SGVTF Level 2A Agency Systems Architecture

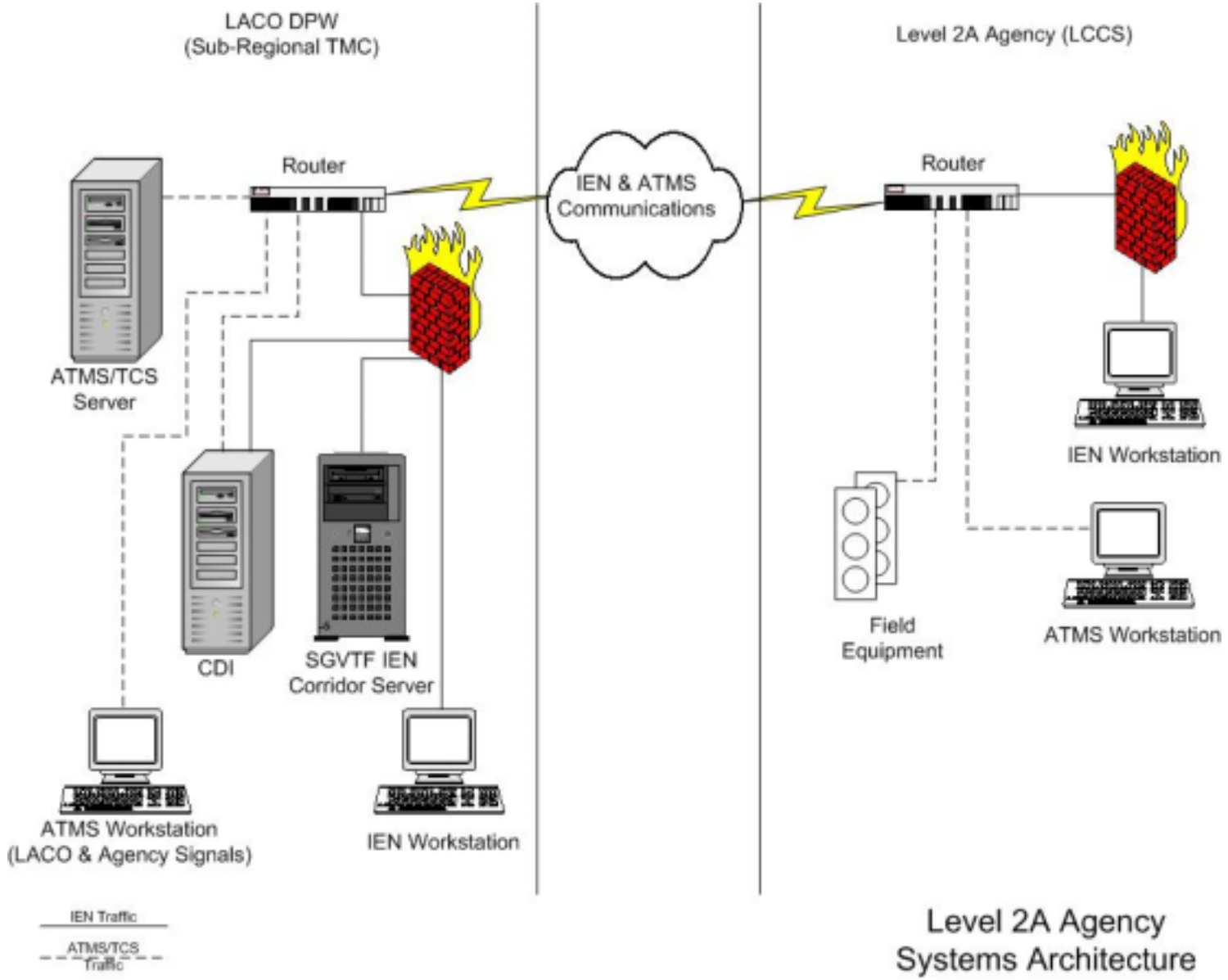


Exhibit 2.6 - SGVTF Level 