Department of Public Works

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# San Gabriel Valley Pilot Project

# DELIVERABLE 5.1 – IEN XML CDI SPECIFICATION

## (Traffic Control System Interface)

Final

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# LOS ANGELES COUNTY

# INFORMATION EXCHANGE NETWORK

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# 1. INTRODUCTION

## 1.1 Overview

Today's prevailing technologies for system-to-system data exchange are Extensible Markup Language (XML) and web services. The Los Angeles County Department of Public Works (LACO DPW) is interested in developing an XML-based web services interface for their Information Exchange Network (IEN) System that participating Agencies can use to report their traffic signal data to the IEN. This new IEN XML Traffic Control System (TCS) Interface [aka Command/Data Interface (CDI)] will allow additional types of TCSs to share data with the IEN thereby increasing the number of Agencies that can participate in the program.

## 1.2 Purpose

This document describes the architecture and operations of the IEN XML TCS Interface.

## 1.3 Audience

This document is intended for the software developers who will be responsible for implementing the Interface. Readers of this document should be familiar with the following technologies:

- Web Services
- XML
- WSDL
- SOAP

Readers should also be familiar with concepts of the IEN domain as described on the IEN project web site at http://www.ladpw.org/TNL/ITS/IENWeb/index.cfm and the NTCIP 2306 and TMDD V3.0 standards.

## 1.4 References

This specification references the following documents:

- NTCIP 2306 v01.69r National Transportation Communications for ITS Protocol (NTCIP) Application Profile for XML Message Encoding and Transport in ITS Center-To-Center Communications (NTCIP C2C XML) , December, 2008.
- Traffic Management Data Dictionary (TMDD) V3.0, November 2008.
- Web Services Description Language (WSDL) Version 2.0 Part 0: Primer, http://www.w3.org/TR/2007/REC-wsdl20-primer-20070626/
- Web Services Description Language (WSDL) Version 2.0 Part 1: Core Language, http://www.w3.org/TR/wsdl20/
- SOAP Version 1.2 specification, http://www.w3.org/TR/soap12/
- Los Angeles County Department of Public Works IEN project web site: http://www.ladpw.org/TNL/ITS/IENWeb/index.cfm.

## 1.5 Definitions, Acronyms, and Abbreviations

The following terms are used within this document:

**Table 1-1: Definitions of Terms**

| TERM | DEFINITION |
|---|---|
| Accumulation Period | The length of time over which raw detector measurements are accumulated. |
| Arterial System Detectors | A device used to measure traffic speed, volume, and occupancy across a particular section of roadway at an intersection. |
| Averaging Period | The length of time over which detector measurements are averaged. For example, a 15-minute averaging period means that 15-minutes worth of data accumulations were averaged. |
| C2C | Center-to-Center |
| CORBA | Common Object Request Broker Architecture, a standard that enables software components written in multiple computer languages and running on multiple computers to work together. |
| Data Frame | A set of frames which are involved in elaborating other data concepts such as information dialogue and messages. |
| External Center | A center that requests data from another center (*see also* "Owner Center"). The IEN is an external center in the sense that it requests data from member traffic management Agencies. |
| HTTP | Hypertext Transfer Protocol |
| IEN | Los Angeles County Information Exchange Network |
| IEN Site Server | A software program within the IEN architecture that is responsible for collecting data from local traffic control systems and sending that data to central IEN servers located at LACO DPW. Can also refer to the computer system on which the Site Server software is installed. |
| Intersection Signal Controller | A device that controls the operation of an intersection's vehicle and pedestrian signals. It can function independently or as part of a computerized traffic control system. |
| ITE | Institute of Transportation Engineers |
| ITIS | International Traveler Information System |
| ITS | Intelligent Transportation Systems. Computerized systems for managing vehicular traffic. |
| LRMS | Location Referencing Message Specification |
| NEMA | National Electrical Manufacturers Association |
| NTCIP | National Transportation Communication for ITS Protocols. USA national standard protocols for use with intelligent transportation systems. |
| Owner Center | A center that provides information developed or stored within itself to other centers (*see also* "External Center"). Local traffic management Agencies are owner Agencies from which the IEN requests data. |
| Request/Response | A message exchange pattern in which a requestor sends a request message to a replier, which then returns a message in response. |

| TERM | DEFINITION |
|---|---|
| Signal | See intersection signal controller |
| Site | A local Agency at which IEN components are installed. |
| Site Server | *See* IEN Site Server. |
| SOAP | A protocol specification for exchanging structured information in XML formatted messages in the implementation of Web Services. |
| TCS | Traffic Control System |
| TMC | Traffic Management Center |
| TMDD | *See* Traffic Management Data Dictionary |
| Traffic Management Data Dictionary | Standard NTCIP dictionary of traffic management data items and messages. Usually referred to as the TMDD. |
| Volume | Vehicles per hour crossing a detector, link, or node. |
| Web Client | A program for retrieving data from a web server. |
| Web Server | A program that implements a set of web service operations. Within the context of this document, Web Server refers to the program that the IEN will connect to in order to get XML-formatted data from a traffic control system. |
| Web Services | A software communication standard that supports data exchange between remote computers using web servers and data encoded in XML |
| Web Services Description Language | A standard XML schema for describing web services supported by a system. |
| WSDL | *See* Web Services Description Language |
| XML | Extensible Markup Language. A standard for representing structured data using text characters in a format similar to that used for web pages. |
| XML Schema | A document used to describe the XML messages that are sent via the services in the WSDL. |
| XSD | A standard XML schema document used to describe the XML messages that are sent via the services in the WSDL. |

# 2. INTERFACE DESIGN GOALS AND ASSUMPTIONS

The following objectives, goals, constraints, and assumptions affect the design of the Interface.

## 2.1 Objective

To establish an XML-based web services interface standard that will allow the IEN to collect data from local Agency traffic control systems.

## 2.2 Design Goals

- The Interface should be based on open and widely adopted internet standards and technologies.
- The Interface should implement IEN functions using industry standards where practical.
- The Interface should be loosely tied to software Vendors, platforms, and programming languages.

## 2.3 Design Constraints

- The Interface should provide the same functionality as the IEN's CORBA-based TCS Interface (CDI) except that signal and section commands and all section-related data will not be supported.
- Traffic control systems may not be able to collect real-time data such as cycle counters and active phases from all their signals each second. The Interface should only be required to collect real-time data for a few signals at a time.
- The design of the Interface should not preclude the following functionality from being added in the future. (Note that this the functionality will not be supported in the initial implementation of the Interface):
    - Signal and section commands
    - Section data
    - Other types of devices and data
    - The Interface will need to function across LACO DPW/local Agency firewalls

## 2.4 Design Assumptions

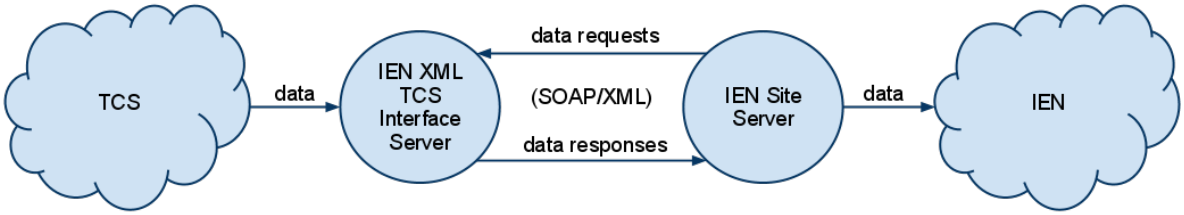
- Traffic control systems are able to collect summary status data such as control mode, timing plan, and operational status from all their signals each second.
- IEN users only need to see detailed real-time data (shown in intersection diagrams) for a few devices at a time and they need to see status summary data (shown on the map) for every device all of the time.
- Traffic Control System Vendors prefer to implement an interface based on National Standards rather than a custom interface designed to support only the IEN's needs.
- Security measures such as data encryption will not be required for the Interface.
- The Interface may have to work through multiple firewalls.

- An IEN Site Server will be located at each Agency.
- The IEN Site Server and local traffic control systems will communicate over a local area network with a bandwidth of 100Mbps (or better).
- Assumed typical data update rates for devices:
    - Signal status summary data changes a few times per cycle.
    - Arterial system detector status data changes every upload period, which is every 30-seconds or longer.
    - Signal and detector inventory data changes infrequently.

