System Requirements

I-15
Managed Lanes TOLL SYSTEM

San Diego ASSOCIATION OF GOVERNMENTS

Wilbur Smith Associates
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Prepared for
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Prepared by
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# TABLE OF CONTENTS

1. **Introduction** ................................................................. 1

2. **Account Management System (AMS)** ............................... 1
   2.1 **Customer Service Center** ........................................ 1
       2.1.1 Customer Service Center Location ........................... 1
   2.2 **Digital Document Imaging System** ............................... 1
       2.2.1 Internet CSC Web Site ........................................... 2
       2.2.2 Bar Code Scanning System ..................................... 2
       2.2.3 Account Initiation and Setup ................................. 2
       2.2.4 Transponder Distribution ....................................... 10
       2.2.5 Initial Account Deposits and Payments .................... 10
       2.2.6 Account Replenishment ................................-------- 10
       2.2.7 Account Reconciliation ......................................... 10
       2.2.8 Account Statements and Invoices ............................ 10
       2.2.9 CSR Reconciliation .............................................. 10
       2.2.10 Transponder History ........................................... 10
       2.2.11 Transponder Battery Replacement Notice .............. 10

3. **Toll Transaction System** ................................................... 10
   3.1 **Functional Requirements** ........................................... 10
       3.1.1 Determination of Level of Service (LOS) .................... 10
       3.1.2 Trip Construction ................................................. 10
       3.1.3 Dynamic Pricing ................................................ 10
       3.1.4 Variable Message Sign Control .............................. 10
       3.1.5 California Highway Patrol Interface ...................... 10
   3.2 **Technical Requirements** ............................................ 10
       3.2.1 Existing Moveable Barrier Guidance System ............ 10
       3.2.2 Network/Communications Architecture ................... 10
       3.2.3 In Lane Hardware .............................................. 10
       3.2.4 Inventory Control ................................................ 10
   3.3 **Parts Inventory** .......................................................... 10
   3.4 **Transponder Inventory** .............................................. 10

4. **Communications Architecture** .......................................... 10
   4.1 **Network Configuration** ............................................. 10

5. **Fiber Optic Communications** ............................................ 10

6. **CALTRANS Traffic Management Center Interface** ............. 10

7. **Graphical User Interfaces (GUI)** ....................................... 10

8. **Operator Definable Requirements** ...................................... 10

9. **Hardware and Field Installation General Requirements** .... 10
   9.1 **System Life** ............................................................ 10
   9.2 **New Equipment** ..................................................... 10
   9.3 **Modular Design** ...................................................... 10
   9.4 **Uniform Design for All Lanes and Types** .................. 10
   9.5 **Non-Proprietary** .................................................... 10
   9.6 **Interchangeability** .................................................. 10
   9.7 **Accessibility** ........................................................... 10
9.8  Test Points............................................................................................................... 10
9.9  Electronic Components.......................................................................................... 10
9.10 Plugs, Connectors, and Terminal Blocks ................................................................ 10
9.11 Wires and Cables .................................................................................................. 10
9.12 Insulation............................................................................................................... 10
9.13 Circuit Protection ................................................................................................. 10
9.14 Housings and Cabinets ........................................................................................ 10
9.15 Hardware ............................................................................................................... 10
9.16 No Interference ..................................................................................................... 10
9.17 Fabrication ............................................................................................................ 10
9.18 Stainless Steel Materials ...................................................................................... 10
9.19 Toll System Lock Requirements .......................................................................... 10
9.20 Capacities ............................................................................................................. 10
9.21 Applicable Codes ................................................................................................. 10
9.22 Equipment Diagnostic and Self-Test Requirements .............................................. 10
10  Life, Reliability, and Availability ............................................................................ 10
11  Installation Plans and Documentation ...................................................................... 10
12  Security .................................................................................................................. 10
12.1 Computer Access Security ................................................................................... 10
12.2 Physical Security .................................................................................................. 10
13  Electrical Requirements .......................................................................................... 10
14  Environmental Requirements .................................................................................. 10
15  Capacity and Data Retention ................................................................................... 10
16  Time of Day/Date Control and Synchronization ...................................................... 10
17  Toll System Maintenance Management System .................................................... 10
17.1 Maintenance On-line Management System Administration ................................ 10
17.2 Failure/Malfunction Reporting ............................................................................ 10
17.3 Performance and Status Monitoring - Real-Time Display ................................... 10
17.3.1 Field Components .......................................................................................... 10
17.3.2 TTC Level ...................................................................................................... 10
17.4 Remote Access/Dial-Up Networking .................................................................. 10
17.5 Inventory/Spare Parts Control ............................................................................. 10
1 Introduction

The following system functional requirements have been developed to describe the needed system functions with technology existing at this time. It is understood that the system will not be procured for several years and the technology will undoubtedly change in some respects. However, the functions needed to accomplish SANDAG goals may not change. These requirements will be reviewed at the appropriate time and updated to reflect current technology.

2 Account Management System (AMS)

2.1 Customer Service Center
As part of the Account Management System, there shall be a Customer Service Center (CSC) application provided and operated by the CONTRACTOR.

The CONTRACTOR shall provide a phone response system for customers to access their ETC account information.

The CONTRACTOR shall provide an Internet site for customers to access their ETC account information.

2.1.1 Customer Service Center Location

2.2 Digital Document Imaging System
A digital document imaging system shall be provided allowing the OWNER to scan documents and store them as digital images in the system.

The imaging system shall allow authorized users access to scanned documents on demand.

The imaging system does not need to be fully integrated with the ETC processing software. Instead, the application allowing users to view the images shall run in a network environment allowing users to open it and search for documents without closing any other running applications.

The system shall have the following features at a minimum:

- A document scanner with 300 X 300 DPI quality;
- A document sheet feeder allowing 20 sheets per minute to be scanned;
- Ability to handle sizes from business card up to legal size sheets including letter sheets;
- Digital images shall be stored on a recordable DVD;
- The DVD drive must be linked to the system network;
- Application software allowing the viewing of stored documents must be accessible from any workstation on the network;
- Application software shall allow an authorized user to add notes to any scanned document; and
• A minimum of 6 indices shall be available for each document including date scanned, document creation date, file number, account number, and last name.

2.2.1 Internet CSC Web Site

The CONTRACTOR shall provide an Internet web site with the following services:

• Information Section, with OWNER, highway and ETC account information;
• Customer Service Section (new customers), from which site visitors may either download an application to fill out and send in later, or fill in on-line for credit-card accounts; and
• Customer Service Section (existing customers), which, with ID and password security, will enable customers to look at and print out detailed transaction histories, account balances, and existing account data.

The Internet access shall be designed, incorporating secure ‘firewall’ arrangements to prevent any alteration of accounts by unauthorized persons through Internet access or otherwise.

2.2.2 Bar Code Scanning System

The CONTRACTOR shall provide a bar code scanner for each CSC workstation.

The bar code scanner shall include software fully integrated to the customer application software allowing the automatic scanning of bar codes into the appropriate fields on the customer application software.

The bar code scanner and software shall be capable of scanning the bar codes placed on the Title 21 transponders by the manufacturer and properly interpreting them.

The bar code scanner and software shall be capable of scanning multiple bar code formats and properly interpreting them.

The bar code software shall be capable of formatting bar codes for printing on labels, etc.

2.2.3 Account Initiation and Setup

The Customer Service Center (CSC) personnel will establish customer accounts. Account application data may be received in person, by telephone, mail, fax, or Internet.

Data tables shall be developed to contain all customer account data.

Customer account information shall:

• Be updated with changing data;
• Be used for violation enforcement;
• Contain the data for account statements;
• Store account status codes; and
• Maintain prepaid toll account and deposit amounts.

There shall be three types of accounts groups:

• Personal Accounts;
• Commercial Accounts; and
• Non-revenue Accounts

2.2.3.1 Personal Accounts

Personal accounts shall be established for individuals using the toll system.

Multiple transponders and multiple vehicles shall be associated with personal accounts.

Table 1 describes the data desired from the person responsible for each account.

<table>
<thead>
<tr>
<th>Table 1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GENERAL DATA - PERSONAL ACCOUNT</strong></td>
</tr>
<tr>
<td><strong>Issuing Company</strong></td>
</tr>
<tr>
<td><strong>Account Type</strong></td>
</tr>
<tr>
<td><strong>Account Number</strong></td>
</tr>
<tr>
<td><strong>Personal Identification Number (PIN)</strong></td>
</tr>
<tr>
<td><strong>Established Date</strong></td>
</tr>
<tr>
<td><strong>Modified Date</strong></td>
</tr>
<tr>
<td><strong>Contact Information and address information</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Replenishment Method</strong></td>
</tr>
<tr>
<td>--------------------------</td>
</tr>
<tr>
<td><strong>Replenishment Amount</strong></td>
</tr>
<tr>
<td><strong>Credit/Debit Card Number</strong></td>
</tr>
<tr>
<td><strong>Credit/Debit Card Exp. Date</strong></td>
</tr>
<tr>
<td><strong>Credit/Debit Card Type</strong></td>
</tr>
<tr>
<td><strong>Bank Name</strong></td>
</tr>
<tr>
<td><strong>Bank Account Number</strong></td>
</tr>
<tr>
<td><strong>Low Balance Level</strong></td>
</tr>
<tr>
<td><strong>Minimum Balance</strong></td>
</tr>
<tr>
<td><strong>Allow Negative Balance</strong></td>
</tr>
<tr>
<td><strong>Negative Balance Count</strong></td>
</tr>
<tr>
<td><strong>Mailed Monthly Statement</strong></td>
</tr>
<tr>
<td><strong>Electronic Statement (Email)</strong></td>
</tr>
<tr>
<td><strong>Signed Application on File</strong></td>
</tr>
</tbody>
</table>
The data in Table 2 shall be needed for each vehicle when multiple transponders are issued to a personal account.

**Table 2**

<table>
<thead>
<tr>
<th>TRANSPONDER INFORMATION</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Account Number</td>
<td>Required - Default to related account</td>
</tr>
<tr>
<td>Transponder Number</td>
<td>Required - Scanned from Transponder</td>
</tr>
<tr>
<td>Vehicle License Plate Number</td>
<td>Not Required</td>
</tr>
<tr>
<td>Vehicle Make</td>
<td>Not Required</td>
</tr>
<tr>
<td>Vehicle Model</td>
<td>Not Required</td>
</tr>
<tr>
<td>Vehicle Year</td>
<td>Not Required</td>
</tr>
<tr>
<td>Vehicle Color</td>
<td>Not Required</td>
</tr>
<tr>
<td>transponder Class</td>
<td>Required - Default to 2-axle</td>
</tr>
<tr>
<td>transponder Style</td>
<td>Required - Default to &quot;Internal&quot;, Option &quot;External&quot;</td>
</tr>
<tr>
<td>transponder Deposit</td>
<td>Required - Default to user value in parameter table</td>
</tr>
<tr>
<td>transponder Status</td>
<td>Required - Default to &quot;Valid&quot;</td>
</tr>
<tr>
<td>Account Changes</td>
<td>All Required, Scanned Retrieval Numbers</td>
</tr>
<tr>
<td>Comment</td>
<td>Not Required</td>
</tr>
</tbody>
</table>

Hardware and software shall be provided allowing the original application document and update documents to be scanned into the system and referenced in the customer account records.
Activity statements shall be produced as either summary (all transactions from all transponders by date and time) or by sub account (by date and time).

The system software shall be designed with a method for rapid direct access to data for sub-accounts. This will allow all sub accounts to be readily accessible from the main account.

Each time a field in any account data table or related table is changed, a data table containing a log of the changes shall be updated containing, as a minimum, the following:

- Change document number (for retrieval);
- Account Number;
- Vehicle License Plate Number (LPN);
- Field Name;
- Old Value;
- New Value;
- Date; and
- CSC User ID.

This information shall be available on demand (keystroke, menu event, etc.) anytime application data is being reviewed.

2.2.3.2 Commercial Accounts

Commercial accounts are set up for companies using the toll system for business purposes.

Commercial accounts shall have one of three possible status:

- Regular;
- Discount; or
- Non-revenue.

Regular commercial accounts shall be setup on either a pre-pay or post payment basis.

Regular commercial account trip charges shall be processed at the full rate as determined by the trip information received from the TTC.

The regular commercial account balance shall be adjusted by the full trip charge.

Discount commercial accounts shall be setup on either a pre-pay or post payment bases.

Discount commercial account trip charges shall be processed at the full rate as determined by the trip information received from the TTC.

Discount commercial account trip charges shall be changed by the amount determined by the discount plan established for the account.
The discount commercial account balance shall be adjusted by the discounted trip charge. Full rate trip charges and discounted trip charges shall be retained for reporting purposes.

Non-revenue commercial account trip charges shall be processed at the full rate as determined by the trip information received from the TTC.

Non-revenue commercial account trip charges shall be reduced to zero.

The non-revenue commercial account balance shall always remain at zero.

Full rate trip charges and the actual trip charge of zero shall be retained for reporting purposes.

Commercial accounts shall have three control levels:

- Corporate;
- Division; and
- Individual.

The corporate level shall have the functionality for batch or single transponder number entry for the company or agency.

The corporate level shall have the functionality for batch or single transponder number entry for a single or multiple divisions of the company or agency.

The AMS shall prepare statements and/or invoices for either the corporate level or the division level.