2B Agency Systems Architecture

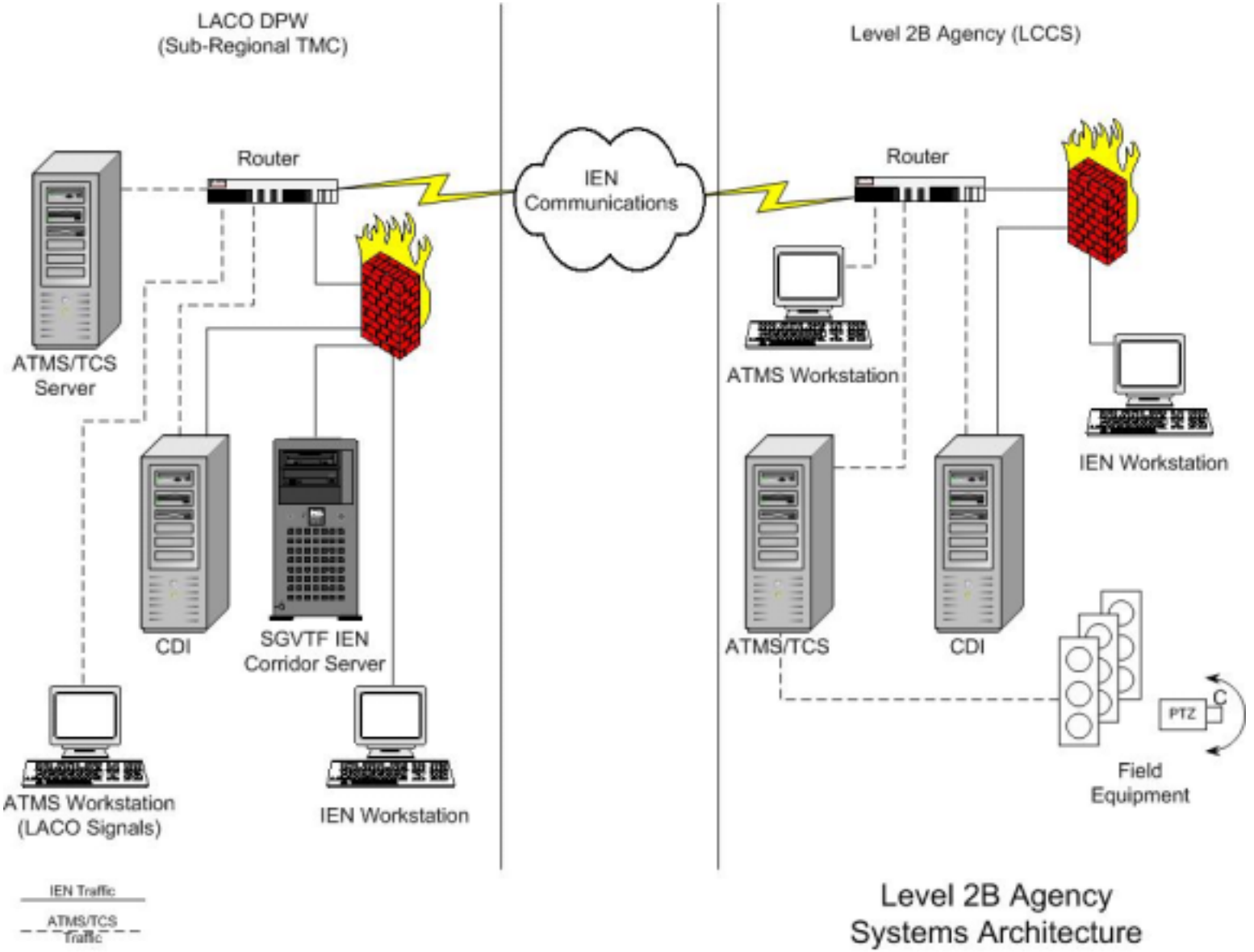
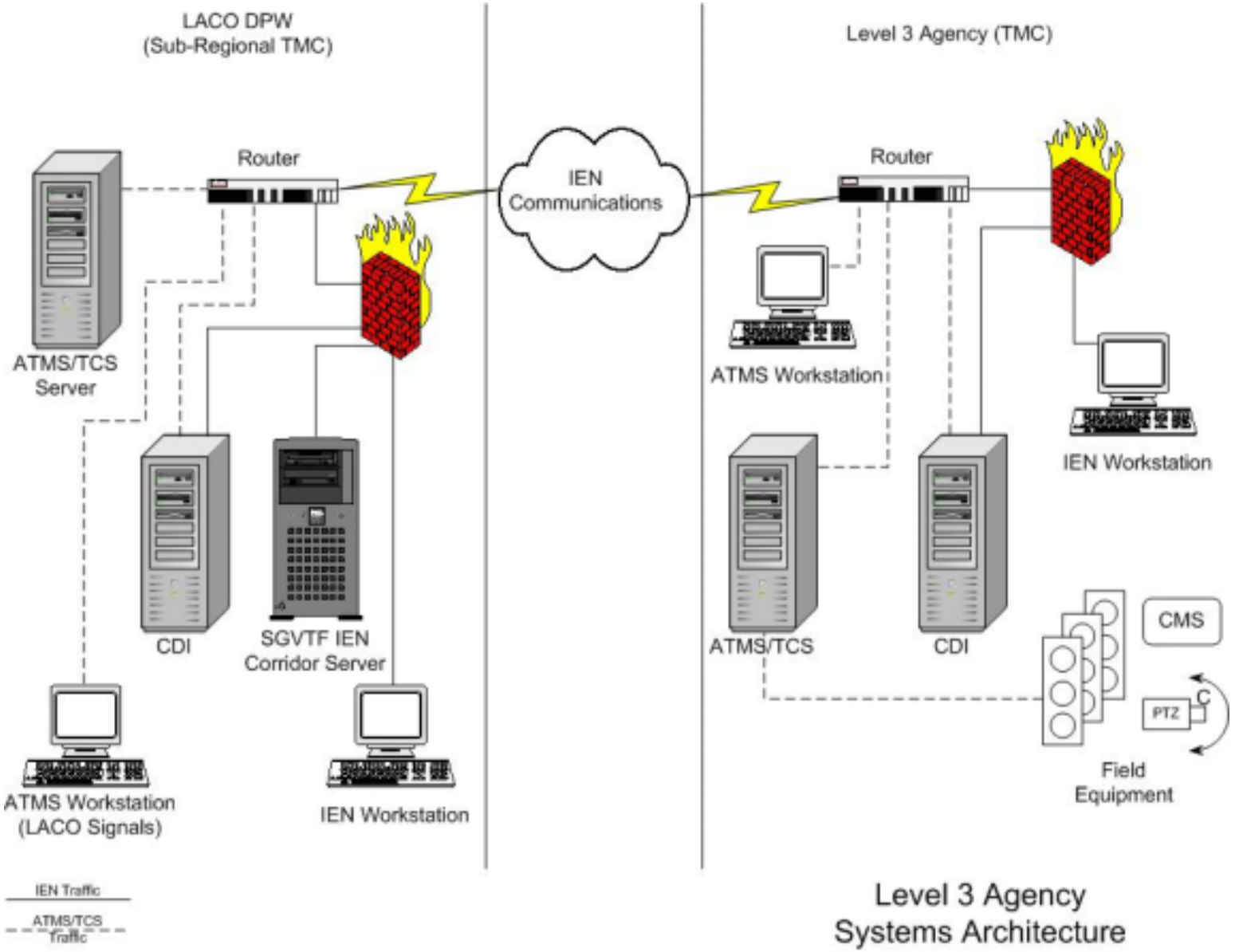