# 3. INTERFACE ARCHITECTURE

The IEN XML TCS Interface (CDI) consists of a request/response style web service that uses SOAP messages to exchange XML-formatted data. The Interface architecture is illustrated in Exhibit 3-1 below.

**Exhibit 3-1: High-Level Interface Architecture**




It consists of a traffic control system, an IEN XML TCS Interface Server, an IEN Site Server, and the IEN program as a whole.

A traffic control system is the originating system of the data that the IEN is interested in. It handles communications with Agency intersection signals and arterial system detectors in the field. There are many different types of traffic control systems available.

The IEN XML TCS Interface Server is a Web Server that supports the IEN XML TCS Interface Web Service that is described throughout the remainder of this document. It receives data requests from the IEN Site Server, collects the requested data from a local traffic control system, and then responds back to the Site Server with that data.

The IEN Site Server is a program that runs on a computer system located at each member Agency. It uses operations of the IEN XML TCS Interface Web Service to request and receive data for local Agency traffic devices. It sends local data off to the rest of the IEN.

The IEN program is a set of software applications, computer systems, and network links whose purpose is to share arterial traffic data between Agencies within Los Angeles County.

## 3.1 Interface Files

The IEN XML TCS Interface is defined by the following files:

- IEN-DataInterface.wsdl: Defines the operations of the IEN XML TCS Interface Web Service.
- IEN-DataInterfaceExtension.xsd: Defines the messages and native data elements of the IEN XML TCS Interface Web Service.
- C2C.xsd: NTCIP 2306 Center to Center administration message set.
- ITIS-Adopted-03-00-02.xsd: ITIS codes and phrases used in various ITS standards.
- ITIS-Local-03-00-02.xsd: Adds local content to ITIS-Adopted-03-00-02.xsd.
- LRMS-Adopted-02-00-00.xsd: LRMS location references for ITS applications that require the communication of spatial data references between systems.
- LRMS-Local-02-00-00.xsd: Adds local content to LRMS-Adopted-02-00-00.xsd.

- NTCIP-References.xsd: NTCIP provided list of NEMA roadside device and control material.
- TMDD.xsd: TMDD provided list of ITE traffic management material, provides the dialogs, message sets, data frames, and data elements to manage the shared use of devices and the regional sharing of data and incident management responsibility.

Structures and elements of the schema files listed above are referenced throughout this document. These references include a name space notation to identify the schema in which the structures and elements reside. The notation "lacoien:" means that the structure or element is from the IEN-DataInterfaceExtension schema. The notation "tmdd:" means that the structure or element is from the TMDD schema.

## 3.2 Use of National Standards

The IEN XML TCS Interface makes use of national ITS standards in the following ways:

1. The Interface's messages and data structures are based on the messages and data frames of the TMDD v3.0 standard. Where necessary, TMDD data frames have been extended following the extension rules of the standard.
2. The Interface uses the SOAP over HTTP sub-profile and request-response data exchange pattern of the NTCIP 2306 v01 standard.

In Center-to-Center vernacular, local Agencies are the "Owner Centers" (generators of data) and the IEN is an "External Center" (a consumer of data that is generated outside of itself). The IEN also acts as an Information Service Provider (ISP) in that it shares the data it collects with third-party systems.

### 3.2.1 IEN Extensions for TMDD Data Frames

The IEN XML TCS Interface extends the following TMDD data frames in compliance with Section 2.6.1 of the TMDD Standard for Traffic Management Center-to-Center Communications Volume II: Design Content V3.0 document:

**Table 3-1: IEN Extensions for TMDD Data Frames**

| TMDD DATA FRAME | IEN EXTENSION |
|---|---|
| DetectorDataDetail | lacoIenDetectorDataDetailExtension |
| DetectorInventoryDetails | lacoIENDetectorInventoryDetailExtension |
| DeviceInformationRequest | lacoIENRealTimeIntersectionSignalDeviceListExtension |
| IntersectionSignalInventory | lacoIENIntersectionSignalInventoryExtension |
| IntersectionSignalStatus | lacoIENIntersectionSignalStatusExtension |

## 3.3 Real-Time Intersection Data

The IEN desires very dynamic "real-time" intersection signal data that changes as frequently as once-per-second.

Real-time IEN Intersection Signal Data:

- Local cycle counter

- Master cycle counter
- Active green phases
- Active pedestrian phases
- Active vehicle calls
- Last cycle length
- Last cycle phase green times
- Planned phase green times

The data listed above is not always available in all traffic control systems for all signals every second due to limitations of the center-to-field communications or the signal controller hardware/firmware platform. The IEN addresses this problem by 1) only asking for real-time data when an IEN user has opened a screen that requires that data, and 2) only asking for real-time data for the intersection signal(s) that are contained within that screen. This also helps to reduce the size of IEN messages that are exchanged between member Agencies across low bandwidth connections.

Some of the real-time data that the IEN desires is available in the TMDD v3.0 schema; some is not and therefore is defined in the IEN-DataInterfaceExtensions schema instead. The TMDD does not provide a mechanism for telling a server when a client wants more or less of the optional elements within the TMDD data frames.

The IEN XML TCS Interface has implemented such a mechanism by extending the tmdd:DeviceInformationRequest data frame used in the OP_IntersectionSignalStatus operation to include a Real-time-intersection-id-list element. Real-time-intersection-id-list contains a list of intersection signal IDs for which the IEN wants real-time data. The IEN will continue to request real-time data for an intersection signal while a user has a screen open that needs it. IEN users frequently leave intersection detail screens open for hours or days. The IEN will stop requesting real-time data when that data is no longer needed within the IEN.

See Sections 6.8 – DeviceInformationRequest and 0 – for information about the data frames that are involved in real-time data requests and responses.

### 3.4 IEN Polling

The IEN Site Server will poll the IEN XML TCS Interface Server for data at the following rates:

- Inventory Data: The IEN Site Server will request inventory data for all local devices when it first starts up. It will then request inventory data for each device once-per-day.
- Summary Intersection Signal Status Data: The IEN Site Server will request summary status data for all local intersections once-per-second.
- Real-time Intersection Signal Status Data: When the IEN requires real-time data for an intersection signal, the IEN Site Server will request real-time data for that signal once-per-second.
- System Detector Status Data: The IEN Site Server will have to do two (2) requests for detector status data; once to get actual measurements and then again to get

averaged measurements. The IEN will poll for actual measurements every 30-seconds and for "averaged" measurements at the interval of the reported averaging period for each detector.

The IEN will provide the device-filter element of the tmdd:DeviceInformationRequest data frame (See Sections 6.8) when it needs to request data for specific devices. The IEN will not provide the device-filter element when it wants data for all devices.

### 3.5 Handling Unknown or Unsupported Data

Traffic control systems may not support all of the IEN XML TCS Interface data set. The IEN expects IEN XML TCS Interface Servers to provide all elements required by the TMDD standard for the data frames listed in Section 6 of this document and all elements of the IEN-DataInterfaceExtensions schema. If data for an element is not known or not supported, the element should still be provided and the value set to "unknown" according to the documentation for the element. Typically strings can be left empty (nil), while numbers should be set to "-1". Some enumerations include an "unknown" type. Please consult the Interface schema files for more information.

# 4. INTERFACE OPERATIONS

IEN XML TCS Interface Web Service operations are described in the following sections.

## 4.1 OP_CenterInformation

Use: Allows the IEN to request and receive information about the owner center's traffic control system.

Input message: MSG_CenterInformationRequest (See Section 5.1)

Output message: MSG_CenterInformationResponse (See Section 5.2)

Fault message: MSG_ErrorReport (See Section 5.9)

## 4.2 OP_DetectorData

Use: Allows the IEN to request and receive arterial system detector measurement data from a local traffic control system.

Input message: MSG_DetectorDataRequest (See Section 5.4)

Output message: MSG_DetectorData (See Section 5.3)

Fault message: MSG_ErrorReport (See Section 5.9)

## 4.3 OP_DetectorInventory

Use: Allows the IEN to request and receive arterial system detector inventory data from a local traffic control system.

Input message: MSG_DeviceInformationRequest (See Section 5.7)

Output message: MSG_DetectorInventory (See Section 5.5)

Fault message: MSG_ErrorReport (See Section 5.9)

## 4.4 OP_DetectorStatus

Use: Allows the IEN to request and receive arterial system detector status data from a local traffic control system.