The division level shall have the functionality for batch or single transponder number entry for the division.

The individual level shall contain all the data required by the owner to identify the user of the transponder.

All trip charges shall be recorded at the individual level and rolled up to the division and corporate levels.

Summary and detail trip record reporting shall be available at all three levels.

Table 3 contains the minimum data elements needed for development of a commercial account.

<table>
<thead>
<tr>
<th>Table 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GENERAL APPLICATION DATA – COMMERCIAL ACCOUNT</strong></td>
</tr>
<tr>
<td>Issuing Company</td>
</tr>
<tr>
<td>Account Type</td>
</tr>
<tr>
<td>------------------------------</td>
</tr>
<tr>
<td>Account Number</td>
</tr>
<tr>
<td>Account Active Date</td>
</tr>
<tr>
<td>Business Name</td>
</tr>
<tr>
<td>Contact Person Information</td>
</tr>
<tr>
<td>Billing Name and Address</td>
</tr>
<tr>
<td>Shipping Name and Address</td>
</tr>
<tr>
<td>Replenishment Method or Invoice</td>
</tr>
<tr>
<td>Replenishment Amount</td>
</tr>
<tr>
<td>Credit/Debit Card Number</td>
</tr>
<tr>
<td>Credit/Debit Card Exp. Date</td>
</tr>
<tr>
<td>Credit/Debit Card Type</td>
</tr>
<tr>
<td>Bank Name</td>
</tr>
<tr>
<td>Bank Account Number</td>
</tr>
<tr>
<td>Low Balance Level</td>
</tr>
<tr>
<td>Minimum Balance Level</td>
</tr>
<tr>
<td>-----------------------</td>
</tr>
<tr>
<td>Allow Negative Balance</td>
</tr>
<tr>
<td>Negative Balance Limit</td>
</tr>
<tr>
<td>Mailed Monthly Statement</td>
</tr>
<tr>
<td>Number of Returned Payments</td>
</tr>
<tr>
<td>Date of Last Returned Payment</td>
</tr>
<tr>
<td>E-Mail Statement</td>
</tr>
<tr>
<td>Invoice</td>
</tr>
<tr>
<td>Comments</td>
</tr>
</tbody>
</table>

Individual transponders assigned to these accounts shall require separate data.

Each division level account shall require the data elements, such as shown in Table 4.

**Table 4**

<table>
<thead>
<tr>
<th>BATCH TRANSPONDER ENTRY – COMMERCIAL ACCOUNT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Account Number</td>
</tr>
<tr>
<td>Beginning transponder Number</td>
</tr>
<tr>
<td>Ending Transponder Number</td>
</tr>
<tr>
<td>Transponder Class</td>
</tr>
<tr>
<td>-----------------------</td>
</tr>
<tr>
<td>Transponder Style</td>
</tr>
<tr>
<td>Deposit Per Transponder</td>
</tr>
<tr>
<td>Transponder Status</td>
</tr>
<tr>
<td>Violation reads</td>
</tr>
<tr>
<td>Date Issued</td>
</tr>
<tr>
<td>Comment</td>
</tr>
</tbody>
</table>

Activity statements shall be produced either summary (all transactions from all transponders by date and time) or by division or individual accounts (by date and time).

The commercial account holders shall have the ability to receive statements which track division or individual accounts.

Transaction records shall be identified by division and printed in division account order.

All invoices and statements shall be sent to the billing address.

Minimum Commercial individual account data elements are as shown in Tables 5 and 6.

**Table 5**

**INDIVIDUAL ACCOUNTS TRANSPONDER DATA (Commercial)**

<table>
<thead>
<tr>
<th>Issuing Company</th>
<th>Required - Default to OWNER name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Account Type</td>
<td>Required - Default to Commercial Individual</td>
</tr>
<tr>
<td>Commercial Account Number</td>
<td>Required - Default to related commercial account</td>
</tr>
<tr>
<td>Commercial Individual Number</td>
<td>Required - Computer Generated</td>
</tr>
<tr>
<td>Individual name</td>
<td>Vehicle ID Number, driver's name, etc.</td>
</tr>
<tr>
<td>Vehicle ID #</td>
<td>Required for tab</td>
</tr>
<tr>
<td>Transponder Number</td>
<td>Required</td>
</tr>
<tr>
<td>--------------------</td>
<td>----------</td>
</tr>
<tr>
<td>Active Date</td>
<td>Required - Computer Generated</td>
</tr>
<tr>
<td>Violation Reads</td>
<td>Number of times transponder did not read</td>
</tr>
<tr>
<td>Transponder Class</td>
<td>Required - Default to 2-axle</td>
</tr>
<tr>
<td>Transponder Style</td>
<td>Required - Default to &quot;Interior&quot;</td>
</tr>
<tr>
<td>Transponder Deposit</td>
<td>Required - Default to user value in parameter table</td>
</tr>
<tr>
<td>Transponder Status</td>
<td>Required - Default to &quot;Valid&quot;</td>
</tr>
<tr>
<td>Vehicle License Transponder #</td>
<td>Not Required</td>
</tr>
<tr>
<td>Vehicle Make</td>
<td>Not Required</td>
</tr>
<tr>
<td>Vehicle Model</td>
<td>Not Required</td>
</tr>
<tr>
<td>Vehicle Year</td>
<td>Not Required</td>
</tr>
<tr>
<td>Vehicle Color</td>
<td>Not Required</td>
</tr>
<tr>
<td>Comment</td>
<td>Not Required</td>
</tr>
</tbody>
</table>

**Table 6**

**VEHICLE DATA – COMMERCIAL INDIVIDUAL-ACCOUNT**

<table>
<thead>
<tr>
<th>Commercial Account Number</th>
<th>Required - Default to related commercial account</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Sub-Account Number</td>
<td>Computer generated</td>
</tr>
<tr>
<td>Transponder Number</td>
<td>Required - Default to related transponder</td>
</tr>
<tr>
<td>License Number</td>
<td>Not Required</td>
</tr>
<tr>
<td>Make</td>
<td>Not required</td>
</tr>
<tr>
<td>Model</td>
<td>Not required</td>
</tr>
<tr>
<td>Year</td>
<td>Not required</td>
</tr>
<tr>
<td>------</td>
<td>--------------</td>
</tr>
<tr>
<td>Color</td>
<td>Not required</td>
</tr>
</tbody>
</table>

Changes to any fields involving commercial accounts shall be logged in the same manner as personal accounts described above.

2.2.3.3 Commercial Account Discount Programs

Commercial account discount programs shall be variations of two types:

- Volume; or
- Value.

Volume discount programs shall allow the operator to enter a percent of the total charges (discount) for a commercial account based on the total number of miles traveled by all users in the account.

Volume discount programs shall allow a fixed dollar discount based on the number of miles traveled in the discount period by all users of the account.

Value discount programs shall allow the operator to enter a percent of the total charges (discount) for a commercial account based on the total value of the trips for the discount period by all users in the account.

Value discount programs shall allow a fixed dollar discount based on the value of all trips during the discount period by all users of the account.

In all cases, the application shall select the discount from a table of discount values for volume and value developed by the operator.

The discount period shall be monthly, quarterly, semi-annually or annually.

2.2.4 Transponder Distribution

Transponder distribution shall be administered solely through the Customer Service Center.

Distribution of transponders shall be carried out directly at the CSC or via mail out to the patron.

Transponder kits containing an activated transponder, instructions and a uniquely coded application form shall be used to market the system and initiate new accounts.

2.2.4.1 Personal Accounts
The typical account opening process shall involve the customer filling out an application and submitting it to the Customer Service Center (CSC) for account data entry.

The functionality allowing applications to be filled out at the CSC where account sign-up is offered, filled out on the Internet web site, or delivered in person, mailed, or faxed shall be provided.

All transponders shall be equipped with a unique bar code identifying the transponder.

The transponder bar code shall be scanned into the customer account when the transponder is issued.

2.2.4.2 Commercial Accounts

Functionality to process Commercial accounts in batch or individual mode shall be provided.

The functionality to scan transponder ID numbers into customer records shall be provided.

2.2.5 Initial Account Deposits and Payments

2.2.5.1 Initial Account Payment

When a pre-paid account is established the patron must provide and initial account payment in order to activate the account.

The AMS shall have configurable default values for initial payments.

There shall be a separate default value for each payment type (i.e.; Cash, Check, Credit and Debit Card)

2.2.5.2 Transponder Deposit

The AMS shall include the ability to record and track deposits made for receipt of a transponder.

2.2.5.3 Post-paid Accounts

For those accounts established as Commercial accounts the AMS shall provide the option of pre-payment (automatic replenishment) or post-payment.

Post payment accounts shall be invoiced on a monthly, quarterly, semi-annual or annual basis.

The functionality to invoice the patron via standard mail, Email, and or web site access shall be provided.

Invoices shall contain information similar to the standard transaction statement.
2.2.6 Account Replenishment

For pre-paid account types, the initial funds deposited into a customer account when established must be periodically replenished. As the facility is used, tolls are assessed and the account balance is reduced.

When a patron's account exceeds the low balance threshold the AMS shall flag the account to be replenished via the patrons preferred method.

By default the AMS shall process automated account replenishments on a nightly basis.

Automated replenishments shall be performed for all Credit, Debit and EFT payment types.

For those accounts setup for Check or Cash replenishment, the AMS shall be designed to automatically issue written notices to the patrons that their account is in need of replenishment.

Notification for Check or Cash replenishment shall be capable of being delivered by mail, Email and web sit access.

Customer Service Representatives (CSR) shall have the ability to replenish accounts by all methods in real time. This is required for patrons that may call in to the CSC or walk in providing payment of any type.

Replenishments, once entered into the system, shall automatically credit the appropriate account immediately.

Upon entry into the system by the clerk, the account shall be updated and any transponder status change shall be transmitted to the lane controllers immediately.

2.2.6.1 ETC Transactions

The TTC shall determine a completed trip and forward the trip record to the AMS.

This record shall include (as a minimum) the ETC transponder number, the trip start date/time, trip start tolling zone, trip end date/time, trip end tolling zone, rate per mile, miles traveled, rate calculation method (miles traveled, minimum, maximum) and total fee.

At the AMS, the toll fee shall be deducted from the ETC account associated with the ETC transponder number on the record.

If this deduction reduces the account balance to the low balance limit, the system shall initiate an account replenishment procedure for automatic replenishment accounts.
For cash/check replenishment accounts, the transponder status shall be changed to “low balance” and the AMS shall send the updated transponder status back to all lane controllers.

If this deduction reduces the cash/check account to the minimum balance limit, the transponder status shall be changed to “Invalid” and a notice automatically prepared to be sent to the party responsible for the account.

If the account is authorized to become negative, the notice shall be sent, but the transponder status shall remain “Low Balance”.

ETC customer accounts shall have two alert levels.

The first shall be a low balance level that indicates account replenishment is needed.

The second shall be a minimum balance level that is set at a point that indicates the transponder status should be changed to invalid until account replenishment has taken place unless the OWNER has authorized allowing the account to be below the minimum or negative balances.

Unless negative balances have been authorized by the OWNER, when the account has reached a minimum balance level, the AMS shall generate a notice to the responsible party that the transponder status has been changed to “invalid” until payment has been received.

If the negative balance authorization has been specified, the notice shall be sent but the transponder status shall remain valid.

This notice format shall be approved by the OWNER and the ENGINEER (the use of “self mailers” is preferred).

Notices shall include a “return with payment” section.

To take advantage of bulk mailing rates when printing notices, sorting capabilities shall be available complementing the U.S. postal system.

The AMS shall provide for charging a fee for processing the notice and reinstating the account after payment has been received.

The AMS shall provide for each ETC account to be replenished by one of the following methods:

- Cash or check payment at the CSC;
- Payment by check through the mail;
- Charging a credit card when an account low balance is reached (automatic); and
- Issuing a bank debit against a bank account when an account low balance is reached (automatic).
2.2.6.2 Replenishment Threshold (Low Balance)

A threshold, or low balance level shall be established for each account and sub-account. At the time of account establishment low balance levels shall be set to a default level maintained by the AMS.

Default values for low balance levels shall be configurable by authorized users of the AMS.

Default values shall be configurable based on account type and payment type.

At the time of enrollment and any future activity, the CSC application shall have the ability to change/update the low balance level on any specific account, sub-account or individual transponder.

2.2.6.3 Replenishment (Rebill) Amount

The AMS shall process all replenishment activities, both through automated functions as well as manually (through a CSR).

Configurable default replenishment amounts shall be maintained by the AMS for each account type.

Only authorized users at the AMS level shall have the ability to change the default values for account replenishment.

Through the CSC application (CSR interaction) replenishment amounts can be changed/modified for each individual account.

The CSR shall also have the ability of selecting a standard algorithm in place of entering a dollar amount for account replenishment.

The algorithm shall be developed and administered by the CONTRACTOR with pre-approval from SANDAG of the methodology.

It is intended that the algorithm be based on a patrons usage so that rebill activity is calculated approximately once a month.

The algorithm developed shall contain provisions that it not be less than the default values set by the AMS.

2.2.7 Account Reconciliation

On a daily basis, the system shall prepare a list of bank transfers, either through credit card charges or direct bank debits, made to or from the ETC accounts.

The AMS shall have the ability to define a business day to meet the OWNER'S needs (virtual midnight).
This list shall include daily totals and shall be used by the OWNER to reconcile bank accounts.