Exhibit 2.7 - SGVTF Level 3 Agency Systems Architecture



2.2.2 Integrated Systems

The following Turbo Architecture diagrams present the integration of systems from various viewpoints. Each diagram shows what systems are to be integrated. Views are presented for each SGVTF Agency Level, the SGVTF overall, and IEN-centric views (both summarized and detailed). The primary difference between the SGVTF and IEN-centric viewpoints is that the IEN-centric view shows the integration for only those systems directly related to the IEN while the SGVTF overall view also include the various ATMS systems and equipment to be deployed.

Exhibit 2.8 - SGVTF Level 1 Agency Systems Integration

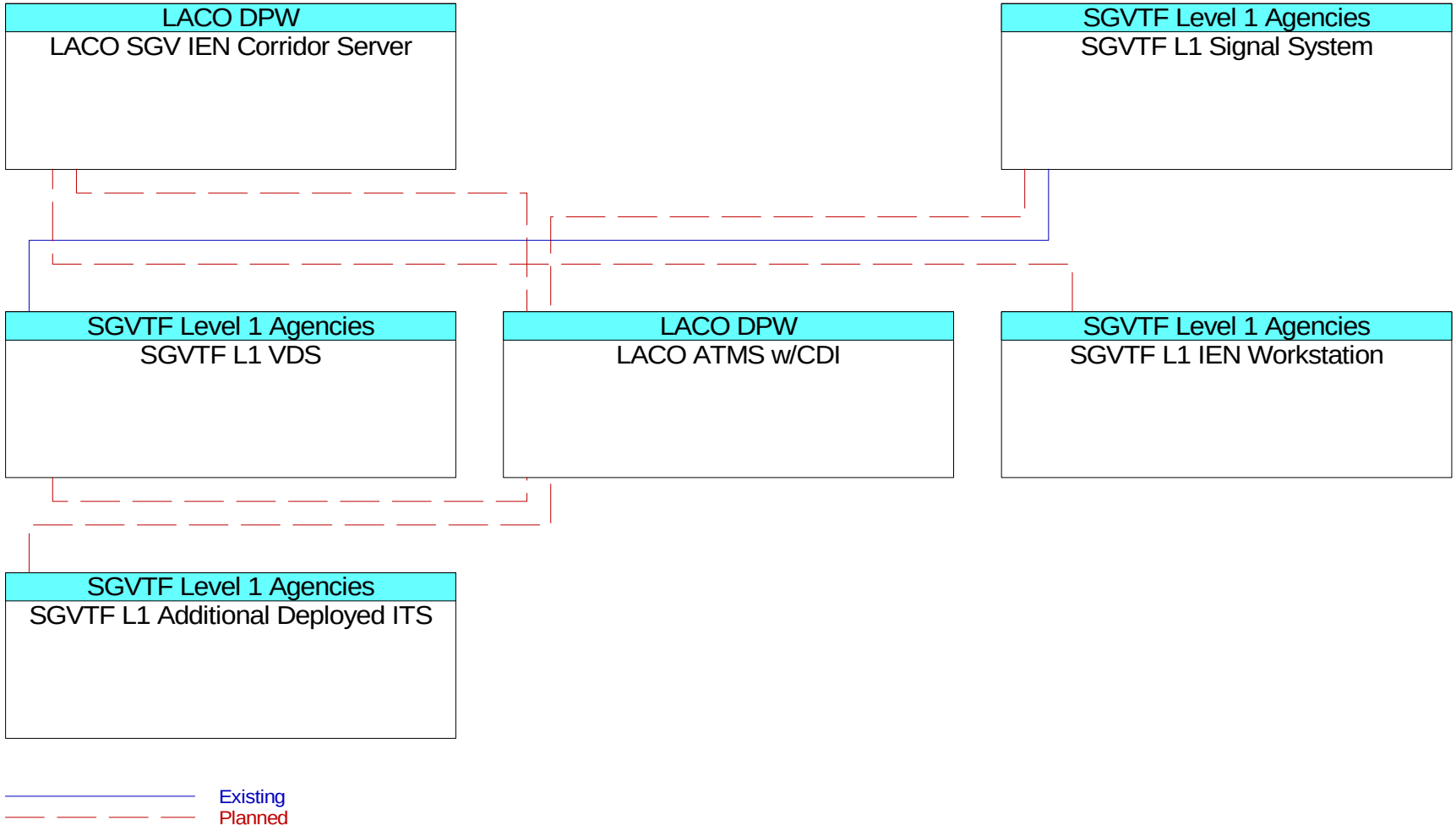