Input message: MSG_DeviceInformationRequest (See Section 5.7)

Output message: MSG_DetectorStatus (See Section 0)

Fault message: MSG_ErrorReport (See Section 5.9)

## 4.5 OP_IntersectionSignalInventory

Use: Allows the IEN to request and receive intersection signal inventory data from a local traffic control system.

Input message: MSG_DeviceInformationRequest (See Section 5.7)

Output message: MSG_IntersectionSignalInventory (See Section 5.10)

Fault message: MSG_ErrorReport (See Section 5.9)

## 4.6 OP_IntersectionSignalStatus

Use: Allows the IEN to request and receive intersection signal status data from a local traffic control system.

Input message: MSG_DeviceInformationRequestRealTime (See Section 5.8)

Output message: MSG_IntersectionSignalStatus (See Section 5.11)

Fault message: MSG_ErrorReport (See Section 5.9)

# 5. INTERFACE MESSAGES

IEN XML TCS Interface Web Service messages are described in the following sections.

## 5.1 MSG_CenterInformationRequest

Use: Requests center data from the web server. Input message for the OP_CenterInformation operation (See Section 4.1).

Base Element: tmdd:organizationInformationMsg

Base Data Frame: tmdd:OrganizationInformation (See Section 6.13)

## 5.2 MSG_CenterInformationResponse

Use: Contains payload center data. Output message for the OP_CenterInformation operation (See Section 4.1).

Base Element: lacoien:lacoIenCenterInformation

Base Data Frame: lacoien:lacoIenCenterInformation (See Section 6.12)

## 5.3 MSG_DetectorData

Use: Contains payload arterial system detector measurement data. Output message for the OP_DetectorData operation (See Section 4.2).

Base Element: lacoien:lacoIenDetectorDataMsg

Base Data Frame: tmdd:DetectorData (See Section 6.1)

## 5.4 MSG_DetectorDataRequest

Use: Specifies which detectors to provide data for. Input message for the OP_DetectorData operation (See Section 4.2).

Base Element: tmdd:detectorDataRequestMsg

Base Data Frame: tmdd:DetectorDataRequest (See Section 6.3)

## 5.5 MSG_DetectorInventory

Use: Contains payload arterial system detector inventory data. Output message for the OP_DetectorInventory operation (See Section 4.3).

Base Element: lacoien:lacoIenDetectorInventoryMsg

Base Data Frame: tmdd:DetectorInventory (See Section 6.4)

## 5.6 MSG_DetectorStatus

Use: Contains payload arterial system detector status data. Output message for the OP_DetectorStatus operation (See Section 4.4).

Base Element: tmdd:detectorStatusMsg

Base Data Frame: tmdd:DetectorStatus (See Section 6.6)

## 5.7 MSG_DeviceInformationRequest

Use: Specifies which devices to provide data for. Input message for the OP_DetectorInventory (See Section 4.3), OP_DetectorStatus (See Section 4.4), and OP_IntersectionInventory (See Section 0) operations.

Base Element: tmdd:deviceInformationRequestMsg

Base Data Frame: DeviceInformationRequest (See Section 6.8)

## 5.8 MSG_DeviceInformationRequestRealTime

Use: Specifies which intersection signal devices to provide data for. Input message for the OP_IntersectionStatus operation (See Section 4.6).

Base Element: lacoIenDeviceInformationRequestMsg

Base Data Frame: DeviceInformationRequest (See Section 6.8)

## 5.9 MSG_ErrorReport

Use: Contains information on errors that occur during web service operations.

Base Element: tmdd:errorReportMsg

Base Data Frame: ErrorReport (See Section 6.9)

## 5.10 MSG_IntersectionSignalInventory

Use: Contains payload intersection signal inventory data. Output message for the OP_IntersectionSignalInventory operation (See Section 0).

Base Element: lacoien:lacoIenIntersectionSignalInventoryMsg

Base Data Frame: IntersectionSignalInventory (See Section 6.10)

## 5.11 MSG_IntersectionSignalStatus

Use: Contains payload intersection signal status data. Output message for the OP_IntersectionSignalStatus operation (See Section 4.6).

Base Element: lacoien:lacoIenIntersectionSignalStatusMsg

Base Data Frame: IntersectionSignalStatus (See Section 0)

# 6. INTERFACE DATA FRAMES

IEN XML TCS Interface Web Service uses data frames from the TMDD v3.0 XML schema. Where necessary, TMDD data frames have been extended to include an element from the IEN-DataInterfaceExtensions schema so that the full IEN data set can be supported. The following sections describe the data frames and elements of IEN XML TCS Interface Web Service.

## 6.1 DetectorData

The tmdd:DetectorData data frame contains a sequence of tmdd:DetectorDataDetail data frames (See Section 6.2).

## 6.2 DetectorDataDetail

The IEN is interested in the following elements from the tmdd:DetectorDataDetail data frame:

- detector-id
- detection-time-stamp
- vehicle-occupancy
- vehicle-speed

The IEN XML TCS Interface extends the tmdd:DetectorDataDetail frame by adding a lacoien:lacoIenDetectorDataDetailExtension element, which is of type lacoien:LACO-IENDetectorDataDetailExtension (described below).

- LACO-IENDetectorDataDetailExtension
- volume: The number of vehicles counted over the accumulation period. Expressed in vehicles per hour.
- volumePlusWeightedOccupancy: Volume in vehicles per hour + weighted occupancy.

## 6.3 DetectorDataRequest

The DetectorDataRequest data frame is used in the input message of the OP_DetectorData operation. The IEN will provide all required elements of the tmdd:DeviceInformationRequest data frame including detector-data-type, which the IEN will set to either “actual” or “averaged” to indicate the type of measurement data that the IEN wants.

## 6.4 DetectorInventory

The tmdd:DetectorInventory data frame contains a sequence of tmdd:DetectorInventoryDetails data frames (See Section 6.5).

## 6.5 DetectorInventoryDetails

The IEN is interested in the following elements from the tmdd:DetectorInventoryDetails data frame:

- detector-inventory-header:device-id
- detector-type

- detector-inventory-header:link-direction
- detection-lanes
- detector-inventory-header:link-name
- detector-inventory-header:device-description

The IEN XML TCS Interface extends the tmdd:DetectorInventoryDetails data frame by adding a lacoien:lacoIenDetectorInventoryDetailExtension element, which is of type lacoien:LACO-IENDetectorInventoryDetailExtension (described below).

- LACO-IENDetectorInventoryDetailExtension
- associatedIntersection: The identification number of the intersection that this detector is associated with.
- averagingPeriod: The length of time over which detector measurements are averaged. For example, a 15-minute averaging period means that 15-minutes worth of data accumulations were averaged. Expressed in seconds.
- crossStreet: Name of the street that crosses the road on which the detector is located at its associated intersection.
- weightingFactor: The weighting factor (k) used for V+kO (volume + weighted occupancy) calculations.

## 6.6 DetectorStatus

The tmdd:DetectorStatus data frame contains a sequence of tmdd:DetectorStatusDetails data frames (See Section 6.7).

## 6.7 DetectorStatusDetails

The IEN is interested in the following elements from the tmdd:DetectorStatusDetails data frame:

- detector-station-status-header:device-id
- detector-station-status-header:device-status

The IEN XML TCS Interface does not extend this TMDD data frame.

## 6.8 DeviceInformationRequest

The DeviceInformationRequest data frame is used in the input message of OP_DetectorInventory, OP_DetectorStatus, OP_IntersectionSignalInventory, and OP_IntersectionSignalStatus operations. The IEN will provide all required elements of the tmdd:DeviceInformationRequest data frame including:

- organization-requesting:organization-name
- device-type
- device-information-type

The IEN will also provide the device-filter element when it needs to request data for specific devices. The IEN will not provide the device-filter element when it wants data for all devices.

The IEN XML TCS Interface extends the tmdd:DeviceInformationRequest data frame only for the OP_IntersectionSignalStatus operation by adding a lacoien:lacoIENRealTimeIntersectionSignalDeviceListExtension element, which is of the type lacoien:LACO-IENRealTimeIntersectionSignalDeviceListExtension (described below):

- LACO-IENRealTimeIntersectionSignalDeviceListExtension
- real-time-intersection-id-list
    - device-id: A sequence of intersection signal identification numbers for which the IEN wants real-time data (See Sections 3.3 and 0 for more information about real-time data).

## 6.9 ErrorReport

The tmdd:ErrorReport data frame is used in the fault message of all IEN XML TCS Interface operations. The IEN will provide all required elements of the tmdd:ErrorReport data frame.