On a demand basis, the system shall provide the capability to print this list over any given range of days and for any customer account or all customer accounts.

The AMS shall update customer account records with the total count of returned checks or bank transfers and the date of the last returned check or bank transfer.

2.2.8 Account Statements and Invoices

Hard copy summary or detailed account statements shall be provided to personal and commercial accounts as an option only.

Summary statements shall only contain user name and address information, transponder numbers and monthly total usage.

Summary statements shall be printed in self mailers.

Detailed statements shall include each toll transaction and corresponding toll.

Detailed statements shall be printed in a format approved by SANDAG.

The format of statements and invoices shall be coordinated between the ENGINEER/OWNER and the CONTRACTOR.

Final Statement and Invoice format shall be subject to the ENGINEER’S/OWNER’S review and approval.

Invoices shall include all detail for the period being invoiced.

Account balance and activity shall be available to all account holders through the use of the Internet utilizing the Web site established for this purpose.

Account holders, using their account number and PIN, shall be able to access this information by accessing the OWNER’S Web page, which shall be designed by the CONTRACTOR and approved by the ENGINEER/OWNER.

The CONTRACTOR shall provide a means of prevention of virus migration from the Internet Server to the Account Management System.

2.2.9 CSR Reconciliation

Each day, Customer Service Representatives (CSR) will be accepting cash and checks to replenish ETC accounts.

A method of relating the clerk’s ID with the accounts replenished shall be provided.
An electronic daily deposit form shall be prepared with a break down of currency, coin and checks.

The electronic daily deposit form shall be printable.

A report listing the cash and checks and the accounts related to them shall also be provided allowing a reconciliation of cash/checks and accounts.

2.2.10 Transponder History

The system shall be able to query a transponder use history for variable time periods upon request, showing the location, date, time, clerk, account, transponder status, transponder class, transponder style, transponder account type, and issued by fields, and the chronology of transponder use and rolling account balances.

2.2.11 Transponder Battery Replacement Notice

The AMS shall have the capability of detecting or computing when a transponder battery is reaching the end of its useful life and notifying customers.

In the case of computing low battery status, the system shall track the number of times the transponder is used for a transaction as well as the overall down time since the last battery replacement and predict the end of the battery’s useful life.

The system shall have the capability of automatically generating a battery replacement notice to be sent by mail to ETC patrons at the appropriate time. (The OWNER desires “self mailers” for this function.)

3 Toll Transaction System

3.1 Functional Requirements

The CONTRACTOR shall deliver a toll transaction system that determines the toll transaction rate charged to customers and manages the level of service on the managed lanes that can be adjusted in all aspects without the need to modify the software delivered.

Adjustments to the toll transaction system shall be in the form of changing user defined parameters and/or table values.

The tables and parameters in this section are minimum requirement and the CONTRACTOR shall provide any additional parameters or tables necessary to accomplish system adjustment without additional software programming.

3.1.1 Determination of Level of Service (LOS)

The system shall continuously measure the current level of service in every tolling zone on a user defined repeated periodic basis.
The system shall provide a display on any/all authorized workstations in the network, of the current (latest measured) level of service in every tolling zone/traffic direction, in a graphic form on any system workstation.

The time interval of the level of service measurement shall be included in this display.

The system shall also provide an optional version of this Level of Service display page that includes the measured vehicle count, average speed and number of lanes.

The period or interval over which the level of service is to be measured (nominally 6 minutes or 360 seconds) shall be settable in seconds by the operator (LOS interval).

The levels of service shall be determined by Traffic Density (TD) as indicated in Table 7 below.

<table>
<thead>
<tr>
<th>LOS</th>
<th>TD</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0-11</td>
</tr>
<tr>
<td>B</td>
<td>&gt;11-18</td>
</tr>
<tr>
<td>C</td>
<td>&gt;18-26</td>
</tr>
<tr>
<td>D</td>
<td>&gt;26-35</td>
</tr>
<tr>
<td>E</td>
<td>&gt;35-45</td>
</tr>
<tr>
<td>F</td>
<td>&gt;45</td>
</tr>
</tbody>
</table>

The traffic density (vehicles/hour/lane) shall be computed from vehicle count and speed as follows:

\[
\text{Traffic Density} = \frac{((C/P) \times 3600)}{(S \times N)}
\]

where  
C = The total vehicle count over the period  
\( P \) = length of the measurement period in seconds  
S = Average Measured vehicle speed over the period in MPH  
N = The number of lanes in operation at this tolling zone in this traffic direction.
If the measured average speed should be less than the minimum speed as determined by the operator, the traffic density shall be overridden to 50 and the level of service shall be overridden to level "F" no matter the vehicle count.

The system shall retain an on-line record of measured vehicle count, average vehicle speed, number of lanes in each travel direction, calculated traffic density and level of service for every interval in every tolling zone for the prior 100 days.

3.1.2 Trip Construction

The TTC shall maintain a trip transaction record for every transponder that is read on I-15.

The Contractor shall design the system to be capable of processing 35 tolling zone transponder reads per second and 10 sign controller transponder reads per second while simultaneously calculating levels of service, controlling the traffic density through appropriate adjustments of charging rates and managing the communications with the TMC, the field controllers (tolling zone controllers and sign controllers) and the user workstations.

The Sign Location Controllers and the Tolling Zone Controllers shall forward all transponder reads to the TTC in real time, indicating the read location, the transponder ID and the date and time of the read.

The delivery of messages in the system from one processor to another shall be guaranteed such that the transmitting processor will not treat a message transmission as completed until receiving a confirmation that the recipient has received and stored it.

The tolling zone controller shall forward a status message to the TTC when it has had no transponder reads to transmit for an operator defined interval (Tolling Zone Gap in transponder Read Message Interval).

For each active tolling zone, the TTC shall maintain a record of the Last Transponder Read Transmission Time which shall be the date and time of the most recent toll transaction or the last status message indicating a toll transaction gap, whichever is the most recent.

For each active tolling zone, the TTC shall maintain an indication of how up to date the downstream active tolling Zones are - the Downstream Up-To-Date Measure.

The Downstream Up-To-Date Measure shall be set to the earliest of all the Last Transponder Read Transmission Times for the active downstream tolling zones.

When a transponder is read at a sign location and the read record is forwarded to the TTC the TTC shall check the current status for that transponder.
There shall be three possibilities for transponder status:

- There is no open record of activity for this transponder;
- There is a record of the transponder's having been read at a sign controller; or
- There is a trip open and in progress for the transponder.

If there is no open record for the transponder, a trip record shall be initialized recording the sign controller and the time of the sign passage.

If there is a record of the transponder's previously being read at a sign controller that sign controller read record shall be overwritten with this new one.

If there is a trip record open for the transponder (there are reads recorded at tolling zones in the managed lanes) but the trip record lacks a sign controller transponder read record, this sign controller is the one immediately upstream of the first tolling zone record for the trip, and the time of this sign controller record is within the time window extending 10 minutes prior to the first tolling zone record, then this sign controller shall be added to the trip record.

If the time stamp for this sign controller read is later than the last recorded passage through a tolling zone for this trip then the trip shall be closed, the trip record shall be forwarded to the AMS for processing and a record shall be initialized for a possible new trip.

Otherwise, this sign controller read shall be discarded.

When a transponder is read at a tolling zone the read record shall be transmitted to the TTC and the TTC shall check the current status for that transponder.

There shall be four possibilities for transponder status:

- There is a trip open and in progress for the transponder;
- There is a record of the transponder's having been read at the immediately upstream sign controller;
- There is a record of the transponder's having been read at a sign controller but not the one immediately upstream; or
- There is no open record of activity for this transponder.

If there is a trip open and in progress for this transponder and this tolling zone read could be part of that trip's continuation, the trip record shall be updated, as appropriate.

If this tolling zone read could not be part of the open trip (for instance if the read is at a later time than the open trip and at a point upstream of the open trip) then the open trip shall be closed, the trip record shall be forwarded to the AMS for processing and a record shall be initialized as a new trip.

If there is a record open, reflecting the transponder's having been read at the immediately upstream sign controller, then the trip record shall be updated as appropriate.
If there is a record of the transponder's having been read at a sign controller but not the one immediately upstream, then a trip record shall be opened for the transponder with an indication that no sign controller read is available. [the charging rate being based on the rate displayed on the immediately upstream sign at a time earlier than the tolling zone transponder read time by the what is stored in the Sign to Tolling Zone Travel Time Table for this tolling zone, an operator definable value].

If there is no open record for this transponder, a trip record shall be opened for the transponder with an indication that no sign controller read is available. [the charging rate being based on the rate displayed on the immediately upstream sign at a time earlier than the tolling zone transponder read time by the what is stored in the Sign to Tolling Zone Travel Time Table for this tolling zone, an operator definable value].

Periodically and as a low priority task (at least as frequently as once every three hours), the TTC shall check each active transponder record and any transponder that has had no activity (has not been read at any tolling zone for a period greater than the time parameter for signaling the close of the trip) shall be closed and forwarded to the AMS for processing.

The check for no activity shall only be made if the three closest downstream tolling zones have an up-to-date time of last transmission.

An up to date time of last transmission shall mean it is more recent than the time of the last transponder read in the subject trip record plus the no activity time parameter.

The trip record shall be closed and sent to the AMS for processing for any transponder read in the furthest downstream active tolling zone in either direction of travel or for any transponder read exiting at a bus rapid transit center.

Closing a trip record shall result in transmission of a trip completed message by the TTC to the AMS.

A trip completed message shall include, but shall not be limited to:

- Transponder ID;
- Sign location ID if the transponder was read at a sign location;
- Charging rate assigned to the trip;
- The first and terminal tolling zone ID's on the trip;
- The total charge for the trip; and
- The time of the trip start and the time of the read at the last tolling zone.

When a trip record is closed the charging rate shall be determined as follows:

If the trip record contains a sign controller transponder read record from the active sign controller located immediately upstream of the first recorded toll zone read, then the charging rate shall be lower of the charging rate on the sign at the time of the transponder
read or the charging rate on the sign at a time earlier than the transponder read by the value of the Sign Controller Grace Period, an operator defined parameter.

If the trip record does not contain a sign controller transponder read record from the active sign controller located immediately upstream of the first recorded toll zone read, then the charging rate shall be the charging rate displayed on that sign at a time that is a number of seconds prior to the transponder read at the first toll zone read (the Sign Passage Adjustment Time, an operator defined parameter for this tolling zone).

3.1.3 Dynamic Pricing

The system shall execute a new pricing determination just following each new level of service determination.

The pricing determination shall be computed separately for each entry point to the managed lanes.

The pricing determination shall produce a per mile charge rate, a minimum charge, and a maximum charge for each entry point.

Bus Rapid Transit Stations entrances to the managed lanes are special in that they are entrances to both traffic directions of travel on the managed lanes.

The newly computed charging rates shall be determined from the following:

- The current charging rate;
- The measured speed at the downstream tolling locations; and
- The traffic volume at the downstream tolling locations.

The system shall compute the largest traffic density function (TDF) at the downstream tolling locations as follows:

\[
TDF_n = \text{MAX} \left( A_{n,1} \times TD_1, A_{n,2} \times TD_2, \ldots A_{n,j} \times TD_j \right)
\]

Where \( A_{n,j} \) represent a set of operator definable coefficients, there being one set for each managed lane entrance; each member of the set being used to multiply the traffic density in its tolling zone. The arrangement presumes that there are 'n' managed lane entry points and 'j' tolling zones in the direction of travel. MAX (\(. \ldots \)) represents a function that selects the largest member from a set of values.

The table of coefficients would contain one row for each managed lane entrance or sign location and one column for each tolling zone so the size of Table 8 shown below is not what is expected but it illustrates the general concept.
The system shall compute a new charging rate for the entry point based on the computed traffic density function calculation discussed immediately above.

The new charging rate shall be selected from a two dimensional table based on current charging rate and TDF.

Different tables shall be used during different days of the week-time periods.

The system shall provide 16 separate tables.

The minimum charge and maximum charge for each sign controller shall be computed from the per mile charging rate.

The minimum charge for the sign controller shall be obtained by multiplying the per mile rate by the minimum charge coefficient.

The maximum charge for the sign controller shall be obtained by multiplying the per mile rate by the maximum charge coefficient (Maximum Charge Coefficient Table- an operator defined multiplier, one for each managed lane entrance).

If the charging rate for a given entry point is changed as a result of the computation of charging rate (i.e. the new charging rate is not equal to the previous rate) then the

<table>
<thead>
<tr>
<th>Table 8</th>
<th>Tolling Zone Coefficients</th>
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<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Sign Zone 1</td>
<td>1</td>
</tr>
<tr>
<td>Sign Zone 2</td>
<td>0</td>
</tr>
<tr>
<td>Sign Zone 3</td>
<td>0</td>
</tr>
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<td>0</td>
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<td>0</td>
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<tr>
<td>Sign Zone 8</td>
<td>0</td>
</tr>
<tr>
<td>Sign Zone 9</td>
<td>0</td>
</tr>
<tr>
<td>Sign Zone 10</td>
<td>0</td>
</tr>
</tbody>
</table>
charging rate for that entry point shall be frozen for the number of pricing determination periods set by the parameter for the entry point.

The system shall provide a means for the operator to decide to lock groups of entry points in synch such that all entry points in such a group always have the same per mile charging rate.