Exhibit 2.9 - SGVTF Level 2A Agency Systems Integration

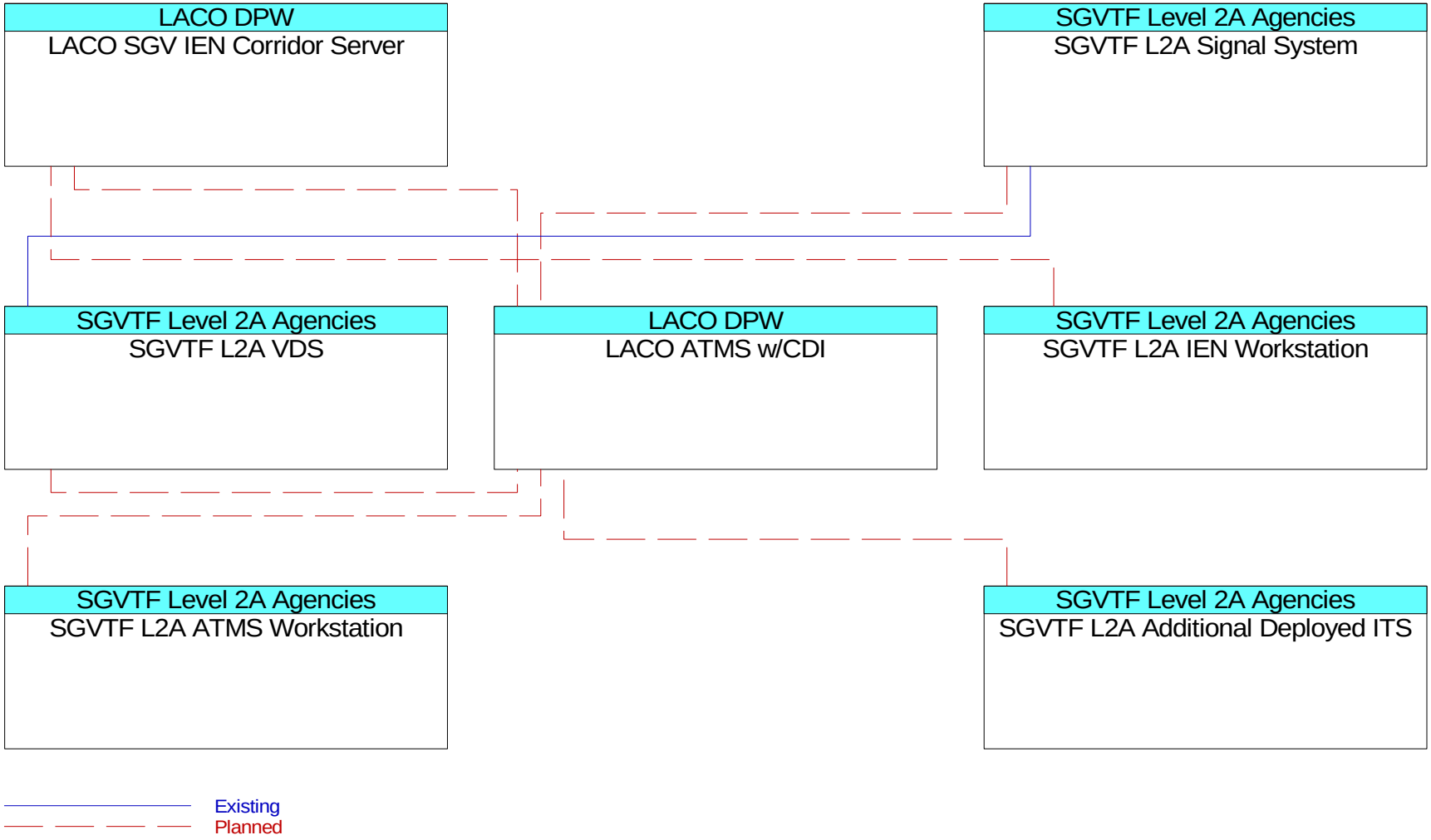


Exhibit 2.10 - SGVTF Level 2B Agency Systems Integration

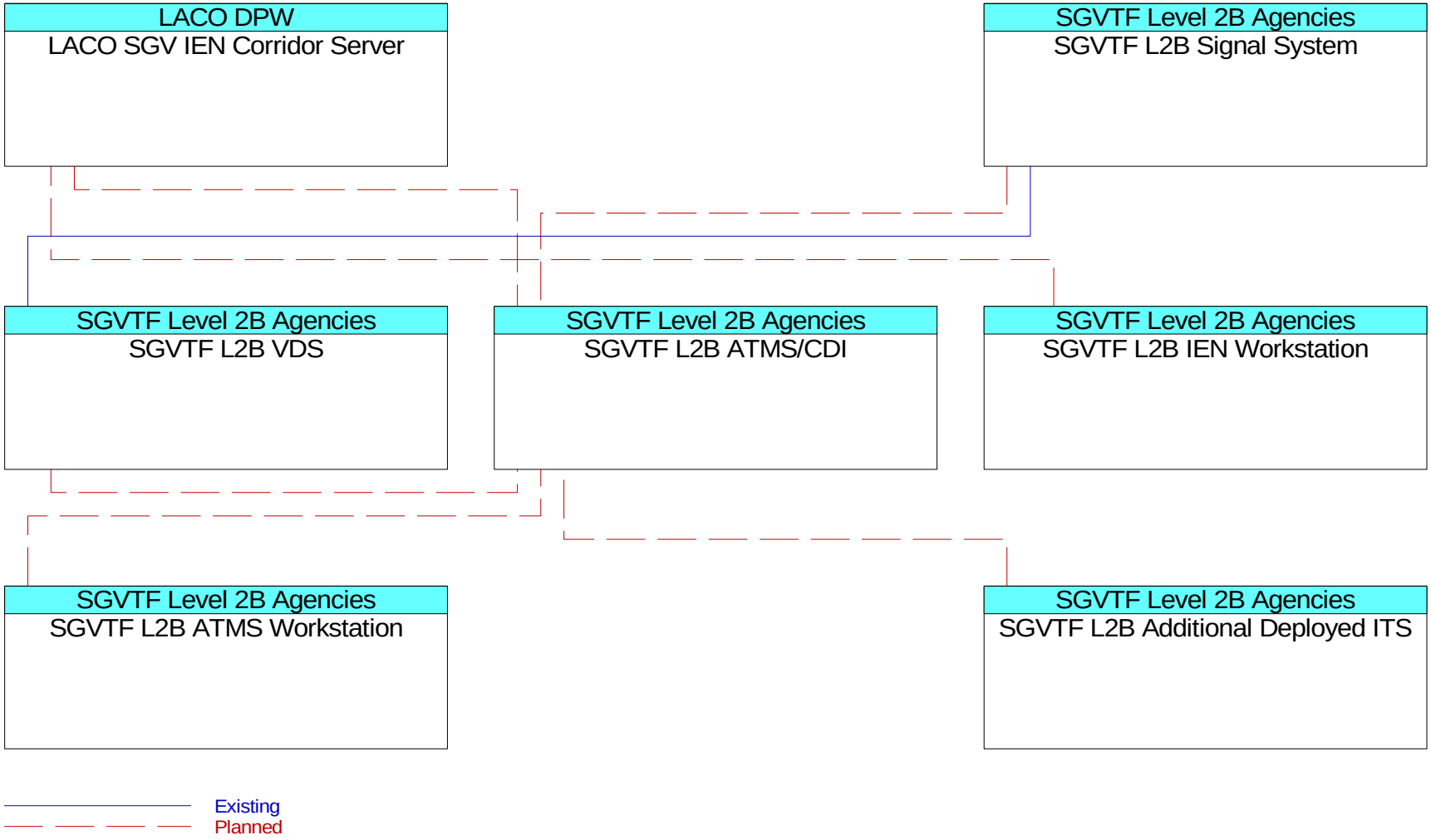


Exhibit 2.11 - SGVTF Level 3 Agency Systems Integration

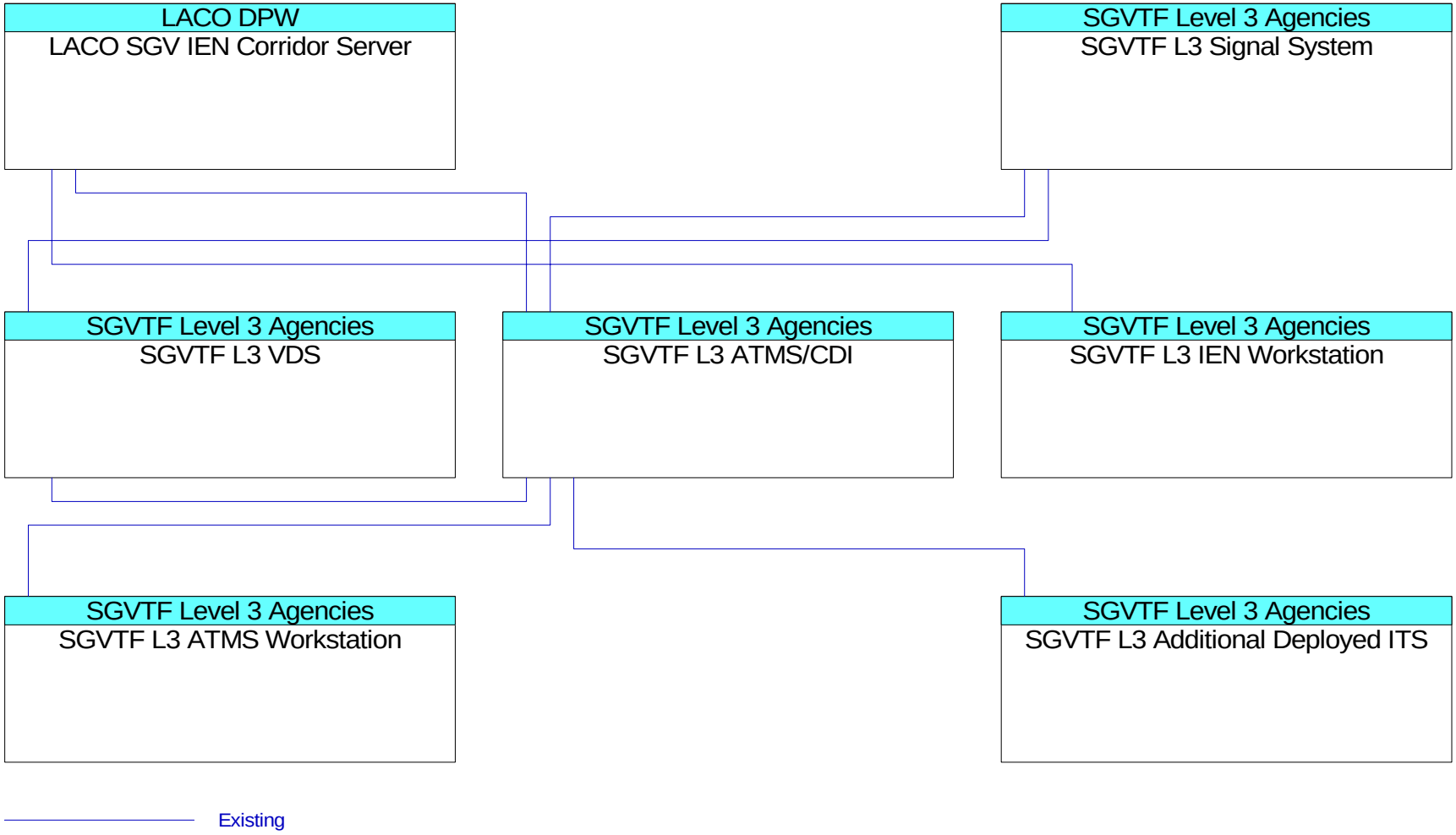


Exhibit 2.12 - SGVTF Agency Systems Integration (Summary)