## 6.10 IntersectionSignalInventory

The IEN is interested in the following elements from the tmdd:IntersectionSignalInventory data frame:

- device-inventory-header:device-id
- device-inventory-header:device-description
- device-inventory-header:device-location:latitude
- device-inventory-header:device-location:longitude
- device-inventory-header:controller-description
- device-inventory-header:link-direction

The IEN XML TCS Interface extends the tmdd:IntersectionSignalInventory data frame by adding the lacoien:lacoIenIntersectionSignalInventoryExtension element, which is of type lacoien:LACO-IENIntersectionSignalInventoryExtension (described below):

- LACO-IENIntersectionSignalInventoryExtension
- crossStreet: The name of the cross street of the intersection.
- mainStreet: The name of the main street of the intersection.
- mainStreetDirection: The direction of traffic flow along the main street of the intersection. A value from the lacoien:Traffic-Direction-LACO-IEN Enumeration (See Section 7.5).
- secondsBetweenPollAttempts: The number of seconds between poll attempts to the intersection signal controller.

## 6.11 IntersectionSignalStatus

The IEN is interested in a core set of intersection signal status data all of the time. It is interested in additional set of "real-time" data only when a user has opened a screen that requires that additional data. Real-time elements are noted below. See Section 3.3 and 6.8 for more information about real-time intersection signal status data requests.

The IEN is interested in the following elements from the tmdd:IntersectionSignalStatus data frame:

- device-status-header:device-id
- device-status-header:device-status
- device-status-header:device-comm-status
- current-signal-timing-mode
- timing-pattern-id-current
- cycle-length-planned
- offset-time-planned
- offset-time-previous
- cycle-counter (real-time)
- cycle-counter-master (real-time)
- cycle-length-previous (real-time)
- phase-status:phase-status-group-greens (real-time)
- phase-status:phase-status-group-walks (real-time)

The IEN XML TCS Interface extends the tmdd:IntersectionSignalStatus frame by adding the lacoien:lacoIENIntersectionSignalStatusExtension element, which is of type lacoien:LACO-IENIntersectionSignalStatusExtension (described below):

- LACO-IENIntersectionSignalStatusExtension
- Alarm-list: The alarms that are currently active for the intersection signal. One or more values from the lacoien:Intersection-Signal-Alarms-LACO-IEN enumeration (See Section 7.1).
- mainStreetGreen: An indication of whether the intersection signal's main street vehicle phases are green. A value from the lacoien:Main-Street-Green-LACO-IEN enumeration (See Section 7.3).
- preemptType: The type of preemption currently active for the intersection signal. A value from the Preempt-Type-LACO-IEN enumeration (See Section 7.2).
- phases-with-calls-list (real-time): Phase vehicle call status mask, when a bit = 1, the phase currently has a vehicle call for service. When a bit = 0, the phase currently does NOT have a vehicle call for service. This element is equivalent to the phaseStatusGroupVehCalls object type in the NTCIP 1202 standard; however, that object type is not supported in the NTCIP-References schema or in the TMDD schema.

- last-phase-times-list (real-time): The time that each vehicle phase spent in green during the last cycle. An array of phase numbers and their green times (in seconds).
- plannedPhaseTimes (real-time): The planned maximum green time for each phase for the current cycle. An array of phase numbers and their green times (in seconds).

### 6.12 lacoIenCenterInformation

The lacoien:lacoIenCenterInformation data frame contains information about the center to which the IEN is connected. It is of the type LACO-IENCenterInformation (described below):

- LACO-IENCenterInformation
- systemStatus: The operational status of the traffic control system. A value from the lacoien:System-Status-LACO-IEN enumeration (See Section 0).
- systemName: The name of the traffic control system (example: "Arcadia *TransSuite* TCS").
- systemVersion: The traffic control system version (example: "7.2.4").

### 6.13 OrganizationInformation

The tmdd:OrganizationInformation data frame is a required element of all IEN XML TCS Interface operations. The IEN will provide all required elements of the tmdd:OrganizationInformation data frame.

# 7. IEN-DATAINTERFACE EXTENSIONS TYPE ENUMERATIONS

The following sections describe the type enumerations contained in the IEN-DataInterfaceExtensions schema.

## 7.1 Intersection-Signal-Alarms-LACO-IEN

The Intersection-Signal-Alarms-LACO-IEN enumeration specifies the IEN intersection signal alarm types.

**Table 7-1: Intersection-Signal-Alarms-LACO-IEN Values**

| VALUE | DEFINITION |
|---|---|
| CONFLICT_FLASH | Intersection signal is reporting a conflict flash alarm. |
| CABINET_DOOR_OPEN | Intersection signal is reporting a cabinet door open alarm. |
| FLASH_ALARM | Intersection signal is reporting a flash alarm. |
| INTERNAL_ERROR_ALARM | Intersection signal is reporting an internal error alarm. |
| NO_ALARM | Intersection signal is not reporting an alarm. |

## 7.2 Preempt-Type-LACO-IEN

The Preempt-Type-LACO-IEN enumeration specifies the IEN intersection signal preemption types.

**Table 7-2: Preempt-Type-LACO-IEN Values**

| VALUE | DEFINITION |
|---|---|
| GENERAL_PREEMPT | General preemption. |
| BRIDGE_PREEMPT | Bridge preemption. |
| EV_PREEMPT | Emergency vehicle preemption. |
| LRT_PREEMPT | Light rail transit preemption. |
| RR_PREEMPT | Rail road preemption. |
| OTHER | Other type of preemption not included in this enumeration. |
| NONE | No preemption is active. |

## 7.3 Main-Street-Green-LACO-IEN

The Main-Street-Green-LACO-IEN enumeration specifies the IEN intersection signal main street green state types.

**Table 7-3: Main-Street-Green-LACO-IEN Values**

| VALUE | DEFINITION |
|---|---|
| ON | Main street vehicle phase(s) is currently green. |
| OFF | Main street vehicle phase(s) is not green. |

## 7.4 System-Status-LACO-IEN

The System-Status-LACO-IEN enumeration specifies the IEN traffic control system status types.

**Table 7-4: System-Status-LACO-IEN Values**

| VALUE | DEFINITION |
|---|---|
| GOOD | Traffic control system is operating normally. |
| BAD | Traffic control system is not operational. |
| UNKNOWN | Traffic control system status is not known. |

## 7.5 Traffic-Direction-LACO-IEN

The Traffic-Direction-LACO-IEN enumeration specifies the IEN traffic flow direction types.

**Table 7-5: Traffic-Direction-LACO-IEN Values**

| VALUES | DEFINITION |
|---|---|
| n | Northbound |
| s | Southbound |
| e | Eastbound |
| w | Westbound |
| ne | Northeast bound |
| nw | Northwest bound |
| se | Southeast bound |
| sw | Southwest bound |
| n_s | Bidirectional traffic flow north and south |
| e_w | Bidirectional traffic flow east and west |
| ne_sw | Bidirectional traffic flow northeast and southwest |
| nw_se | Bidirectional traffic flow northwest and southeast |
| other | Directional, but not one of the other values in the enumeration |
| none | Not directional |

# 8. APPENDICES

## 8.1 Appendix A: IEN-DataInterface.WSDL

The IEN XML TCS Interface Web Service is defined by the WSDL file IEN-DataInterface.wsdl, which is listed below.