The group-charging rate shall always be the highest rate computed for any member in the group.

3.1.4 Variable Message Sign Control

Once a changed charging rate has been computed, the TTC shall compose and send to the appropriate sign controller(s) a message instructing the sign controller(s) to place the new charging rate, minimum charge, and maximum charge on the sign.

The message shall include, in addition to the new charging rate, an operator defined sign display image associated with this sign location and the given charging information.

Once the sign controller receives the revised charging rate sign display image and writes it on the sign, it shall compose and send to the TTC, notification confirming the new rate has been displayed and advising the date and time that the new rate was displayed.

The TTC shall retain a history of the charging rates for each sign location together with the date and time displayed for use in assigning charging rates to vehicle trips and for generating reports showing charging rate variations through operator selectable periods.

The application shall allow the operator to compose sign display images and associate them with charging information for display at each sign locations independently or by groups.

The Caltrans Traffic Management Center (TMC) workstation shall allow Caltrans to compose sign display images including text, graphics, rates, symbols, fonts, etc. for each independent sign location or groups of sign locations.

The system shall provide for the Caltrans TMC computer to override the TTC operation, set the charging rates to zero and place TMC defined messages on independent or groups of signs.

When the TMC application overrides the TTC operation, it shall continue to override until the TMC operator indicates to the TTC operation to return to normal operation.

The system shall incorporate a computer workstation at the TMC (the TMC Workstation) to provide the TMC sign override capability. Alternatively, Caltrans may determine that this capability (the TMC Workstation) shall be installed by the Contractor on a TMC computer provided by Caltrans.
The TMC Workstation shall enable the operator to compose and store a minimum of 2048 pre-defined sign message images for possible later selection for transmission to sign controllers.

The TMC Workstation shall enable the operator to select and possibly modify a pre-defined sign display image for transmission to one sign controller or to a group of sign controllers.

The TMC Workstation shall enable the operator to select sign controller(s) by an identifier, a comma separated list of identifiers, or by a pair of identifiers indicating a range of sign controllers in one of the traffic directions.

The signs at the BRTC shall be divided into two parts; one normally used for announcing charging rates/conditions for the southbound traffic and the other for the northbound traffic.

The two halves of these BRTC signs shall be separately addressable.

There may be a need for the operator to override the charging rates for some group of sign controllers either because there is a problem in the general lanes requiring that all traffic be directed to the managed lanes or there is a problem in the managed lanes requiring all traffic to avoid the managed lanes.

The TMC Workstation shall enable the operator to select a group of sign controllers on which one of the pre-defined sign message images is to be displayed.

When this happens the system shall set the charging rate to zero for all the specified sign controller locations as well as for all trips that pass through the tolling zone locations immediately downstream of any of the affected sign locations, during the period the override is in effect.

The TMC Workstation shall enable the operator to terminate the charging rate override and return the sign locations to the control of the TTC for charging rate and sign display.

The TMC Workstation shall enable the operator to select sign controller(s) by an identifier, a comma separated list of identifiers, or by a pair of identifiers indicating a range of sign controllers in one of the traffic directions.

When the operator returns a group of sign controllers to the control of the TTC the TMC Workstation shall enable the operator to either specify the initial charging rate for those sign controllers or allow the system to choose the initial charging rate from a pre-defined table.

If the initial charging rate is to be chosen from a pre-defined table the system shall select the charging rate based on whether the day is a weekday, weekend, holiday, and on the time of day, and direction of travel.

3.1.5 California Highway Patrol Interface
3.1.5.1 Violation PDA Application

The CONTRACTOR shall provide six (6) full color PDAs capable of receiving a high speed RF signal from the tolling zone lane controller.

Each PDA shall have enough non-volatile memory to operate all enforcement functions as well as all operating system functions.

The PDA shall have the capability to communicate using a wireless LAN with the tolling zone controller when the PDA is within vicinity of the tolling zone controller.

Each PDA shall utilize the latest version of the Palm Operating System available at the time of delivery.

Each PDA shall contain a protective carrying case.

Each PDA shall be capable of receiving the current lane configuration (barrier placement) and traffic direction from the tolling zone lane controller when the PDA is within 800 feet of the tolling zone.

Each PDA shall have a refresh button and a refresh menu choice allowing an enforcement officer to refresh the current lane configuration and lane vehicle information.

Each occurrence of a vehicle passing through a tolling zone shall produce a visual signal on a PDA within 800 feet of the tolling zone.

The PDA visual display shall refresh with the current information within .05 seconds after receiving the information from the tolling zone lane controller.

The visual display on the PDA shall indicate the lane receiving the visual signal with a distinct icon placed on the display in the lane corresponding to real time traffic.

Icons representing valid transponder reads shall be displayed in green.

Icons representing invalid transponder read or vehicles without transponders shall be displayed in red.

The PDA display shall maintain a three (3) vehicle queue for each lane.

The PDA display shall produce a visual indication that the display has changed when conditions would not otherwise have changed the display (All three vehicles in the queue of a lane produce a green icon. The fourth vehicle also results in a green icon. A display indicator is needed to confirm the fourth read was recorded.).

Each PDA shall have "hot" buttons and menu selections allowing the CHP officer to select the options available (enter transponder numbers, enter license plate numbers, refresh toll lane monitoring, etc.).

3.1.5.2 Wireless Protocol
The wireless protocol utilized in the lane controllers and PDAs shall meet IEEE 802.11b specifications.

Each CONTRACTOR shall be responsible for obtaining, reading and understanding the IEEE 802.11b specifications.

The modems provided by the CONTRACTOR shall be either built in to the PDAs or inserted directly into the PDAs as an accessory.

All PDAs and associated modems shall be commercially available, off-the-shelf devices.

Transmission speed between the lane controllers and the PDAs shall not be less than 90% of the transmission speed expected from utilization of the IEEE 802.11b specifications.

Enforcement personnel shall be able to select from the following operating modes of the PDA:

- Downloading of the transponder status file from the nearest toll zone controller over the wireless LAN;
- Display of the vehicles passing beneath the gantry associated with the nearby tolling zone controller;
- Display of the status of a transponder in response to the entry by the enforcement officer of the transponder number; and
- Review of prior pullovers, warnings and citations for this transponder/Record additional current pullover, warning or citation.

The downloading of the transponder status file from the toll zone controller to the PDA shall take place at a minimum rate of 100,000 transponder statuses per second.

In the display of the vehicles passing beneath the tolling zone gantry mode, the PDA shall present the user with a visual indication that conveys the passage of a vehicle, its position (which lane it was in when passing) and whether a read of a valid transponder was associated by the system with the vehicle or not.

In the display of the vehicles passing beneath the tolling zone gantry mode, the PDA shall present the user with an audible indication that conveys the passage of a vehicle, its position (which lane it was in when passing) and whether a read of a valid transponder was associated by the system with the vehicle or not.

When the user enters a transponder ID, requesting a report of its status, the PDA shall present transponder status from the most recently received transponder status file together with the date and time representing time of transfer from the AMS to the tolling zone controller.

The user shall be able to enter a transponder ID and obtain a record of pullovers, warnings and citations for that transponder.
The request entry field for transponder ID shall default to the transponder ID of the most recent transponder status check.

This function shall operate when the PDA is in a location where it can communicate with a tolling zone controller.

The user shall be able to update the record of pullovers, warnings and citations for the selected transponder ID and the PDA shall forward the update record to the tolling zone controller for forwarding to the TTC/AMS at the next opportunity.

### 3.2 Technical Requirements

#### 3.2.1 Existing Moveable Barrier Guidance System

The managed lanes will have a moveable barrier system allowing a 3-1, 2-2, 1-3 lane configuration depending on traffic demands and time of day. The moveable barrier is guided by a large loop (several miles long) imbedded in the pavement. This guidance system precludes imbedding any additional loops for vehicle count or direction determination. The moveable barrier system will be provided by Barrier Systems, Inc.

The CONTRACTOR shall not install vehicle detection loops in the managed lane system.

The CONTRACTOR shall not install any device in the managed lanes that interferes in any way with the moveable barrier guidance system.

The CONTRACTOR shall install devices to track the position of the moveable barrier on the toll system gantries located at each tolling zone.

A moveable barrier position change and its resulting lane configuration (number of lanes in each direction) shall be recorded and stored in the system database at the TTC for toll calculations and reporting.

Moveable barrier position and resulting lane configuration records shall contain, at a minimum, the following:

- Tolling zone ID;
- Barrier position change date and time;
- Barrier position (lane 2-3, lane3-4, etc.);
- Lane 1 traffic direction;
- Lane 2 traffic direction;
- Lane 3 traffic direction; and
- Lane 4 traffic direction.

The position of the moveable barrier and its resulting lane configuration shall be broadcast (RF using IEEE 802.11b specifications) from each of the tolling zone lane controllers.

#### 3.2.2 Network/Communications Architecture
3.2.3 In Lane Hardware

In lane or field equipment for this project shall be installed at two location types; at the tolling zones and at the variable message sign locations. Some of the variable message sign locations will be located on the left side of the general purpose lanes just upstream of the managed lane entrances while the others will be located at the bus rapid transit centers (BRTC).

The Tolling Zone field equipment shall consist of a tolling zone controller, ETC readers and above-lane-mounted antennas, above-lane-mounted vehicle detection and measurement equipment, fiber optic communication equipment to the TTC and wireless LAN equipment for communication with enforcement officer PDAs. Some of the Tolling Zones will be located in the Managed Lanes while others will be located at the entrances to the BRTCs from the Managed Lanes. For the Tolling Zones located in the Managed Lanes, the above lane equipment shall be mounted on gantries, but in some cases will be mounted on existing structures such as overpasses. At the BRTCs the above lane equipment shall be mounted on gantries. The gantries or mounting bars attached to existing structures onto which the Contractor shall mount equipment will be provided and installed by Caltrans.

The variable message sign location equipment shall consist of a sign controller, the variable message sign(s) together with any required sign control electronics, and ETC reader and antenna. The support onto which the sign shall be mounted by the Contractor will be provided and installed by Caltrans.

3.2.3.1 Tolling Zone Controller

The system shall incorporate one or more Tolling Zone Controllers at each tolling zone.

The Tolling Zone Controllers shall be capable of controlling tolling zone lane equipment, components, and subsystems.

Tolling Zone Controllers shall be IP-addressed devices on the network.

The lane controller shall be a PC-based system utilizing a multitasking operating system.

Tolling Zone Controller performance shall be ample to handle all lane processes as designed at a rate of 2,500 vehicles per lane per hour, with 50% of those vehicles displaying transponders; for any 10 second period the Tolling Zone Controller shall be capable of handling all lane processes for transponder vehicle passage rates of 7200 vehicles per lane per hour (assumes all vehicles are displaying transponders).

The Tolling Zone Controller shall be designed to control, communicate with, and integrate the operation of, at a minimum, the following components and/or subsystems:

- Toll Transaction Computer (TTC);
- ETC subsystem;
- Vehicle Detection System; and
• Enforcement Agent Personal Digital Assistant (PDA) over 802.11x wireless LAN.

The Tolling Zone Controller(s) shall support the functionality described throughout these specifications.

The functionality requirements that are to be provided by the Tolling Zone Controller(s) appear in various places in these specifications and are briefly summarized below:

• Communicate with the TTC to receive transponder status file and various operator defined system control parameters;
• Transmit all transponder read records to the TTC;
• Monitor the vehicle detection equipment so as to match transponder reads to the vehicle containing the transponder;
• Send a message to the TTC indicating no additional transponder read data remains to be transmitted after an operator defined number of seconds since the last transponder read transmission;
• Coordinate the data from the ETC reader and the vehicle detection equipment to identify vehicles displaying transponders;
• Support enforcement by transmitting (over the 802.11x wireless link) position information of the vehicles displaying transponders at each transponder read;
• Transmit transponder status file over the 802.11x wireless link to any enforcer’s PDA in its vicinity that requests it;
• Store for later forwarding all transponder reads and other event data that occur while there is an interruption in the communication link to the TTC;
• Use data from the vehicle detection equipment to sense the position of the movable barrier and thus the direction of traffic flow in the lanes in the tolling zone;
• Obtain vehicle count and vehicle speed data and provide it to the TTC so it can compute traffic density, level of service and adjust charging rates; and
• Act as a conduit between a PDA in the vicinity of the Tolling Zone Controller and the TTC for the passage of enforcement history of a particular transponder ID or a particular registration plate number.

The Tolling Zone Controller shall be configured with sufficient storage capacity to store 1,000,000 transponder read transactions and 10 days accumulated vehicle count and speed data in the event of a communications network outage.

When communications are restored following a failure, the system shall automatically upload all stored transactions and data to the TTC, and verify that all transactions were transferred.

Each Tolling Zone Controller shall be able to accommodate an in memory transponder account status database of at least 10,000,000 transponders.

The Tolling Zone system shall be capable of capturing transponder reads for 99.98% of the vehicles with properly mounted transponders.
The design of the Tolling Zone system in the Managed Lanes shall focus on the objective of reading the transponders in vehicles traveling through the Tolling Zone and avoiding the reading of transponders in vehicles traveling in the adjacent general lanes as follows:

The Tolling Zone system shall capture transponder reads for 99.98% of the vehicles with properly mounted transponders passing through the Tolling Zone.