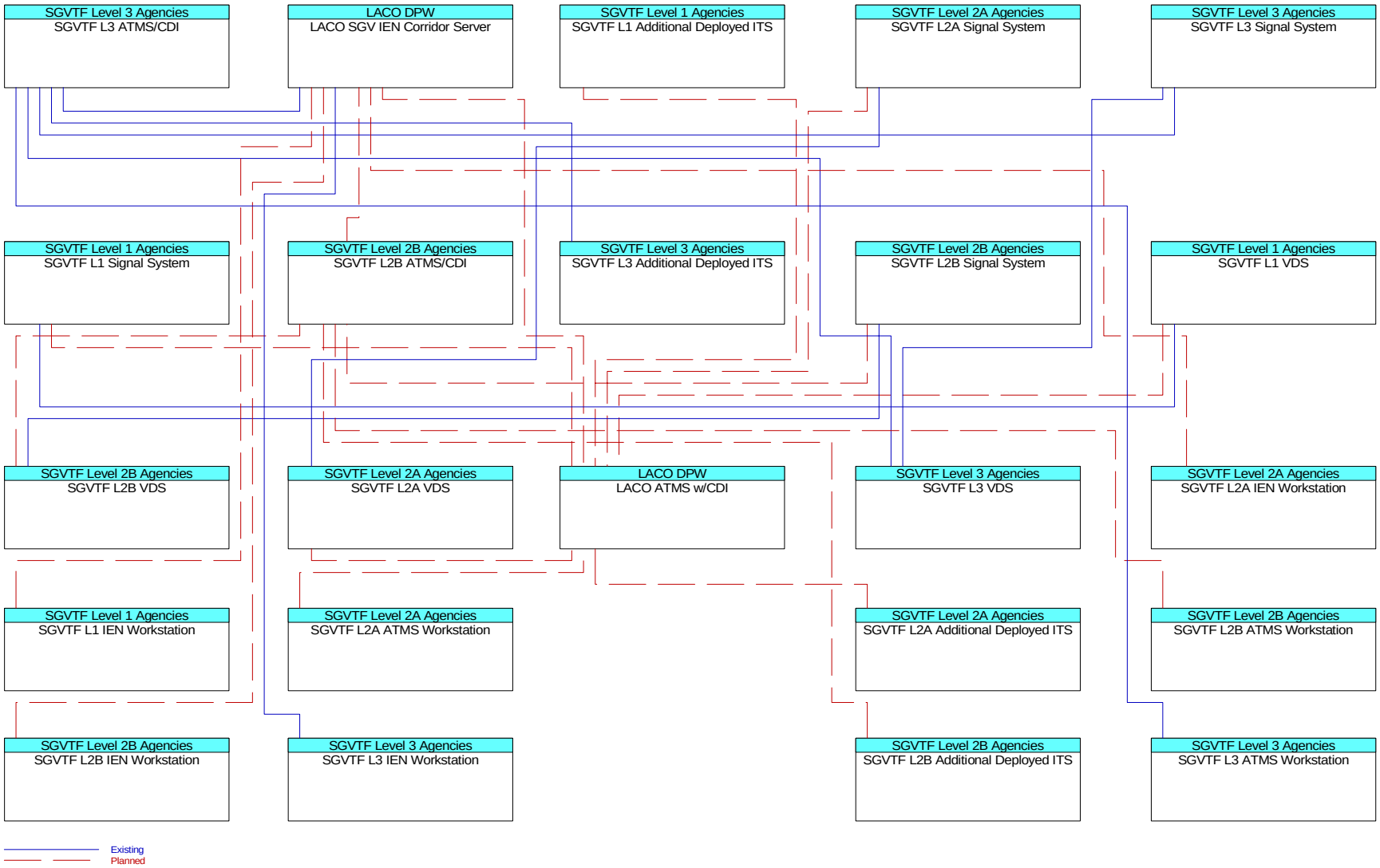


Exhibit 2.13 - SGVTF System Integration – IEN View (Summary)