**Listing 8-1: IEN-DataInterface.WSDL**

```
<?xml version="1.0" encoding="UTF-8"?>

<wsdl:definitions name="IEN-XML-Interface"
targetNamespace="http://ien.ladpw.org/IEN-DataInterface"
            xmlns:xsd="http://www.w3.org/2001/XMLSchema"
            xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
            xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
            xmlns:soapenc="http://schemas.xmlsoap.org/soap/encoding/"
            xmlns:tns="http://ien.ladpw.org/IEN-DataInterface"
            xmlns:tmdd="http://www.tmdd.org/3/messages"
            xmlns:c2c="http://www.ntcip.org/c2c-message-administration"
            xmlns:lacoien="http://ien.ladpw.org/IEN-DataInterfaceExtensions">

   <wsdl:types>
            <xsd:schema elementFormDefault="qualified"
targetNamespace="http://ien.ladpw.org/IEN-DataInterface">
                  <xsd:import namespace="http://www.tmdd.org/3/messages"
schemaLocation="tmdd.xsd"/>
                  <xsd:import namespace="http://ien.ladpw.org/IEN-
DataInterfaceExtensions" schemaLocation="IEN-DataInterfaceExtension.xsd"/>

            </xsd:schema>
   </wsdl:types>

   <wsdl:message name="MSG_CenterInformationRequest">
            <wsdl:part name="request"
element="tmdd:organizationInformationMsg"/>
   </wsdl:message>

   <wsdl:message name="MSG_CenterInformationResponse">
            <wsdl:part name="response"
element="lacoien:lacoIenCenterInformation"/>
   </wsdl:message>

   <wsdl:message name="MSG_DeviceInformationRequest">
            <wsdl:part name="informationRequest"
element="tmdd:deviceInformationRequestMsg"/>
   </wsdl:message>

   <wsdl:message name="MSG_DeviceInformationRequestRealTime">
            <wsdl:part name="informationRequest"
element="lacoien:lacoIenDeviceInformationRequestMsg"/>
   </wsdl:message>

   <wsdl:message name="MSG_DetectorDataRequest">
            <wsdl:part name="dataRequest"
element="tmdd:detectorDataRequestMsg"/>
```

```
   </wsdl:message>

   <wsdl:message name="MSG_DetectorInventory">
            <wsdl:part name="inventory"
element="lacoien:lacoIenDetectorInventoryMsg"/>
   </wsdl:message>

   <wsdl:message name="MSG_DetectorStatus">
            <wsdl:part name="status" element="tmdd:detectorStatusMsg"/>
   </wsdl:message>

   <wsdl:message name="MSG_DetectorData">
            <wsdl:part name="data" element="lacoien:lacoIenDetectorDataMsg"/>
   </wsdl:message>

   <wsdl:message name="MSG_IntersectionSignalInventory">
            <wsdl:part name="inventory"
element="lacoien:lacoIenIntersectionSignalInventoryMsg"/>
   </wsdl:message>

   <wsdl:message name="MSG_IntersectionSignalStatus">
            <wsdl:part name="status"
element="lacoien:lacoIenIntersectionSignalStatusMsg"/>
   </wsdl:message>

   <wsdl:message name="MSG_ErrorReport">
            <wsdl:part name="error" element="tmdd:errorReportMsg"/>
   </wsdl:message>


   <wsdl:portType name="IEN-XML-Interface">
            <wsdl:operation name="OP_CenterInformation">
                  <wsdl:input message="tns:MSG_CenterInformationRequest"/>
                  <wsdl:output message="tns:MSG_CenterInformationResponse"/>
                  <wsdl:fault name="errorReport"
message="tns:MSG_ErrorReport"/>
            </wsdl:operation>

            <wsdl:operation name="OP_DetectorInventory">
                  <wsdl:input message="tns:MSG_DeviceInformationRequest"/>
                  <wsdl:output message="tns:MSG_DetectorInventory"/>
                  <wsdl:fault name="errorReport"
message="tns:MSG_ErrorReport"/>
            </wsdl:operation>

            <wsdl:operation name="OP_DetectorStatus">
                  <wsdl:input message="tns:MSG_DeviceInformationRequest"/>
                  <wsdl:output message="tns:MSG_DetectorStatus"/>
                  <wsdl:fault name="errorReport"
message="tns:MSG_ErrorReport"/>
            </wsdl:operation>

            <wsdl:operation name="OP_DetectorData">
                  <wsdl:input message="tns:MSG_DetectorDataRequest"/>
                  <wsdl:output message="tns:MSG_DetectorData"/>
                  <wsdl:fault name="errorReport"
message="tns:MSG_ErrorReport"/>
            </wsdl:operation>
```

```
            <wsdl:operation name="OP_IntersectionSignalInventory">
                  <wsdl:input message="tns:MSG_DeviceInformationRequest"/>
                  <wsdl:output
message="tns:MSG_IntersectionSignalInventory"/>
                  <wsdl:fault name="errorReport"
message="tns:MSG_ErrorReport"/>
            </wsdl:operation>

            <wsdl:operation name="OP_IntersectionSignalStatus">
                  <wsdl:input
message="tns:MSG_DeviceInformationRequestRealTime"/>
                  <wsdl:output message="tns:MSG_IntersectionSignalStatus"/>
                  <wsdl:fault name="errorReport"
message="tns:MSG_ErrorReport"/>
            </wsdl:operation>
   </wsdl:portType>

   <wsdl:binding name="IEN-XML-InterfaceBinding" type="tns:IEN-XML-
Interface">
            <soap:binding style="document"
transport="http://schemas.xmlsoap.org/soap/http"/>

            <wsdl:operation name="OP_CenterInformation">
                  <soap:operation soapAction=""/>
                  <wsdl:input><soap:body use="literal"/></wsdl:input>
                  <wsdl:output><soap:body use="literal"/></wsdl:output>
                  <wsdl:fault name="errorReport"><soap:fault
name="errorReport" use="literal"/></wsdl:fault>
            </wsdl:operation>

            <wsdl:operation name="OP_DetectorInventory">
                  <soap:operation soapAction=""/>
                  <wsdl:input><soap:body use="literal"/></wsdl:input>
                  <wsdl:output><soap:body use="literal"/></wsdl:output>
                  <wsdl:fault name="errorReport"> <soap:fault
name="errorReport" use="literal"/></wsdl:fault>
            </wsdl:operation>

            <wsdl:operation name="OP_DetectorStatus">
                  <soap:operation soapAction=""/>
                  <wsdl:input><soap:body use="literal"/></wsdl:input>
                  <wsdl:output><soap:body use="literal"/></wsdl:output>
                  <wsdl:fault name="errorReport"><soap:fault
name="errorReport" use="literal"/></wsdl:fault>
            </wsdl:operation>

            <wsdl:operation name="OP_DetectorData">
                  <soap:operation soapAction=""/>
                  <wsdl:input><soap:body use="literal"/></wsdl:input>
                  <wsdl:output><soap:body use="literal"/></wsdl:output>
                  <wsdl:fault name="errorReport"><soap:fault
name="errorReport" use="literal"/></wsdl:fault>
            </wsdl:operation>

            <wsdl:operation name="OP_IntersectionSignalInventory">
                  <soap:operation soapAction=""/>
                  <wsdl:input><soap:body use="literal"/></wsdl:input>
```

```
                  <wsdl:output><soap:body use="literal"/></wsdl:output>
                  <wsdl:fault name="errorReport"><soap:fault
name="errorReport" use="literal"/></wsdl:fault>
            </wsdl:operation>

            <wsdl:operation name="OP_IntersectionSignalStatus">
                  <soap:operation soapAction=""/>
                  <wsdl:input><soap:body use="literal"/></wsdl:input>
                  <wsdl:output><soap:body use="literal"/></wsdl:output>
                  <wsdl:fault name="errorReport"><soap:fault
name="errorReport" use="literal"/></wsdl:fault>
            </wsdl:operation>
   </wsdl:binding>

   <wsdl:service name="IEN-XML-InterfaceService">
            <wsdl:port name="IEN-XML-Interface" binding="tns:IEN-XML-
InterfaceBinding">
                  <soap:address
location="http://localhost:8080/axis2/services/IEN-XML-Interface"/>
            </wsdl:port>
   </wsdl:service>

</wsdl:definitions>
```

## 8.2 Appendix B: IEN-DataInterfaceExtension.XSD

The IEN XML TCS Interface Web Service message structures and data set are described by the XML Schema file IEN-DataInterfaceExtension.xsd, which is listed below.