The Tolling Zone system shall capture transponder reads for less than 0.01% of the transponders traveling in the general lane closest to the managed lanes (leftmost general lane).

The Tolling Zone system shall be capable of determining the direction of travel for all vehicles in the managed lanes with an error rate in the determination of travel direction of no more than 0.01%.

The design of the Tolling Zone system at the BRTCs shall focus on the objective of reading transponders in vehicles traveling from the managed lanes toward the bus rapid transit center and avoiding the reading of transponders in vehicles traveling from the bus center toward the Managed Lanes and in vehicles traveling in either the Managed Lanes or the general lanes.

The Tolling Zone system shall capture transponder reads for 99.98% of the vehicles with properly mounted transponders in vehicles traveling toward the Managed Lanes.

The Tolling Zone system shall capture transponder reads for less than 0.01% of the transponders in vehicles traveling in the Managed Lanes, in the general lanes, or traveling toward the managed lanes from the bus center.

The Tolling Zone system shall be capable of correctly identifying the lane that a transponder-displaying vehicle is in when it passes through the tolling zone for 99.5% of such vehicles. If a vehicle is straddling two lanes identifying either of the straddled lanes shall be judged to be a correct lane identification.

The system shall be designed to read a transponder, determine what lane the vehicle carrying the transponder is in and report this information on an enforcement officer's PDA within 500 milli-second after the rear of the vehicle has passed under the ETC antenna.

The Tolling Zone Controller shall perform diagnostic testing on itself and on lane devices and subsystems and report failures and status to the TTC. The TTC shall communicate this equipment status to the Maintenance On-line Management System (MOMS) for maintenance reporting. Lane equipment status shall be a part of every transaction record.

The Tolling Zone Controller shall incorporate diagnostics on its performance and capacities, as tracked by network monitoring tools, and it shall be possible to remotely reset the lane controller in the event of a malfunction or partial shutdown.
In the event of an extended communication failure, the lane controller shall be designed such that stored data, which would usually be sent to the TTC, can be copied to or from a CD, a DVD or laptop computer.

The stored data shall include all lane information and transaction data from the Tolling Zone Controller and transponder status files and related operational parameters that can be transferred to the Tolling Zone Controller.

Stored data capable of being removed from the Tolling Zone Controller shall allow the Tolling Zone Controller to continue to operate indefinitely in a stand-alone mode.

Each Tolling Zone Controller shall be interchangeable with all other Tolling Zone Controllers in the system.

The Tolling Zone Controller shall use a multi-tasking operating system that shall provide:

- security for control of file access and user login/password protection;
- file integrity in case of power loss;
- an audit trail of user login, logout, and system shutdown;
- automatic restart in the event of interruption of power;
- task monitoring, providing auto detection of looped or frozen tasks; and
- capability of restarting individual tasks without rebooting the entire operating system.

Each Tolling Zone Controller shall contain a real-time clock-calendar with battery backup which shall maintain date and time for at least seventy two (72) hours. The clock shall be synchronized by the TTC clock synchronization upon re-start as well as at least once every 24-hours.

Tolling Zone Controllers shall be installed in NEMA 4X dust-tight and watertight enclosures; all cable access holes, and other required openings shall be gasketed or otherwise sealed to form a watertight seal.

The Tolling Zone Controller housing shall include heating and cooling equipment as required to ensure proper and reliable operation.

Tolling Zone Controller installation methods for all locations shall be included in the Installation Plan that shall be submitted to the Engineer for review and approval.

3.2.3.2 Sign Controller

The system shall be designed with two somewhat different types of sign controller locations. First, there is the type of sign location located on the general lanes just upstream of each entrance to the Managed Lanes. Second, there is the type of sign location on the road leading from the bus rapid transit centers (BRTC) to the Managed Lanes.

The system shall incorporate a Sign Controller at each Sign Location.
The Sign Controllers shall be capable of controlling sign location lane equipment, components, and subsystems.

Sign Controllers shall be IP-addressed devices on the network.

The lane controller shall be a PC-based system utilizing a multitasking operating system.

Sign Controller system performance shall be ample to handle all lane processes as designed at a rate of 2,500 vehicles per hour passing in the lane beneath the antenna(s) (leftmost general lane), with 50% of those vehicles displaying transponders; for periods of 10 seconds the Sign Controller shall be capable of handling all lane processes for transponder vehicle passage rates in the lane beneath the sign of 7200 vehicles per lane per hour (assumes all vehicles are displaying transponders).

The Sign Controller shall be designed to control, communicate with, and integrate the operation of, at a minimum, the following components and/or subsystems:

- Toll Transaction Computer (TTC);
- ETC subsystem;
- The Variable Message Sign(s)

The Sign Controller(s) shall support the functionality described throughout these specifications.

The functionality requirements that are to be provided by the Sign Controller(s) appear in various places in these specifications and are briefly summarized below:

- Communicate with the TTC to receive sign display formats and data plus various operator defined system control parameters;
- Transmit all transponder read records to the TTC;
- Store for later forwarding all transponder reads and other event data that occur while there is an interruption in the communication link to the TTC;
- Control color full matrix signs; the sign controllers at the BRTC shall treat their signs as having three separately addressable sections. One of the sections shall be for northbound traffic, one shall be for southbound traffic and one shall be a common section for presenting a logo or other information of common interest to vehicles traveling in either direction.

The Sign Controller shall be configured with sufficient storage capacity to store 1,000,000 transponder read transactions in the event of a communications network outage. When communications are restored following an outage, the system shall automatically upload all stored transactions and data to the TTC, and verify that all transactions were transferred.

The design of the Sign Location system for the entrances to the Managed Lanes from the general lanes shall focus on the objective of reading the transponders in vehicles in the lane beneath the sign and avoiding the reading of transponders in vehicles traveling in the
adjacent Managed Lanes. Reading transponders in vehicles traveling in general lanes adjacent to lane beneath the sign is desirable though not required.

The Sign location system shall capture transponder reads for 99.98% of the vehicles with properly mounted transponders passing in the lane beneath the sign (leftmost general lane).

The Sign Location system shall capture transponder reads for less than 0.01% of the transponders traveling in the Managed Lane closest to the general lane beneath the sign (leftmost general lane).

The design of the Sign Location system at the BRTCs shall focus on the objective of reading transponders in vehicles traveling from the bus rapid transit center toward the managed lanes and avoiding the reading of transponders in vehicles traveling from the Managed Lanes toward the bus center and in vehicles traveling in the Managed Lanes or the general lanes.

The Sign location system shall capture transponder reads for 99.98% of the vehicles with properly mounted transponders in vehicles traveling toward the Managed Lanes.

The Sign Location system shall capture transponder reads for less than 0.01% of the transponders in vehicles traveling in the Managed Lanes, in the general lanes, or traveling toward the bus center from the managed lanes.

The Sign Controller shall perform diagnostic testing on itself and on lane devices and subsystems and report failures and status to the TTC.

The TTC shall communicate the equipment status to the MOMS System for maintenance reporting.

Lane equipment status shall be a part of every transaction record.

The Sign Controller shall incorporate diagnostics on its performance and capacities, as tracked by network monitoring tools, and it shall be possible to remotely reset the lane controller in the event of a malfunction or partial shutdown.

In the event of an extended communication failure, the lane controller shall be designed such that stored data, which would usually be sent to the plaza computer, can be copied to or from a CD, a DVD or laptop computer.

Stored data shall include all lane information and transaction data from the Sign Controller, and transponder status files and related operational parameters that can be transferred to the lane controller.

Stored data transfer capability shall allow the lane controller to be able to continue to operate indefinitely in a stand-alone mode.
Each Sign Controller at the entrances from the General Lanes shall be interchangeable with all other Sign Controllers at the entrances from the General Lanes in the system.

Each Sign Controller at the BRTCs shall be interchangeable with all other Sign Controllers at the BRTCs.

The Sign Controller shall use a multi-tasking operating system that shall provide:

- security for control of file access and user login/password protection;
- file integrity in case of power loss;
- an audit trail of user login, logout, and system shutdown;
- automatic restart in the event of interruption of power;
- task monitoring, providing auto detection of looped or frozen tasks; and
- capability to restart individual tasks without rebooting the entire operating system.

Each Sign Controller shall contain a real-time clock-calendar with battery backup which shall maintain date and time for at least seventy two (72) hours.

The clock shall be synchronized by the TTC clock synchronization upon re-start as well as at least once every 24-hours.

Sign Controllers shall be installed in NEMA 4X dust-tight and watertight enclosures; all cable access holes, and other required openings shall be gasketed or otherwise sealed to form a watertight seal.

The Sign Controller housing shall include heating and cooling equipment as required to ensure proper and reliable operation.

Sign Controller installation methods for all locations shall be included in the Installation Plan that shall submitted to the Engineer for review and approval.

3.2.3.3 ETC Equipment – Title 21

California law requires that there be interoperability between the ETC operations of all toll roads in the state. The mandatory use of Title 21 ETC equipment, readers and transponders is embedded in that required interoperability.


All ETC equipment provided by the CONTRACTOR shall comply with the requirements of California Code of Regulations, Title21, Division 2, Chapter 16, Articles 1-4.

The system shall be capable of reading any transponder issued by any Title 21 compliant agency in the State of California and generating a toll transaction that includes the same
information as a transaction generated by a SANDAG issued transponder except for the transponder ID number which shall indicate the issuing agency.

The system shall be capable of issuing payment request and tracking payments received from other agencies.

The system shall be capable of receiving payment request from other agencies and tracking those payments and posting those payments against SANDAG accounts.

3.2.3.4 Vehicle Detection Equipment

It will be necessary to accurately separate and count vehicles in each of the managed lanes. The moveable barrier guidance system will preclude in-pavement loop detectors as a means of doing this in the managed lane system.

3.2.3.4.1 Overhead Vehicle Detection Sensors

The CONTRACTOR SHALL provide install and integrate an overhead mounted vehicle detection system.

The sensor installation configuration shall allow for separation of vehicles in the lanes and distinguishing a vehicle straddling two lanes.

The sensors shall be able to determine the vehicle speed of each vehicle detected.

The sensor shall be able to detect the direction of travel of each vehicle detected.

The sensors shall be eye safe.

The sensors shall be able to count vehicles passing the tolling zone. The resulting counts shall be accurate to within plus or minus 1%.

The sensors shall be able to measure the speed of a vehicle to an accuracy of plus or minus 2 MPH.

The overhead vehicle detection system shall detect the position of the moveable barriers and from this determine the managed lane configuration (number of lanes in each direction).

The overhead vehicle detection system shall also conform to the specifications in the “ENVIRONMENTAL REQUIREMENTS” sections of this document.

3.2.3.4.2 Loop Detectors

The CONTRACTOR shall not install a vehicle loop detection system in the managed lanes as part of this project.

3.2.3.5 Variable Message Signs
The variable message signs shall be provided with software providing the following capabilities:

- Message creation & editing capability
- Graphics display capability
- VMS system diagnostics

3.2.3.5.1 Variable Message Signs on Managed Lanes

For this project Variable Message Signs shall be provided and installed on the general purpose lanes on the entry side of, and upstream of, each entrance to the Managed Lanes.

The Contractor shall provide and install Variable Message Signs on cantilevered supports.

The Contractor shall supply and install all fixtures and hardware needed to attach the sign to the cantilevered support.

The cantilevered supports shall be provided and installed by others.

The Variable Message Signs shall be full color (256 colors) full matrix signs.

The VMS display area shall be a minimum of 7.5 feet high by 25 feet wide.

3.2.3.5.2 Variable Message Signs at Bus Rapid Transit Centers

For this project Variable Message Signs shall be provided and installed at the entrances to the bus rapid transit centers from the Managed Lanes.

The Contractor shall provide and install Variable Message Signs on the vertical supports for one of the gantries supporting the ETC antennas for the BRTC Tolling Zone on the side of the gantry adjacent to traffic driving toward the Managed Lanes.

The gantries shall be provided and installed by others.

The Contractor shall supply and install all fixtures and hardware needed to attach the sign to the gantry’s vertical support.

The Variable Message Signs shall be full color (256 colors) full matrix signs.

The VMS display area shall be a minimum of 7.5 feet high by 5 feet wide.

The sign shall have three separately addressable areas.

3.2.4 Inventory Control

3.3 Parts Inventory

A system parts and transponder inventory control mechanism shall be provided.
The inventory control mechanism shall be integrated with the MOMS to allow for real-time database updating of inventoried items.

The inventory control mechanism utilized may be “off-the-shelf” through third party or developed by the CONTRACTOR.

If an “off-the-shelf” product is selected it shall be clearly identified in the Proposal along with supporting documentation.

The parts inventory shall be maintained in a database format in order to allow for cross referencing and look-up functions.

The inventory database shall be maintained on the TTC.

The parts list shall provide not only a listing of the spare parts inventory but also a complete listing of all components comprising the toll collection system.

The parts list and proposed inventory shall be subject to OWNER approval prior to shipping and/or acceptance of the material.

The parts list shall, at a minimum, provide the following information:

- Part Name/Description;
- Manufacturer Serial Number/Model Number/Etc;
- Manufacturer Name, Address, Phone Number;
- Location (if other than stock);
- Contact Name (if applicable);
- Retail Cost;
- Spare Part Quantity; and
- Estimated Lead-Time for Procurement.

3.4 Transponder Inventory
A system transponder tracking mechanism shall be provided.

The transponder tracking mechanism shall be part of the system parts inventory program.