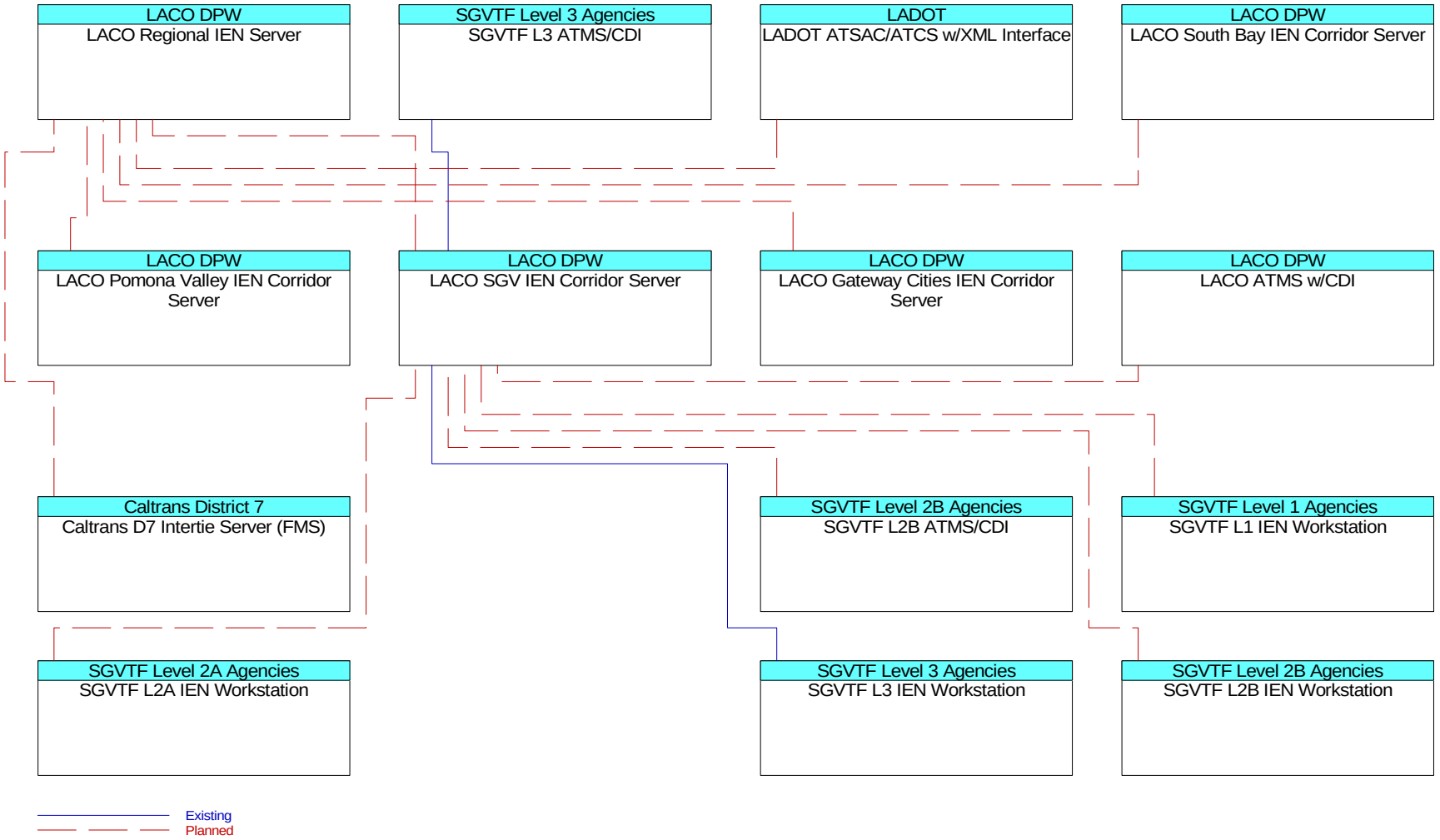
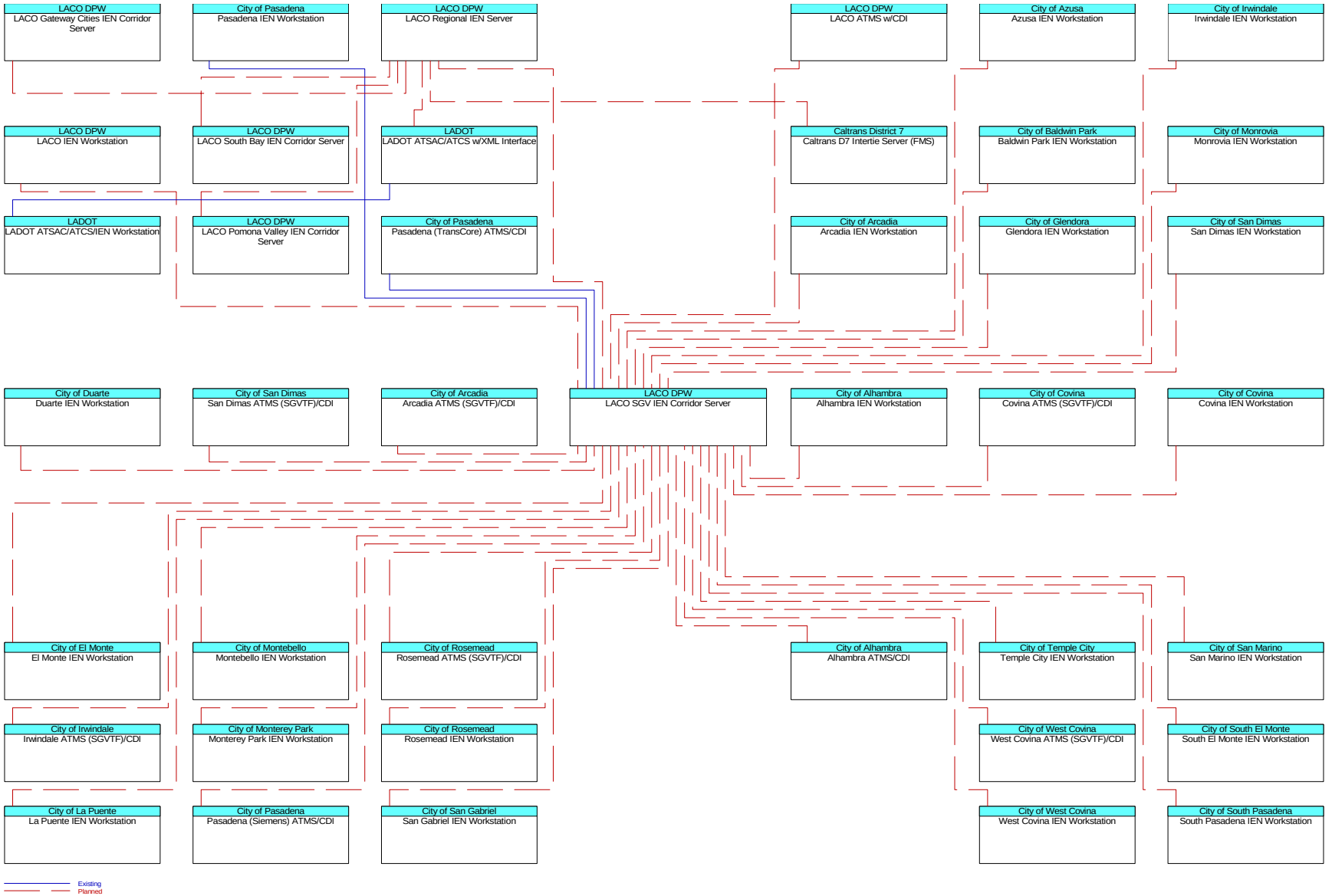