**Listing 8-2: IEN-DataInterfaceExtension.XSD**

```
<?xml version="1.0" encoding="UTF-8"?>

<xsd:schema targetNamespace="http://ien.ladpw.org/IEN-
DataInterfaceExtensions"
            xmlns:xsd="http://www.w3.org/2001/XMLSchema"
            xmlns:tns="http://ien.ladpw.org/IEN-DataInterfaceExtensions"
            xmlns:tmdd="http://www.tmdd.org/3/messages">

      <xsd:import namespace="http://www.tmdd.org/3/messages"
            schemaLocation="tmdd.xsd"/>

      <xsd:element name="lacoIenDeviceInformationRequestMsg"
            type="tmdd:DeviceInformationRequest"/>

      <xsd:element name="lacoIenIntersectionSignalInventoryMsg">
            <xsd:complexType>
                  <xsd:sequence maxOccurs="unbounded">
                        <xsd:element name="intersection-signal-inventory-
item" type="tmdd:IntersectionSignalInventory"/>
                  </xsd:sequence>
            </xsd:complexType>
      </xsd:element>

      <xsd:element name="lacoIenIntersectionSignalStatusMsg">
            <xsd:complexType>
                  <xsd:sequence maxOccurs="unbounded">
                        <xsd:element name="intersection-signal-status-item"
type="tmdd:IntersectionSignalStatus"/>
                  </xsd:sequence>
            </xsd:complexType>
      </xsd:element>

      <xsd:element name="lacoIenDetectorInventoryMsg">
            <xsd:complexType>
                  <xsd:sequence maxOccurs="unbounded">
                        <xsd:element name="detector-inventory-item"
type="tmdd:DetectorInventory"/>
                  </xsd:sequence>
            </xsd:complexType>
      </xsd:element>

      <xsd:element name="lacoIenDetectorDataMsg">
            <xsd:complexType>
                  <xsd:sequence maxOccurs="unbounded">
                        <xsd:element name="detector-data-item"
type="tmdd:DetectorData"/>
                  </xsd:sequence>
            </xsd:complexType>
      </xsd:element>
```

```
<!-- Types of IEN Intersection Signal Alarms -->
<xsd:simpleType name="Intersection-Signal-Alarms-LACO-IEN">
      <xsd:restriction base="xsd:string">
            <xsd:enumeration value="CONFLICT_FLASH"/>
            <xsd:enumeration value="CABINET_DOOR_OPEN"/>
            <xsd:enumeration value="FLASH_ALARM"/>
            <xsd:enumeration value="INTERNAL_ERROR_ALARM"/>
            <xsd:enumeration value="NO_ALARM"/>
      </xsd:restriction>
</xsd:simpleType>

<!-- Types of IEN Intersection Signal Preemptions -->
<xsd:simpleType name="Preempt-Type-LACO-IEN">
      <xsd:restriction base="xsd:string">
            <xsd:enumeration value="GENERAL_PREEMPT"/>
            <xsd:enumeration value="BRIDGE_PREEMPT"/>
            <xsd:enumeration value="EV_PREEMPT"/>
            <xsd:enumeration value="LRT_PREEMPT"/>
            <xsd:enumeration value="RR_PREEMPT"/>
            <xsd:enumeration value="OTHER"/>
            <xsd:enumeration value="NONE"/>
      </xsd:restriction>
</xsd:simpleType>

<!-- Types of IEN Main Street Green States -->
<xsd:simpleType name="Main-Street-Green-LACO-IEN">
      <xsd:restriction base="xsd:string">
            <xsd:enumeration value="ON"/>
            <xsd:enumeration value="OFF"/>
      </xsd:restriction>
</xsd:simpleType>

<!-- Types of IEN TCS Statuses -->
<xsd:simpleType name="System-Status-LACO-IEN">
      <xsd:restriction base="xsd:string">
            <xsd:enumeration value="GOOD"/>
            <xsd:enumeration value="BAD"/>
            <xsd:enumeration value="UNKNOWN"/>
      </xsd:restriction>
</xsd:simpleType>

<!-- Types of IEN Traffic Flow Directions -->
<xsd:simpleType name="Traffic-Direction-LACO-IEN">
      <xsd:restriction base="xsd:string">
            <xsd:enumeration value="n"/>
            <xsd:enumeration value="s"/>
            <xsd:enumeration value="e"/>
            <xsd:enumeration value="w"/>
            <xsd:enumeration value="ne"/>
            <xsd:enumeration value="nw"/>
            <xsd:enumeration value="se"/>
            <xsd:enumeration value="sw"/>
            <xsd:enumeration value="n_s"/>
            <xsd:enumeration value="e_w"/>
            <xsd:enumeration value="ne_sw"/>
            <xsd:enumeration value="nw_se"/>
            <xsd:enumeration value="none"/>
```

```
                  <xsd:enumeration value="other"/>
            </xsd:restriction>
      </xsd:simpleType>


      <!-- LACO IEN extension for the tmdd:DetectorIventoryDetail Data Frame.
 -->
      <xsd:element name="lacoIENDetectorInventoryDetailExtension"
            type="tns:LACO-IENDetectorInventoryDetailExtension"/>
      <xsd:complexType name="LACO-IENDetectorInventoryDetailExtension">
            <xsd:sequence>
                  <!-- The id of the signal that this detector is associated
with. -->
                  <xsd:element name="associatedIntersection"
                        type="tmdd:Organization-resource-identifier"
nillable="true"/>
                  <!-- The averaging period in seconds. Set to -1 if not
known. -->
                  <xsd:element name="averagingPeriod" type="xsd:int"
nillable="true"/>
                  <!-- Name of the street that crosses the road on which the
detector
                        is located at its associated intersection. -->
                  <xsd:element name="crossStreet" type="xsd:string"
nillable="true"/>
                  <!-- The weighting factor for volume+weighted occupancy
                         calculations. Set to -1 if not known or not
supported.-->
                  <xsd:element name="weightingFactor" type="xsd:int"
nillable="true"/>
            </xsd:sequence>
      </xsd:complexType>

      <!-- LACO IEN extension for the tmdd:DetectorDataDetail Data Frame. -->
      <xsd:element name="lacoIenDetectorDataDetailExtension"
            type="tns:LACO-IENDetectorDataDetailExtension"/>
      <xsd:complexType name="LACO-IENDetectorDataDetailExtension">
            <xsd:sequence>
                  <!-- The number of vehicles counted over the accumulation
period.
                         Expressed in vehicles per hour. Set to -1 if not
known.-->
                  <xsd:element name="volume" type="xsd:int" nillable="true"/>
                  <!-- The average volume of the detector over the
averagingPeriod.
                         Expressed in vehicles per hour. Set to -1 if not
known.-->
                  <xsd:element name="avgVolume" type="xsd:int"
nillable="true"/>
                  <!-- Volume in vehicles per hour + weighted occupancy.
                         Set to -1 if not known.-->
                  <xsd:element name="volumePlusWeightedOccupancy"
type="xsd:int"
                         nillable="true"/>
                  <!-- The average volume in vehicles per hour + weighted
occupancy
                         Set to -1 if not known. -->
```

```
                    <xsd:element name="avgVolumePlusWeightedOccupancy"
type="xsd:int"
                           nillable="true"/>
             </xsd:sequence>
      </xsd:complexType>

      <!-- LACO IEN extension for the tmdd:IntersectionSignalInventory Data
Frame. -->
      <xsd:element name="lacoIENIntersectionSignalInventoryExtension"
             type="tns:LACO-IENIntersectionSignalInventoryExtension"/>
      <xsd:complexType name="LACO-IENIntersectionSignalInventoryExtension">
             <xsd:sequence>
                    <!-- The name of the cross street -->
                    <xsd:element name="crossStreet" type="xsd:string"
nillable="true"/>
                    <!-- The name of the main street -->
                    <xsd:element name="mainStreet" type="xsd:string"
nillable="true"/>
                    <!-- The traffic flow direction on the main street -->
                    <xsd:element name="mainStreetDirection"
                           type="tns:Traffic-Direction-LACO-IEN"
nillable="true"/>
                    <!-- Polling interval in number of seconds. Set to -1 if
not known. -->
                    <xsd:element name="secondsBetweenPollAttempts"
type="xsd:int"
                           nillable="true"/>
             </xsd:sequence>
      </xsd:complexType>

      <!-- Phase number and its green time. -->
      <xsd:complexType name="LacoIenPhaseGreenTime">
             <xsd:sequence>
                    <!-- The id of the phase -->
                    <xsd:element name="phase-id" type="xsd:short"/>
                    <!-- The number of seconds green -->
                    <xsd:element name="phase-time" type="xsd:short"/>
             </xsd:sequence>
      </xsd:complexType>

      <!-- LACO IEN extension for the tmdd:IntersectionSignalStatus Data
Frame. -->
      <xsd:element name="lacoIENIntersectionSignalStatusExtension"
             type="tns:LACO-IENIntersectionSignalStatusExtension"/>
      <xsd:complexType name="LACO-IENIntersectionSignalStatusExtension">
             <xsd:sequence>
                    <!-- The alarms currently active for the signal. One or
more values
                           from tns:Intersection-Signal-Alarms-LACO-IEN. -->
                    <xsd:element name="alarm-list" minOccurs="0">
                           <xsd:complexType>
                                  <xsd:sequence maxOccurs="5">
                                         <xsd:element name="alarm"
                                                type="tns:Intersection-Signal-
Alarms-LACO-IEN"/>
                                  </xsd:sequence>
                           </xsd:complexType>
                    </xsd:element>
```

```
                    <!-- Whether the signal's main street phases(s) are
currently green.
                         Set to nil if not known. -->
                    <xsd:element name="mainStreetGreen"
                                 type="tns:Main-Street-Green-LACO-IEN"
nillable="true"/>
                    <!-- The type of preemption currently active for the
signal.
                         A value from tns:Preempt-Type-LACO-IEN. Set to nil
if not known. -->
                    <xsd:element name="preemptType" type="tns:Preempt-Type-
LACO-IEN"
                         nillable="true"/>

                    <!-- The remaining elements should only be set for
intersection
                                 signals that are specified in the real-time-
intersection-id-list
                                 part of the input message.-->
                      <!-- List of vehicle phases that have active actuation
calls. -->
                      <xsd:element name="phases-with-calls-list" minOccurs="0">
                          <xsd:complexType>
                                 <xsd:sequence maxOccurs="128">
                                       <!-- Bitmask. When a phase has a call,
                                             set the corresponding bit=1. -->
                                       <xsd:element name="phaseWithCall"
type="xsd:byte"/>
                                 </xsd:sequence>
                          </xsd:complexType>
                    </xsd:element>
                    <!-- An array of actual green times for each phase for the
last
                          cycle. -->
                    <xsd:element name="last-phase-times-list" minOccurs="0">
                          <xsd:complexType>
                                 <xsd:sequence maxOccurs="128">
                                       <xsd:element name="lastCyclePhaseTime"
                                             type="tns:LacoIenPhaseGreenTime"/>
                                 </xsd:sequence>
                          </xsd:complexType>
                    </xsd:element>
                    <!-- An array of planned maximum green times for each phase
for
                         the current cycle. -->
                    <xsd:element name="planned-phase-times-list" minOccurs="0">
                          <xsd:complexType>
                                 <xsd:sequence maxOccurs="128">
                                       <xsd:element name="plannedPhaseTimes"
                                             type="tns:LacoIenPhaseGreenTime"/>
                                 </xsd:sequence>
                          </xsd:complexType>
                    </xsd:element>
             </xsd:sequence>
      </xsd:complexType>

      <!-- LACO IEN extension for the tmdd:DeviceInformationRequest Data
Frame. -->
```

```
      <!-- Specifies the intersection signals for which real-time data is
desired. -->
      <xsd:element
name="lacoIENRealTimeIntersectionSignalDeviceListExtension"
            type="tns:LACO-
IENRealTimeIntersectionSignalDeviceListExtension"/>
      <xsd:complexType name="LACO-
IENRealTimeIntersectionSignalDeviceListExtension">
            <xsd:sequence>
                  <xsd:element name="real-time-intersection-id-list"
minOccurs="0">
                        <xsd:complexType>
                              <xsd:sequence maxOccurs="unbounded">
                                    <xsd:element name="device-id"
                                          type="tmdd:Organization-resource-
identifier"/>
                              </xsd:sequence>
                        </xsd:complexType>
                  </xsd:element>
            </xsd:sequence>
      </xsd:complexType>

      <!-- Information that helps provide status of the system and name and
             version of the TCS system providing the information -->
      <xsd:element name="lacoIenCenterInformation" type="tns:LACO-
IENCenterInformation"/>
      <xsd:complexType name="LACO-IENCenterInformation">
            <xsd:sequence>
                  <!-- The operational status of the traffic control system.-
->
                  <xsd:element name="systemStatus" type="tns:System-Status-
LACO-IEN"
                         nillable="false"/>
                  <!-- The name of the traffic control system. -->
                  <xsd:element name="systemName" type="xsd:string"
nillable="false"/>
                  <!-- The traffic control system version. -->
                  <xsd:element name="systemVersion" type="xsd:string"
                         nillable="false"/>
            </xsd:sequence>
      </xsd:complexType>

</xsd:schema>
```