The transponder tracking mechanism shall, at a minimum, track the following:

- In stock;
- Issued to CSR (including name);
- Issued to Patrons;
- Returned by Patrons; and
- On Order from the Manufacturer.

4 Communications Architecture
4.1 Network Configuration
The CONTRACTOR shall develop a network configuration similar to the following.
The network configuration shall accommodate all functions described in this document as well as any requirements developed by the CONTRACTOR.

5 Fiber Optic Communications

The existing Caltrans District 11 I-15 Fiber Optic Backbone cable infrastructure shall be used to connect the I-15 Managed Lane field devices with the TTC.

This shall be accomplished by installing fiber optic tail circuits used to connect the terminating fiber optic transport equipment to the fiber optic backbone network.

Fiber cable splicing shall be performed in fiber optic pull boxes or vaults using an outside installation rated fiber optic slicing enclosure.

All cable splicing shall be performed by use of the fusion technique only.

Fiber optic connectors located at the equipment (terminating) end of the fiber optic tail circuits shall be compatible with the fiber optic connector of the fiber optic transport equipment.

All fiber optic tail circuits shall be 100% compatible with the fiber optic backbone system.
All fiber optic backbone strands connecting the I-15 field devices shall be configured in a logical “ring” topology.

All fiber optic terminating equipment shall include a fault tolerant, self healing function.

The fiber optic card chassis located in the central site shall have a back power supply.

Spare fiber optic backbone and tail circuits shall be identified and installed respectively.

One set of fiber optic end equipment, field cabinet transceiver and central system terminating chassis card shall be provided as a spare.

Fiber optic patch cords “pig tails” shall be used on the fiber optic patch panel to cross-connect the fiber optic backbone strands with the fiber optic transport equipment located at the central site.

Fiber optic patch cords shall be 100% compatible with the existing fiber optic patch panel and the fiber optic connector of the fiber optic transport equipment.

All fiber optic circuits shall be labeled.

A fiber circuit cabling spread sheet detailing all fiber cable interconnects and assignments shall be provided.

The fiber optic transport equipment located at the central site shall be networked with the TTC to provide a means of transporting data between field devices and the TTC.

6 CALTRANS Traffic Management Center Interface

The System to be installed as part of the I-15 Managed Lanes project, shall be integrated and conform to the SANDAG ITS Regional Architecture.

It is understood that there is a SANDAG Regional Architecture which conforms to the Southern California ITS Priority Corridor’s Architecture. The Southern California Priority Corridor ITS Network interconnects the traffic management centers of Southern California to enable the agencies to cooperatively improve the efficiency and performance of the overall system. The SANDAG Regional Architecture covers all operating agencies and systems in San Diego County, and includes a center-to-center protocol for the transmission of data and information. The regional architecture includes a Regional Traveler Information System that delivers real-time travel information for freeways, arterial streets, transit, and commercial vehicles through traditional media sources and new technologies.

Caltrans District 11, whose jurisdiction includes all state highways in San Diego County, plays a major role as a stakeholder in the SANDAG Regional Architecture. Per the Regional Architecture requirements, Caltrans Advanced Transportation Management System ver. i (ATMSi), the District 11 traffic management system which operates and controls various ITS traffic management field devices and systems, provides information to the Intermodal Transportation Management System (IMTMS) Network in a Common
Object Request Broker Architecture (CORBA) platform. The ATMSi is housed at the San Diego Transportation Management Center (TMC), which integrates Caltrans Traffic Operations, Caltrans Maintenance, and California Highway Patrol (CHP) Communications in a unified, co-located communication and command center. The TMC is providing the communications, surveillance and computer infrastructure necessary for coordinated transportation management on State Highways during normal commute periods, as well as special events, and major incidents. Their responsibilities include control and operation of the Reversible I-15 HOV Express Lanes.

The System shall meet Caltrans data sharing and integration requirements, and provide information from the I-15 Managed Lanes (ML) System to the District 11 ATMSi.

As the ML system will be situated in a highway environment, it is proposed that the system meet Caltrans data sharing and integration requirements, which satisfies the regional architecture requirements. This requires providing the information from the ML System to the District 11 ATMSi.

The following requirements describe the information that shall be sent to Caltrans and the Regional Traveler Information System, and the proposed process for transmission.

**Changeable Message Signs (CMS)**

The CONTRACTOR shall provide the same data configuration as Caltrans ATMSi database (to be provided by Caltrans),

The CONTRACTOR shall provide the status of operations and their related messages.

The system shall include allowance for Caltrans TMC to override CMS in event of an incident, which includes opening of the ML to all traffic as a response.

Each CMS needs direct input to the ML System for pricing information, and Caltrans ATMSi at the TMC for operator override capability, therefore each CMS shall interface with both system protocols.

The CMS must be operable from an existing Caltrans operator workstation in the TMC.

The CMS will be an LED full-matrix sign, not a standard Caltrans model. Therefore, the CONTRACTOR shall provide trouble-shooting tools and methods for maintenance.

**Vehicle Detectors**

The detection system shall provide travel time and other data collected (i.e. speed, volume, density) to the Caltrans ATMSi, as well as the ML system.

The detection system must be an overhead-mounted microwave radar sensor, capable of providing speed, volume and occupancy (density) information in multiple zones.
The detector system needs direct input to the ML Server for data input, and Caltrans ATMSi for surveillance information and possible incident detection on the Managed Lanes. As the Caltrans Front End Processors (FEPs) interface with a 170-series controller through a serial port for surveillance information, the detector system local controller interface shall “fool” the FEPs that they are talking to a 170-series controller.

**Facility Status**

Much of this information related to the Reversible Lane Control System (RLCS), includes: status information per each directional segment or “zone” (the area between ingress and egress points), zone name, limits, direction, number of lanes open to traffic, mode of operation (i.e. any restrictions), current pricing etc.

The ML System shall be integrated with the Reversible Lane Control System.

The I-15 ML System requires input from I-15 RLCS (i.e. gate status, etc.) therefore, integration between the two systems shall be provided.

A Baseline version I-15 RLCS System Requirements Specification for procurement of development/integration vendor services, dated March, 2002 should be consulted for details.

The field device information shall be provided to the Caltrans District 11 ATMSi via external Oracle 8i databases.

The information from the ML System and the RLCS shall be provided to the District 11 172 TMC Network, just as information from Caltrans field elements provides processed information.

The information from the two systems shall be provided to the network via external Oracle 8i databases, as required by Caltrans.

Each external database server should have a firewall between it and the respective system that feeds them data for safety protection.

Required communications for all field system elements will be provided by Caltrans.

**7 Graphical User Interfaces (GUI)**

The CSC application shall include a Graphical User Interface (GUI) between the CSC application and the Customer Service Representatives (CSR) and patrons of the AMS.

There shall be a GUI allowing the operator to batch enter transponders to a commercial account.

There shall be a GUI allowing the operator to batch enter transponders.

There shall be a GUI allowing operators at the CSC workstations to have simple data entry forms (SANDAG approved) for account data entry.
There shall be a GUI allowing the operator to create and edit account replenish amounts.

8 Operator Definable Requirements

The I-15 Managed Lanes project is undertaking to employ pricing to dynamically control the level of service on a roadway with many entrances and exits, an objective never previously attempted. The goal is to provide the operator with a set of easily adjustable parameters that will permit this ability. The discussion elsewhere in this document makes reference to such operator adjustments and the need to provide a graphical user interface (GUI) to adjust the parameters.

The Contractor shall develop this toll system so that the operator will have the ability to tune the system’s response to varying traffic conditions without needing to resort to programming revisions.

The Contractor shall provide a comprehensive set of parameters to satisfy the need to tune the control of LOS.

The Contractor shall provide a set of variables and GUIs to vary the parameters that enables the operator to tune the system’s control of LOS.

The variables to be controlled shall include but shall not necessarily be limited to those shown in Table 9 below.

<table>
<thead>
<tr>
<th>Item</th>
<th>Name</th>
<th>Description</th>
<th>Format/Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>LOS Interval</td>
<td>The time interval between computations of traffic density, LOS and the possible posting of new charge rates.</td>
<td>XXXX/Seconds</td>
</tr>
<tr>
<td>2.</td>
<td>LOS Override Traffic Speed</td>
<td>The threshold speed, below which traffic density and LOS shall be overridden by the system</td>
<td>XXXX/Miles/hour</td>
</tr>
<tr>
<td>3.</td>
<td>Tolling Zone Gap in transponder Read Message Interval</td>
<td>When the Tolling Zone computer has had no transponder reads for this interval of time it shall send a message to the TTC indicating that is the case.</td>
<td>XXXX/seconds</td>
</tr>
<tr>
<td>4.</td>
<td>Sign Controller Grace Period</td>
<td>The adjustment subtracted from the time of recorded passage under a sign controller when the charging rate is increasing.</td>
<td>XXXX/seconds</td>
</tr>
<tr>
<td></td>
<td>Description</td>
<td>Details</td>
<td>Example</td>
</tr>
<tr>
<td>---</td>
<td>-----------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>---------</td>
</tr>
<tr>
<td>5</td>
<td>No Sign Read Adjustment Time</td>
<td>The adjustment subtracted from the time of a vehicle’s passing the first tolling zone to estimate time of passage under the upstream sign.</td>
<td>XXXX/SECONDS (Table with an entry for each tolling zone)</td>
</tr>
<tr>
<td>6</td>
<td>Traffic Density Coefficients Tables</td>
<td>Tables of coefficients (one for each traffic direction) that is used to multiply the measured traffic densities in the associated tolling zone to select the MAX level that will serve to obtain the charging rate adjustment. Though a multiplier can be any value, typically they would be set to either zero or one.</td>
<td>XX.XX/dimensionless A table with a row for each sign location and a column for each tolling zone in the direction of travel</td>
</tr>
<tr>
<td>7</td>
<td>Charging Rate Adjustment Tables</td>
<td>A set of tables used to obtain an adjustment to the charging rate based on the current charging rate and the computed traffic density. For any given re-computation of revised charging the day of week characteristic (weekday, Saturday, Sunday, and Holiday plus the time of day shall determine the particular table. Provide for 10 variation levels of charging rate and 10 variation levels of traffic density</td>
<td>+/- $XX.XX/Dollars A set of tables suitable for a double table lookup for the suitable charging adjustment</td>
</tr>
<tr>
<td>8</td>
<td>Time Day of Week selection Table</td>
<td>Used to select the Charging Rate Adjustment Table based on the type of day, the time of day and the direction of travel. Provide for 4 tables in each direction for each type of day (32 tables).</td>
<td>Table ID/ -</td>
</tr>
<tr>
<td>9</td>
<td>Maximum charge coefficient Table</td>
<td>The number when multiplied by the charging rate produces the maximum charge for a trip.</td>
<td>XXXX/- Table with an entry for each managed lane entrance.</td>
</tr>
<tr>
<td>10</td>
<td>Minimum charge coefficient Table</td>
<td>The number when multiplied by the charging rate produces the minimum charge for a trip.</td>
<td>XXXX/- Table with an entry for each managed lane entrance.</td>
</tr>
<tr>
<td>11</td>
<td>Adjustment</td>
<td>A time period long enough to allow the effect of a charging rate</td>
<td>XXXX/-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>response time adjustment to have its effect, measured in multiples of the LOS interval</td>
<td><strong>12. Sign Charging Group Membership Table</strong></td>
<td>TBD</td>
<td></td>
</tr>
<tr>
<td>A table that identifies whether a sign controller is a member of a group whose charging rates must be locked together and if so indicates to which group it belongs (which other sign controllers are in the same group)</td>
<td><strong>13. Sign Display Image</strong></td>
<td>Software tool required??</td>
<td></td>
</tr>
<tr>
<td>A sign image to be forwarded to the sign controller by the operator along with the charging, minimum and maximum rates.</td>
<td><strong>14. Sign Display Override Image</strong></td>
<td>Software tool required??</td>
<td></td>
</tr>
<tr>
<td>A sign image to be forwarded to the sign controller by the TMC Workstation when an override of the tolling system is to take place</td>
<td><strong>15. Initial Charging Rate after an override Table</strong></td>
<td>XX.XX/ Dollars A table with entries selectable by type and time of day</td>
<td></td>
</tr>
<tr>
<td>A table of initial charging rates to be set after a toll system override has been terminated. The table entry shall be selected based on the type of day (weekday, Saturday, Sunday, Holiday) and the time of day.</td>
<td><strong>16. Active Sign Controller Table</strong></td>
<td>Yes/No Tables of entries, one for each direction of travel</td>
<td></td>
</tr>
<tr>
<td>A definition for each Sign Controller as to whether it is currently active</td>
<td><strong>17. Active Tolling Zone Controller Table</strong></td>
<td>Yes/No Tables of entries, one for each direction of travel</td>
<td></td>
</tr>
<tr>
<td>A definition for each Tolling Zone Controller as to whether it is currently active</td>
<td><strong>18. Tolling Zone Distance Table</strong></td>
<td>XX.XX/Miles</td>
<td></td>
</tr>
<tr>
<td>Two dimensional distance providing the distance traveled for trips traversing through any combination of tolling zones.</td>
<td><strong>19. Trip Closing Time Parameter</strong></td>
<td>XX/Minutes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td>Percent Discount for Volume</td>
<td>A two dimensional table giving the percent discount for miles traveled.</td>
<td></td>
</tr>
<tr>
<td>21.</td>
<td>Dollar Discount for Volume</td>
<td>A two dimensional table giving the dollar discount for miles traveled</td>
<td></td>
</tr>
<tr>
<td>22.</td>
<td>Percent Discount for Value</td>
<td>A two dimensional table giving the percent discount for total dollar value.</td>
<td></td>
</tr>
<tr>
<td>23.</td>
<td>Dollar Discount for Value</td>
<td>A two dimensional table giving the dollar discount for total dollar value.</td>
<td></td>
</tr>
</tbody>
</table>

The GUIs provided shall be access restricted to those authorized to modify the variables.