Exhibit 2.14 - SGVTF System Integration – IEN View



3. COMMAND/DATA INTERFACE

3.1 BACKGROUND

The open design of the Countywide IEN allows for any Vendor's TCS to connect with the IEN via a Command/Data Interface (CDI). The CDI is the system software application that integrates an Agency TCS with the IEN (see Section 2.1). A separate CDI must be developed for each Vendor's TCS, but once the CDI is developed, it can be reused by any Agency using that type of TCS and needing to connect with the IEN. The County, the affected Agencies, and Vendor(s) must address the initial CDI development, costs, and potential licensing issues, if any.

In most cases, the CDI communicates with the IEN using the industry-standard Common Object Request Broker Architecture (CORBA). A TCS CDI must support the set of CORBA interfaces needed to implement the required functionality.

3.2 CDI DATA TRANSFERS

The primary function of a TCS CDI is to translate commands and data between the IEN and the target TCS. In general, the CDI supplies traffic control system data from the TCS in response to requests from the IEN (due to a user request at an IEN Workstation or directly from the SGVTF Corridor Server). Exhibit 3.1 summarizes the data that must be supported by all CDIs.

Exhibit 3.1 –CDI Data

Data	Description
Intersection Information	Used to update the IEN when a new intersection is added to or removed from the TCS.
Intersection Real-Time Status	Used to provide second-by-second controller status from the TCS for requested intersections.
Intersection Real-Time Summary	Used to notify the IEN when the intersection controller status or control mode changes.
Phase State	Used to provide intersection controller phase data when the controller's phase state changes (identify green phases only).
Pedestrian Phase State	Used to provide intersection controller phase data when the controller's walk signal state changes.
Actuation Detector State	Used whenever any controller's actuation detectors changes its actuation state.
Last Cycle Phase Data	Used at the completion of an intersection controller cycle (total green time for all phases that were active in the just-completed cycle).
Timing Plan Phase Data	Used when the maximum permissible green time changes for any of the controller's defined phases.
Detector Configuration Information	Used when a detector is added to or deleted from the TCS, or when the detector configuration changes.
Detector State	Used when new data has been uploaded from the field detector to the TCS.
Section Information	Used when a section is created or deleted, and when intersections are add to or removed from an existing section on the TCS.
Section State	Used when any defined sections changes its control mode or timing plan number.

This section provides an overview of CDI functionality and design. Please refer to the *IEN Recommendations for the Implementation of New TCS CDI Programs* document for more detailed information on the actual data definitions as well as when the events are triggered.

3.3 CDI DEPLOYMENT STATUS

Several Vendor TCS CDIs are currently completed or the development is well under way. Others have not yet started planning. The status of the major TCS Vendors' CDI development efforts are summarized in Exhibit 3.2, below. Included in the table is the status of two (2) additional non-CDI IEN interfaces (XML-based) for ATSAC and CT-NET.

Exhibit 3.2 – CDI Deployment Status

Vendor/TCS	CDI Status	Agency(ies)	Date	Comments
TransCore *TransSuite™*	Developed	Pasadena	3Q2000	• Available to SGVTF Agencies
Kimley-Horn KITS	Under development	LA County	1Q2006	• Developed by TransCore • Will be available to SGVTF Agencies
BI Tran Systems QuicNet IV	Developed	Inglewood (non SGVTF Agency)	2Q2005	• Available to SGVTF Agencies
PB Farradyne MIST	N/A	N/A	N/A	• No known plans to develop MIST CDI
Siemens I2TMS	Under development	Pasadena	3Q2006	• Will be available to SGVTF Agencies
Econolite Pyramids	N/A	N/A	N/A	• No known plans to develop Pyramids CDI
Econolite icons	N/A	N/A	N/A	• No known plans to develop icons CDI
LADOT ATSAC	Developed (XML interface)	LADOT	2Q2005	• Not available to SGVTF Agencies
Caltrans CT-NET	Under development (XML interface)	Caltrans	4Q2007	• Not available to SGVTF Agencies