## 8.3 Appendix C: Example Messages

Example IEN XML TCS Interface Web Service messages are provided below.

### 8.3.1 OP_CenterInformation

#### 8.3.1.1 MSG_CenterInformationRequest

**Listing 8-3: MSG_CenterInformationRequest Example**

```
<organizationInformationMsg xmlns="http://www.tmdd.org/3/messages">
  <organization-information-item xmlns="">
    <organization-name>LACO IEN</organization-name>
  </organization-information-item>
</organizationInformationMsg>
```

#### 8.3.1.2 MSG_CenterInformationResponse

**Listing 8-4: MSG_CenterInformationResponse Example**

```
<lacoIenCenterInformation xmlns="http://ien.ladpw.org/IEN-DataInterfaceExtensions">
  <systemStatus xmlns="">GOOD</systemStatus>
  <systemName xmlns="">TransSuite TCS</systemName>
  <systemVersion xmlns="">1.0</systemVersion>
</lacoIenCenterInformation>
```

### 8.3.2 OP_DetectorData

#### 8.3.2.1 MSG_DetectorDataRequest

**Listing 8-5: MSG_DetectorDataRequest Example**

```
<detectorDataRequestMsg xmlns="http://www.tmdd.org/3/messages">
  <device-information-request-header xmlns="">
    <organization-requesting>
      <organization-name>LACO IEN</organization-name>
    </organization-requesting>
    <device-type>signal controller</device-type>
    <device-information-type>device data</device-information-type>
    <device-filter>
      <device-id-list>
        <device-id>1</device-id>
      </device-id-list>
    </device-filter>
  </device-information-request-header>
</detectorDataRequestMsg>
```

#### 8.3.2.2 MSG_DetectorData

**Listing 8-6: MSG_DetectorData Example**

```
<lacoIenDetectorDataMsg xmlns="http://ien.ladpw.org/IEN-DataInterfaceExtensions">
  <detector-data-item xmlns="">
    <detector-list>
      <detector-data-detail>
        <detector-id>1</detector-id>
        <detection-time-stamp>
          <date>121710</date>
          <time>162626</time>
        </detection-time-stamp>
        <vehicle-occupancy>30</vehicle-occupancy>
        <vehicle-speed>50</vehicle-speed>
        <ien:lacoIenDetectorDataDetailExtension xmlns:ien="http://ien.ladpw.org/IEN-
DataInterfaceExtensions">
          <volume>82</volume>
          <avgVolume>51</avgVolume>
          <avgOccupancy>25</avgOccupancy>
          <avgSpeed>67</avgSpeed>
          <volumePlusWeightedOccupancy>34</volumePlusWeightedOccupancy>
          <avgVolumePlusWeightedOccupancy>31</avgVolumePlusWeightedOccupancy>
        </ien:lacoIenDetectorDataDetailExtension>
      </detector-data-detail>
    </detector-list>
  </detector-data-item>
</lacoIenDetectorDataMsg>
```

### 8.3.3 OP_DetectorInventory

#### 8.3.3.1 MSG_DeviceInformationRequest

**Listing 8-7: MSG_DeviceInformationRequest Example**

```
<deviceInformationRequestMsg xmlns="http://www.tmdd.org/3/messages">
  <organization-requesting xmlns="">
    <organization-name>LACO IEN</organization-name>
  </organization-requesting>
  <device-type xmlns="">detector</device-type>
  <device-information-type xmlns="">device inventory</device-information-type>
  <device-filter xmlns="">
    <device-id-list>
      <device-id>1</device-id>
    </device-id-list>
  </device-filter>
</deviceInformationRequestMsg>
```

#### 8.3.3.2 MSG_DetectorInventory

**Listing 8-8: MSG_DetectorInventory Example**

```
<detectorInventoryMsg xmlns="http://www.tmdd.org/3/messages" xmlns:ien="http://ien.ladpw.org/IEN-DataInterfaceExtensions">
  <detector-inventory-item xmlns="">
    <detector-list>
      <detector>
        <detector-inventory-header>
          <device-id>1</device-id>
          <device-name>roadway name</device-name>
          <link-direction>e</link-direction>
        </detector-inventory-header>
        <detector-type>inductive loop</detector-type>
        <detection-lanes>
          <lanes>1</lanes>
        </detection-lanes>
        <ien:lacoIENDetectorInventoryDetailExtension>
          <averagingPeriod>300</averagingPeriod>
          <weightingFactor>4</weightingFactor>
        </ien:lacoIENDetectorInventoryDetailExtension>
      </detector>
    </detector-list>
  </detector-inventory-item>
</detectorInventoryMsg>
```