The GUIs shall provide reasonableness checks on the entered values- numeric fields must be numeric values, range checking on entered numerics, etc.

### 9 Hardware and Field Installation General Requirements

#### 9.1 System Life

The system design goal shall be ten years minimum Service Life.

Equipment shall be designed, fabricated, and tested to ensure that it operates satisfactorily without material degradation for a minimum of ten years. Expendable and consumable materials and supplies are not to be included in this requirement.

#### 9.2 New Equipment

All equipment, supplies, and materials for this system shall be new, off-the-shelf, current technology, field proven items, modified only to the extent required to meet the overall special requirements of this specification.

Materials and products which have been previously used for development work, leased systems, or any other type of used equipment, shall not be permitted for this project.

#### 9.3 Modular Design

Modular Design principles shall be used throughout the system, and shall be defined as the packaging of components together in replaceable units according to the function they perform and by using standardized hardware and components to achieve flexibility of use and to facilitate maintenance.

Replaceable and repairable modules shall be used whenever possible to simplify troubleshooting, reduce downtime, and reduce operational and maintenance costs.

Modules which perform identical functions shall be interchangeable.
All modules shall be keyed or otherwise identified so that the correct module is easily distinguished and can only be properly inserted in its receptacle.

9.4 Uniform Design for All Lanes and Types
All lanes shall be designed, installed, connected, and documented in a uniform manner as described in the specifications.

Uniform components shall be designed and configured for all lanes to the extent possible.

Each system component shall be configured identically to the extent possible, with the same boards in the same slots, the same hardware and software, the same RAM configuration, and the same connectivity.

9.5 Non-Proprietary
Components shall be readily available from many different vendors when possible. Every effort should be made in the design process to prevent reliance on a single vendor for any system components.

9.6 Interchangeability
All major assemblies such as toll collector terminals, subassemblies, modules, and parts which perform identical functions shall be electrically and mechanically interchangeable.

Standard commercially available parts and hardware shall be used to the maximum extent possible.

9.7 Accessibility
All assemblies, subassemblies, and modules shall be readily accessible for removal, testing or replacement without extensive removal of other modules or assemblies.

Components shall be located so that there is visibility and access for the use of hand tools and standard test probes where maintenance is required.

9.8 Test Points
All Test Points necessary for maintenance while equipment is in operation shall be located and accessible on a test panel, or the individual module. Test Points shall be capable of accepting standard commercial test probes and leads. LED indicators shall be used to indicate presence or condition of various circuits and voltages where feasible. All test points and indicators shall be clearly marked to identify their function.

9.9 Electronic Components
All Electronic Components shall be Industry Standard items available from several manufacturers.

All components shall be new, undamaged, and clearly marked with permanent identification.
9.10 Plugs, Connectors, and Terminal Blocks
All plug-in connectors shall be keyed or polarized to prevent mis-mating of connections.

Where multiple plug-in connections occupy a small area, different style connectors shall be used for each function to prevent connecting to the incorrect circuits.

All connectors shall be designed to prevent accidental loosening due to vibration or use, or be provided with locking devices to accomplish this goal.

Strain relief shall be provided to protect the conductors at the point of joining the connector.

Terminal Blocks and Connectors shall contain at least 20% spare connections.

Terminal Blocks shall utilize screw-type terminations.

All wire terminations shall be insulated and properly sized crimp-on insulated terminals of the proper size for the corresponding terminal block.

9.11 Wires and Cables
All Electrical Wires and Cables shall be installed point to point with no interruptions.

All Wires and Cables shall be permanently marked or color coded for easy identification.

No wrap on or other temporary marking methods shall be used.

There shall be no exposed wires or cables.

All conductors shall be enclosed in conduit, cabinets, cable trays or other protective enclosure approved by the Owner.

All internal wires shall be color-coded or ribbon cable. Similar uses, such as data lines, control lines, specific voltages, grounds, etc. shall be color coded the same as far as practical.

Universal color-codes and cable identifiers shall be utilized throughout the system. All communications cables, including computer wiring and fiber-optic cables, shall meet the latest requirements of the National Electrical Code, (NEC) applicable at the time of this procurement.

Multi-conductor cables shall be color coded in conformance to the applicable Color Code as published by the Insulated Cable Engineers Association (ICEA).

All data and power cable in the field (i.e., not in NEMA 4 rated cabinets) shall be in conduit or flexible conduit, water-tight and dust-tight, including at all fittings.
9.12 Insulation
All Electrical Wires and Cables exiting an enclosure shall be properly insulated and grommeted to prevent wear and abrasion.

Cable access holes shall be gasketed and sealed to conform to the environmental requirements.

9.13 Circuit Protection
Components and devices which are susceptible to damage upon failure of the regulating element within a power supply shall be protected by means of an over voltage protective circuit.

All fuses shall be mounted with retention devices at both ends.

All fuse types shall contain visual indicators to indicate a blown fuse.

The Contractor's design and recommendations shall conform to the applicable lightning protection, surge, and transient protection standards, such as NFPA-78, IEEE Std 587, and UL-1447, as they apply to each area of protection.

9.14 Housings and Cabinets
The material and finish for new housings and cabinets shall be environmentally resistant to outdoor highway environments with wide temperature fluctuations and heavy use of salt.

A minimum of ten (10) years service without additional painting or repairs is required.

All cabinets and housings shall be fitted with required gaskets, grommets, and filters to prevent the entry of dust, dirt, smoke, moisture or other contaminants from entering the enclosures in accordance with the application in which the equipment is employed.

9.15 Hardware
All mounting hardware, bolts, nuts, studs, washers, brackets, screws, hinges, and others shall be new and shall be constructed of non-corrosive material, and of a design to perform their respective functions for the specified ten (10) year system life.

9.16 No Interference
Electronic toll collection equipment, vehicle detection equipment, data cables and the system power distribution wiring shall operate without interference or degradation from electrical conditions found on a highway and adjacent to airports.

Equipment shall not be adversely affected by conditions including, but not be limited to, electrical interference from communications, RF radiation, all radios, vehicle ignition, treadle contacts, lighting fixtures, transients, ETC systems and electrical interference, direct sunlight, darkness, indirect sunlight, radiation heat loss, convective heat loss, wind, salt, all forms of precipitation, dust, smog, fungus, vehicle exhaust, and vibration.
9.17 Fabrication
All chassis, attachments, and hardware shall be fabricated from corrosion and rust resistant materials, or properly plated to achieve corrosion and rust resistance.

For those housings and cabinets requiring locked covers, there shall be no exposed hardware visible or accessible from the outside.

The covers shall fit flush with the main body of the housing with no exposed gaskets or seals visible when the cover is closed.

9.18 Stainless Steel Materials
The provision and fabrication of all stainless steel materials used in the system shall conform to current ASTM requirements.

All welds shall be thoroughly cleaned to remove all oxide scale. Discoloration resulting from the welding process shall be removed from all external surfaces.

All grinding, polishing and buffing shall be in accordance with the requirements of the material used.

9.19 Toll System Lock Requirements
All equipment and cabinet locks shall be removable and replaceable cylinder lock types.

The lane equipment shall be keyed alike.

Each major area (maintenance, revenue, and toll collection) shall be keyed differently.

If multiple compartments for each area must be accessed, they shall be keyed alike.

The Contractor shall submit the keying index system for review and approval.

9.20 Capacities
No more than 75 percent of any computer processor's RAM shall be used when all the operating system, utilities, communications, networking and application software are running under normal business conditions.

This spare capacity shall exist when the maximum number of anticipated equipment and options are installed and operating at peak design loads.

Average CPU cycle usage shall be less than 50 percent for all one minute sample periods when all the operating system, utilities, communications, networking and application software are running for the maximum number of anticipated equipment and options.

Data disk drives shall have at least 70 percent free space at time of acceptance.
9.21 Applicable Codes
All work for this Contract shall be in conformity with the current requirements of the following:

- National Electric Code;
- National Electrical Contractors Association (NECA);
- Occupational Safety and Health Act (OSHA);
- National Fire Protection Association (NFPA);
- National Electrical Manufacturers Association (NEMA);
- Institute of Electrical and Electronic Engineers (IEEE);
- Applicable Electronic Industries Association (EIA) Standards for Interface and Intercommunication; and
- Underwriters Laboratories (UL).

9.22 Equipment Diagnostic and Self-Test Requirements
Diagnostic Firmware shall be imbedded in each tolling zone controller, sign controller, and toll transaction computer to be interactive with operation and to self-test at the time the equipment is powered on and/or the lane is opened.

Diagnostics shall operate automatically to detect malfunctions and failures and to report such failures to the MOMS system at the time of occurrence.

Diagnostic Software shall be provided in the lane controller and plaza computer to test and evaluate the operational condition of the entire system including communications.

On-line diagnostics shall be capable of being performed from the toll transaction computer, MOMS computer, and traffic management center.

Diagnostics callable from a remote location shall provide appropriate output to that remote location.

If inoperable, a message such as "OUT OF ORDER" shall be displayed.

10 Life, Reliability, and Availability
The toll collection system, with appropriate maintenance, shall be sized and designed for a ten-year usable life.

Each major part of the system shall meet or exceed specific Mean Time Between Failures and Mean Time To Repair criteria listed in Table 10 below.

Equipment MTBF and MTTR
Table 10

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Minimum Mean Time Between Failures</th>
<th>Maximum Mean Time To Repair</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tolling Zone Controllers</td>
<td>10,000 hours</td>
<td>1 hour</td>
</tr>
<tr>
<td>Sign Controllers</td>
<td>10,000 hours</td>
<td>1 hour</td>
</tr>
<tr>
<td>ETC Reader/Antenna</td>
<td>14,000 hours</td>
<td>1 hour</td>
</tr>
<tr>
<td>ETC Transponders (excluding battery)</td>
<td>50,000</td>
<td>N/A</td>
</tr>
<tr>
<td>Vehicle detection equipment</td>
<td>8000 hours</td>
<td>2 hours</td>
</tr>
<tr>
<td>Field Controller/TTC Local Area Network</td>
<td>18,000 hours</td>
<td>1 hour</td>
</tr>
<tr>
<td>TTC/MOMS Servers</td>
<td>8,000 hours</td>
<td>1 hour</td>
</tr>
<tr>
<td>All Standard Workstations</td>
<td>8,000 hours</td>
<td>1 hour</td>
</tr>
<tr>
<td>Wide Area Network Connections</td>
<td>18,000 hours</td>
<td>1 hour</td>
</tr>
</tbody>
</table>

MTTR is based on average repair times for typical system failures

11 Installation Plans and Documentation

The Contractor shall prepare:

- Standard Installation Plans for use with all field equipment;
- Shop drawings for installation-specific hardware, mounting attachments, supports, etc.;
- Site-specific plans showing supplemental and variant information for each plaza and specific settings, addresses, etc.; and
- Conduit Plans.

The Standard Installation Plan shall include technician’s installation instructions.

Once developed and approved, the standard installation plans and installation procedures shall become the tool used by Contractor technicians in the field necessary for:

- Site preparation;
- Hardware installation;
- Power connection;
- Data network connection including detailed standard wiring diagrams and pin settings;
• Equipment calibration; and
• Component testing during installation.

The Standard Installation Plan shall include the following:

• Standard Lane Plan - for each field equipment location type - showing typical construction requirements and equipment dimensions and offsets with respect to the gantry centerlines or other physical features, heights, clearances, distances of hardware from controlling features;
• Standard Lane Plan - for each field equipment location type - showing typical construction requirements and equipment dimensions and offsets with respect to the gantry centerlines or other physical features, heights, clearances, distances of hardware from controlling features;
• Standard Equipment Dimensions and Cabinet/ Housing / Mounting Requirements. These will show the standard installation dimensions and details, type, size and location of mounting hardware, provisions for calibration and adjustment, cabinet selection and equipment clearances within and around cabinets;
• Standard data and power termination requirements (location of housing penetrations, design/specification of gasketing and weatherproofing, support for cable jacks to ensure no weight on port pins, etc.);
• Standard Lane Equipment Connectivity Requirements - details and diagrams showing standard equipment settings and switch settings, ports to be connected, grounding locations and requirements; and
• Standard Schedule & Procedures to be followed during installation. This shall be based on the final DDD (Detailed Design Document) as approved by the Owner as well as this specification. It shall provide the standard procedures and sequences of activities for each site.

The installation plans shall include a tabulation of quantities relating pay items and Bill of Materials for the field location.

12 Security

12.1 Computer Access Security
Access to information shall be controlled in accordance with the user’s assigned role and its security level.

Application software shall be required to have a minimum of eight security levels.

These levels shall apply to the following application types:

• Operational Parameter Definition/Modification
• Display screens;
• Data entry windows on display screens;
• Reports;
• Report generators;
• Menu selections; and
• Interactive “button” commands.

Security levels shall range from the most inclusive to the least and the Engineer shall work with the Contractor to define the levels at the time of Detail Design Document development.

12.2 Physical Security
Access to all electronic cabinets of the system shall require keys. This requirement includes field controllers, routers/network interface cabinets, workstation housings, host server housings, etc.

13 Electrical Requirements
Electrical Power (unfiltered 120V 60 Hz line power) will be brought to each of the field locations and to the TTC location by the Owner.

The Contractor shall provide, install, and test all needed power protection devices required to ensure that the system is protected against power surges, brown-outs, ground faults, power outages of up to 10 minutes duration and any other power condition that would affect system operation.

The Contractor shall distribution of line and conditioned power to all field equipment from line power major locations.

UPS subsystems at the field locations shall send warning messages to the Tolling Zone Controllers and/or Sign Controllers and the TTC when UPS battery power is about to be exhausted and the controllers or the TTC shall shut down gracefully before UPS power is completely exhausted.

The UPSs shall supply sufficient power and time to allow safe, secure, regular shutdown of all system components, operations, and toll lanes such that no data is lost or altered due to the power failure.

At a minimum, ten (10) minutes of power for the key system processors shall be provided.

When generator power comes on line or utility power is restored, the toll collection system shall restart automatically.

The UPSs shall be self monitoring and shall provide operational signals, fully charged, charging, depleted, and system failure messages to the toll collection system.

As part of the power system and communication system, full lightning protection for all equipment shall be included at the device level.

Lightning protection at main power distribution location shall not be sufficient to fulfill this requirement.
14 Environmental Requirements
The toll collection equipment installed in the plaza areas will be exposed to the exterior environmental conditions prevailing at the various field sites.

The exterior equipment shall be designed, fabricated and environmentally tested for operation in the temperature range of –20 degrees C to 55 degrees C with a relative humidity of 15 to 95 percent, non-condensing.

The field equipment shall be suitably protected and designed to operate in conditions of rain, airborne dust, exhaust emissions and other contaminates found in the area.

The toll collection equipment, data cables, and the system power distribution wiring shall not be affected by the electrical noise conditions found in a highway area. These conditions include, but are not limited to, communications, RF radiation, CB radios, ignition noise, lighting fixture static, transients, and electrical interference.

The interior equipment to be installed in buildings shall be designed to operate in a range of 10 degrees C to 40 degrees C with a relative humidity of 10 to 95 percent, non-condensing. The equipment shall not be damaged when stored in a temperature range of 0 degrees C to 55 degrees C.

15 Capacity and Data Retention
All system capacities and data retention capabilities shall be sufficient to meet all operational requirements of this specification.

It may be possible that any part of the communications between the various system components may fail for periods of time. In case of failure, each system component shall be designed to run independently recording all necessary toll data for a specific time frame.

The field controllers shall be able to operate without communications to the TTC for a period of 14 days.

During such time, all toll transactions and violation images shall be saved on the field controller’s disk system for later transfer to the plaza computer when the communications link is re-initiated.

The TTC shall be able to operate without communications to the Account Management System for a period of 60 days.

During such time, all toll trips which the TTC would normally forward to the AMS shall be stored in the TTC.

When communications to the AMS are restored, data shall be automatically sent to the AMS.
The AMS shall be capable of performing all regular functions not requiring direct communications with the TTC in case of network failure as well as be able to report all data up until time of communications loss.

16 Time of Day/Date Control and Synchronization
All processing hardware, computer terminals, and any other device whose operation involves current date and time data for system functionality shall have automatic synchronization features such that all equipment time and date parameters are within necessary synchronization to provide full functionality of the system.

Synchronization shall be such that these shall be at most one second difference between the TTC and all other equipment.

Master clock functions shall be controlled by the TTC and the TTC shall obtain outside time synchronization from an official time source or internet time server.

System Date and Time functions shall automatically account for leap years and Automatic daylight savings features shall be built into the system Date and Time functions.

17 Toll System Maintenance Management System
As part of the system provided under this Contract, a Maintenance On-line Management System (MOMS) shall also be provided.

The MOMS shall serve the purpose and provide the functionality to allow for complete monitoring and control of the entire toll collection system as described herein.

The MOMS shall be the focal point for all toll system maintenance activities including routine preventative maintenance, corrective maintenance, real-time monitoring, repair calls, and report generation.

17.1 Maintenance On-line Management System Administration
The administration and management of the MOMS shall be at authorized network work stations, the CONTRACTOR’S field location and the Caltrans Traffic Management Center.

The MOMS shall be comprised of a separate server/CPU from the TTC or AMS computer.

The MOMS server shall be fully integrated with the TTC in order to accurately receive system status information on a real-time basis.

At a minimum, the MOMS shall be capable of providing the following information to its users:

- Current System Status (Level defined by user);
- Tolling Zone/Sign Location Operation Status;
• Failure and/or Malfunction Location;
• Failure and/or Malfunction Description (w/ priority level);
• Spare Inventory Quantity;
• Part/Equipment description (including part/serial no.) (if applicable);
• Record of last maintenance activity entered by maintenance staff;
• Record of last preventative and corrective maintenance activity as entered by maintenance staff;
• Historical system information/report generation; and
• Online Access to Maintenance condition of installed lanes equipment.

The MOMS shall be designed and developed in such a manner as to allow for stand-alone capability.

The MOMS shall be capable of operation regardless of the status of the TTC computer.

17.2 Failure/Malfunction Reporting
One of the primary purposes and functions of the MOMS is to automate the process of expediting repair/service calls to technicians.

The MOMS shall be designed with the ability to generate work orders with little or no human intervention.

The MOMS shall allow for the possibility of generating, at a minimum, five (5) different types of work orders.

The MOMS shall also provide for the capability to build ad-hoc work orders for unusual occurrences of maintenance activities.

In addition, a work order shall include, but not be limited to, the following information regardless of its format.

• Date/Time of Work Order Generation;
• Date/Time/Location of repair or maintenance call;
• Work Order Number (sequential); and
• Failure or Malfunction description.

The MOMS shall also provide the capability to generate blank work orders for repairs or malfunctions not directly reported by the MOMS.

Blank work orders shall still be generated for the sequential list maintained in MOMS.

The MOMS shall allow for the automatic paging of technicians once a work order has been generated.
17.3 Performance and Status Monitoring - Real-Time Display

As part of the MOMS, a performance monitoring application shall be provided which will, on a real-time basis, provide information regarding the status of all levels of toll system equipment and performance.

The performance monitoring function shall be developed in such a way as to allow the user to select and observe the status and/or performance of several predefined levels of the toll collection system.

The following is a breakdown of the various levels and, at a minimum, the degree of information required to be displayed for each level.

17.3.1 Field Components

- All equipment status
- Status of all lane applications
- Lane ID/Type
- Lane Location (Plaza, Lane No.)
- Current mode of operation (If applicable)
- Tolling Zone/Sign Location Operation Status

17.3.2 TTC Level

- Status of Field/TTC Communications Links
- Status of TTC applications

In addition to the varying levels of monitoring, the MOMS shall allow for the real-time overview of lane activity based on field controller selection from the user.

17.4 Remote Access/Dial-Up Networking

The MOMS shall be designed with the capability to allow technicians and/or other users to access the MOMS network from a remote location.

Technicians or maintenance staff will typically utilize this function while on-site or to log-in and close out a work order.

The dial-up access shall be designed to utilize simple dial-up connection tools typically found on any laptop computer.

Access shall be password protected to prevent unauthorized users from gaining access to the MOMS.

A single network password shall not be acceptable for dial-up users.

Each user shall be required to enter its own personal password when logging into the MOMS.
17.5 Inventory/Spare Parts Control

The MOMS shall have the capability of accessing the inventory and spare parts database in an automated form.

This function shall be integrated with the Work Order generation function, which will automatically update and maintain the system and spare parts inventory based on Work Orders and technician input during a work order closeout.
### Glossary of Terms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AMS</td>
<td>Accounts Management System – The system receiving completed trip detail from the toll system and applying it to the proper account holder.</td>
</tr>
<tr>
<td>ATMSi</td>
<td>Advanced Transportation Management System Version “i” – A traffic management system that manages various ITS devices.</td>
</tr>
<tr>
<td>BRTC</td>
<td>Bus Rapid Transit Center – Centers used for transferring local bus and commuter customers to direct service to downtown San Diego.</td>
</tr>
<tr>
<td>CDR</td>
<td>Critical Design Review – Final review of the DDD.</td>
</tr>
<tr>
<td>CHP</td>
<td>California Highway Patrol – The police agency responsible for enforcing toll policies on the managed lanes.</td>
</tr>
<tr>
<td>CMS</td>
<td>Changeable Message Sign – Signs that electronically display one of a number of predetermined messages.</td>
</tr>
<tr>
<td>CORBA</td>
<td>Common Object Request Broker Architecture – The software platform used to standardize ITS data.</td>
</tr>
<tr>
<td>CSC</td>
<td>Customer Service Center – The on-site center processing new customers and managing the toll system.</td>
</tr>
<tr>
<td>CSR</td>
<td>Customer Service Representative – An agent of the owner employed to assist customers of the toll system.</td>
</tr>
<tr>
<td>DDD</td>
<td>Detailed Design Document – Details of all aspects of the system to be provided to meet the requirements.</td>
</tr>
<tr>
<td>EFT</td>
<td>Electronic Funds Transfer – Transfer of funds from a patrons account to the owners account based on toll transactions.</td>
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<tr>
<td>EIA</td>
<td>Electronic Industries Association</td>
</tr>
<tr>
<td>ETC</td>
<td>Electronic Toll Collection – The use of transponders to collect tolls in the system.</td>
</tr>
<tr>
<td>GUI</td>
<td>Graphical User Interface – The interface used to allow operators to interact with a computer application.</td>
</tr>
<tr>
<td>HOV</td>
<td>High Occupancy Vehicle – A term used to identify vehicles on a roadway occupied by more than one person.</td>
</tr>
<tr>
<td>ICEA</td>
<td>Insulated Cable Engineers Association</td>
</tr>
<tr>
<td>IEEE</td>
<td>Institute of Electrical and Electronic Engineers</td>
</tr>
<tr>
<td>IMTMS</td>
<td>Intermodal Transportation Management System – A system integrating transportation systems in a region.</td>
</tr>
<tr>
<td>ITS</td>
<td>Intelligent Transportation System – A generic expression dealing with the management of traffic on a highway network through the use of traffic counters, cameras, variable message signs, etc.</td>
</tr>
<tr>
<td>LED</td>
<td>Light Emitting Diodes – The technology used in variable and changeable message signs.</td>
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<tr>
<td>LOS</td>
<td>Level of Service – The measure of traffic density on the managed lanes.</td>
</tr>
<tr>
<td>LPN</td>
<td>License Plate Number – The number on a license plate registered with an account holder.</td>
</tr>
<tr>
<td>ML</td>
<td>Managed Lanes</td>
</tr>
</tbody>
</table>
| MOMS    | Maintenance On-line Management System – A system that manages all the }
maintenance and inventory requirements of the ML system.

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
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<tbody>
<tr>
<td>NEC</td>
<td>National Electrical Code</td>
</tr>
<tr>
<td>NECA</td>
<td>National Electrical Contractors Association</td>
</tr>
<tr>
<td>NEMA</td>
<td>National Electrical Manufacturers Association</td>
</tr>
<tr>
<td>NFPA</td>
<td>National Fire Protection Association</td>
</tr>
<tr>
<td>OSHA</td>
<td>Occupational Safety and Health Act</td>
</tr>
<tr>
<td>PDA</td>
<td>Personal Digital Assistant – A hand-held processor used by police to communicate with the toll system and assist with identifying violators.</td>
</tr>
<tr>
<td>PDR</td>
<td>Preliminary Design Review – Preliminary review of the DDD.</td>
</tr>
<tr>
<td>PIN</td>
<td>Personal Identification Number – The number used, along with a user name, to identify an authorized user of a computer system.</td>
</tr>
<tr>
<td>RF</td>
<td>Radio Frequency – Describes the communication method between the toll system and the PDA units.</td>
</tr>
<tr>
<td>RLCS</td>
<td>Reversible Lane Control System – The system used to reverse the direction of traffic in a section of the managed lanes.</td>
</tr>
<tr>
<td>SANDAG</td>
<td>San Diego Association of Governments – Project owner.</td>
</tr>
<tr>
<td>TBD</td>
<td>To Be Determined</td>
</tr>
<tr>
<td>TD</td>
<td>Traffic Density – The number of vehicles per mile per lane on the managed lanes.</td>
</tr>
<tr>
<td>TDF</td>
<td>Traffic Density Function – The maximum down stream traffic density from a given tolling point.</td>
</tr>
<tr>
<td>TMC</td>
<td>Traffic Management Center – The center managing traffic conditions on all highways in the San Diego area.</td>
</tr>
<tr>
<td>TTC</td>
<td>Toll Transaction Computer – The computer system gathering transaction data from the lanes and composing customer trips.</td>
</tr>
<tr>
<td>UL</td>
<td>Underwriters Laboratories</td>
</tr>
<tr>
<td>VMS</td>
<td>Variable Message Sign – Signs used to display rates and information on the managed lanes.</td>
</tr>
</tbody>
</table>