### 8.3.4 OP_DetectorStatus

#### 8.3.4.1 MSG_DeviceInformationRequest

**Listing 8-9: MSG_DeviceInformationRequest Example**

```
<deviceInformationRequestMsg xmlns="http://www.tmdd.org/3/messages">
  <organization-requesting xmlns="">
    <organization-name>LACO IEN</organization-name>
  </organization-requesting>
  <device-type xmlns="">signal controller</device-type>
  <device-information-type xmlns="">device status</device-information-type>
  <device-filter xmlns="">
    <device-id-list>
      <device-id>1</device-id>
    </device-id-list>
  </device-filter>
</deviceInformationRequestMsg>
```

#### 8.3.4.2 MSG_DetectorStatus

**Listing 8-10: MSG_DetectorStatus Example**

```
<detectorStatusMsg xmlns="http://www.tmdd.org/3/messages">
  <detector-status-item xmlns="">
    <detector-list>
      <detector>
        <detector-status-header>
          <device-id>1</device-id>
          <device-status>on</device-status>
        </detector-status-header>
      </detector>
    </detector-list>
  </detector-status-item>
</detectorStatusMsg>
```

### 8.3.5 OP_IntersectionSignalInventory

#### 8.3.5.1 MSG_DeviceInformationRequest

**Listing 8-11: MSG_DeviceInformationRequest Example**

```
<deviceInformationRequestMsg xmlns="http://www.tmdd.org/3/messages">
  <organization-requesting xmlns="">
    <organization-name>LACO IEN</organization-name>
  </organization-requesting>
  <device-type xmlns="">signal controller</device-type>
  <device-information-type xmlns="">device inventory</device-information-type>
  <device-filter xmlns="">
    <device-id-list>
      <device-id>1</device-id>
    </device-id-list>
  </device-filter>
</deviceInformationRequestMsg>
```

#### 8.3.5.2 MSG_IntersectionSignalInventory

**Listing 8-12: MSG_IntersectionSignalInventory Example**

```
<xml-fragment xmlns:ien="http://ien.ladpw.org/IEN-DataInterfaceExtensions">
  <device-inventory-header>
    <device-id>1</device-id>
    <device-location>
      <latitude>123456789</latitude>
      <longitude>987654321</longitude>
    </device-location>
    <controller-description>hardware name.hardware type</controller-description>
  </device-inventory-header>
  <ien:lacoIENIntersectionSignalInventoryExtension>
    <crossStreet>cross</crossStreet>
    <mainStreet>main</mainStreet>
    <mainStreetDirection>n_s</mainStreetDirection>
    <secondsBetweenPollAttempts>2</secondsBetweenPollAttempts>
  </ien:lacoIENIntersectionSignalInventoryExtension>
</xml-fragment>
```

### 8.3.6 OP_IntersectionSignalStatus

#### 8.3.6.1 MSG_DeviceInformationRequest

**Listing 8-13: MSG_DeviceInformationRequest Example**

```
<deviceInformationRequestMsg xmlns="http://www.tmdd.org/3/messages">
  <organization-requesting xmlns="">
    <organization-name>LACO IEN</organization-name>
  </organization-requesting>
  <device-type xmlns="">signal controller</device-type>
  <device-information-type xmlns="">device status</device-information-type>
  <device-filter xmlns="">
  </device-filter>
</deviceInformationRequestMsg>
```

#### 8.3.6.2 MSG_DeviceInformationRequest Requesting Real-time Data

**Listing 8-14: MSG_DeviceInformationRequest Requesting Real-time Data Example**

```
<deviceInformationRequestMsg xmlns="http://www.tmdd.org/3/messages">
  <organization-requesting xmlns="">
    <organization-name>LACO IEN</organization-name>
  </organization-requesting>
  <device-type xmlns="">signal controller</device-type>
  <device-information-type xmlns="">device status</device-information-type>
  <device-filter xmlns="">
    <device-id-list>
      <device-id>1</device-id>
    </device-id-list>
  </device-filter>
</deviceInformationRequestMsg>
```

#### 8.3.6.3 MSG_IntersectionSignalStatus without Real-time Data

**Listing 8-15: MSG_IntersectionSignalStatus without Real-time Data Example**

```
<intersectionSignalStatusMsg xmlns="http://www.tmdd.org/3/messages"
xmlns:ien="http://ien.ladpw.org/IEN-DataInterfaceExtensions">
  <intersection-signal-status-item xmlns="">
    <device-status-header>
      <device-id>1</device-id>
      <device-status>on</device-status>
      <device-comm-status>operational</device-comm-status>
    </device-status-header>
    <current-signal-timing-mode>fixed time</current-signal-timing-mode>
    <timing-pattern-id-current>1</timing-pattern-id-current>
    <cycle-length-planned>100</cycle-length-planned>
    <cycle-length-current>90</cycle-length-current>
    <cycle-counter>5</cycle-counter>
    <cycle-counter-master>42</cycle-counter-master>
    <offset-time-previous>45</offset-time-previous>
    <phase-status>
      <phase-status-group>
        <phase-status-group-number>1</phase-status-group-number>
        <phase-status-group-greens>5</phase-status-group-greens>
        <phase-status-group-walks>16</phase-status-group-walks>
      </phase-status-group>
    </phase-status>
    <ien:lacoIENIntersectionSignalStatusExtension>
      <mainStreetGreen>ON</mainStreetGreen>
    </ien:lacoIENIntersectionSignalStatusExtension>
  </intersection-signal-status-item>
</intersectionSignalStatusMsg>
```

#### 8.3.6.4 MSG_IntersectionSignalStatus with Real-time Data

**Listing 8-16: MSG_IntersectionSignalStatus with Real-time Data Example**


```
<intersectionSignalStatusMsg xmlns="http://www.tmdd.org/3/messages"
xmlns:ien="http://ien.ladpw.org/IEN-DataInterfaceExtensions">
  <intersection-signal-status-item xmlns="">
    <device-status-header>
      <device-id>1</device-id>
      <device-status>on</device-status>
      <device-comm-status>operational</device-comm-status>
    </device-status-header>
    <current-signal-timing-mode>fixed time</current-signal-timing-mode>
    <timing-pattern-id-current>1</timing-pattern-id-current>
    <cycle-length-planned>100</cycle-length-planned>
    <cycle-length-current>90</cycle-length-current>
    <cycle-counter>5</cycle-counter>
    <cycle-counter-master>42</cycle-counter-master>
    <offset-time-previous>45</offset-time-previous>
    <phase-status>
      <phase-status-group>
        <phase-status-group-number>1</phase-status-group-number>
        <phase-status-group-greens>5</phase-status-group-greens>
        <phase-status-group-walks>16</phase-status-group-walks>
      </phase-status-group>
    </phase-status>
    <ien:lacoIENIntersectionSignalStatusExtension>
      <mainStreetGreen>ON</mainStreetGreen>
      <phases-with-calls-list>
        <phaseWithCall>2</phaseWithCall>
      </phases-with-calls-list>
      <last-phase-times-list>
        <lastCyclePhaseTime>
          <phase-id>1</phase-id>
          <phase-time>60</phase-time>
        </lastCyclePhaseTime>
        <lastCyclePhaseTime>
          <phase-id>2</phase-id>
          <phase-time>30</phase-time>
        </lastCyclePhaseTime>
        <lastCyclePhaseTime>
          <phase-id>3</phase-id>
          <phase-time>60</phase-time>
        </lastCyclePhaseTime>
        <lastCyclePhaseTime>
          <phase-id>4</phase-id>
          <phase-time>30</phase-time>
        </lastCyclePhaseTime>
      </last-phase-times-list>
      <planned-phase-times-list>
        <plannedPhaseTimes>
          <phase-id>1</phase-id>
          <phase-time>50</phase-time>
        </plannedPhaseTimes>
        <plannedPhaseTimes>
          <phase-id>2</phase-id>
          <phase-time>50</phase-time>
```

```
      </plannedPhaseTimes>
      <plannedPhaseTimes>
        <phase-id>3</phase-id>
        <phase-time>50</phase-time>
      </plannedPhaseTimes>
      <plannedPhaseTimes>
        <phase-id>4</phase-id>
        <phase-time>50</phase-time>
      </plannedPhaseTimes>
    </planned-phase-times-list>
  </ien:lacoIENIntersectionSignalStatusExtension>
 </intersection-signal-status-item>
</intersectionSignalStatusMsg>
```