

# Interstate 80 Integrated Corridor Mobility Project

Request For Proposal

**Draft For Industry Review**

Volume II – Functional Requirements

Software Development and System Integration (SI) services



**Issued By:**

**Alameda County Congestion Management Agency**

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January 8, 2010

**Document Description**

Client	ACCMA
DKS Project / Proposal Number	07239-001
Project / Proposal Name	I-80 Integrated Corridor Mobility Project
Related Task / WBS Number	WBS 5.8
Document Name	Volume II – Functional Requirements Software Development and System Integration (SI) services
File Path	p:\p\07\07239-001 i-80 icm project phase 2\05 - functional requirements\04 - rfp & system specification\rfp vol two v3-0.docx
Date Document Issued	January 8, 2010

**Version Control**

Version Number	Date	Description of Change	Author
1-0	7/30/09	Released as Draft to Client	TJF
2-0	12/1/09	Released to updated draft to client	TJF
3-0	1/8/2010	Released to Clint for Industry Review	TJF

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# **1 I-80 ICM MANAGEMENT APPLICATION**

## **1.1 Functional Requirements**

### **1.1.1 System Operation**

#### **System Interfaces**

1. I-80 ICM Management Application shall be provided with realtime vehicle data from I-80 that includes:
  - a. Location (milepost marker)
  - b. Date (MM DD YYYY)
  - c. Day of Week
  - d. Time (HH:MM:SS 24 HR)
  - e. Average Operating Speed (mph)
  - f. Volume (number of vehicles)
  - g. Density (number of vehicles per time period per lane)
2. I-80 ICM Management Application shall comply with Caltrans District 4 protocol of 30 second data collection periods.
3. I-80 ICM Management Application shall obtain data from the comparative travel time system for publishing on the VMS predicted travel time for multiple modes of travel, including private vehicle, bus, rail, ferry.
4. I-80 ICM Management Application shall obtain data from the parking information system for publishing on the VMS current parking availability at specified parking stations.
5. I-80 ICM Management Application shall obtain data from the commercial vehicle information system for publishing on the VMS.
6. I-80 ICM Management Application shall obtain data from the vehicle travel time system for publishing predicted travel times on the VMS.
7. I-80 ICM Management Application shall obtain real-time ferry information for the ferry terminals at Berkeley, Hercules, and Richmond.

#### **Algorithms**

##### **Congestion Detection**

1. The congestion detection system shall determine if there is an obstruction on the freeway roadway within 1 minute.
2. The congestion detection system shall determine if a vehicle is traveling in the wrong direction along the freeway roadway within 1 minute.
3. The congestion detection system shall identify the presence of stationary or slow moving vehicles within 1 minute.

4. The congestion detection system shall determine the presence of a freeway incident based on realtime vehicle detection data within 1 minute of the date being received.
5. The congestion detection system shall ignore closed lanes when detecting events on the freeway.
6. The congestion detection system shall ignore detected events that have been scheduled in the congestion detection system scheduled activities log.
7. The congestion detection system shall detect incidents and abnormal traffic conditions through pattern recognition or other mechanisms.

#### ***Variable Speed Limit Algorithm***

1. VSL algorithm shall calculate speed limits based on realtime vehicle detection data.
2. VSL calculation shall gradually reduce vehicle speeds upstream of the back of a queue.
3. VSL calculation shall recommend the speed limit appropriate for each VSL sign.
4. VSL calculation shall have a parameter to adjust the bias for the VSL between long distance freeway users and local freeway users.
5. VSL calculation for a freeway segment shall be based on detection obtained from a user specified group of vehicle detection stations.
6. VSL calculated speed limit shall comply with Caltrans speed limit standards.
7. VSL calculations shall account for current lane assignments.
8. VSL calculation shall be based on freeway speed.
9. VSL calculation shall be based on freeway occupancy level.
10. VSL calculation shall be based on freeway volume.
11. VSL calculation shall gradually reduce vehicle speeds upstream of a bottleneck or incident.

#### ***Adaptive Ramp Metering Algorithm***

1. System Integrator shall use either the Hero, Stratified Zone or Fuzzy Logic adaptive ramp metering algorithm to calculate the ramp metering rate at each ramp meter.
2. Authorized User shall be able to specify which vehicle detectors to use to determine ramp meter rates.
3. Ramp metering rate shall be based on desired level bias between reducing volume of vehicles traveling on the freeway mainline versus volume of vehicles entering freeway from freeway onramp.
4. Ramp metering rate at an on ramp shall increase as the on ramp queue approaches end of storage area within two seconds of the ramp queue being detected approaching the end of the storage area..
5. ARM algorithm shall be capable of operating adaptively when connectivity to some field devices is lost.
6. Ramp metering rate shall be based on freeway lane assignments.

7. Ramp metering rate shall be based on freeway speed.
8. Ramp metering rate shall be based on freeway occupancy level.
9. Ramp metering rate shall be based on freeway volume.
10. Ramp metering rate shall be based on time of day and day of week.
11. Ramp metering rate shall be based on the ramp queue length.

## **Rules and Schedules**

### ***Applies to all systems***

1. Authorized users shall be able to configure any of the systems to require the approval from an authorized user before instructing a field device to perform an action.
2. Authorized users shall be able to configure any of the systems to instruct a field device to perform an action, without requiring an authorized user to approve the action.
3. Authorized users shall be able to schedule instructions to field devices, based on Time-of-Day and Day-of-Week.
4. Authorized users shall be able to specify the minimum time that may elapse between successive changes to a field devices settings.
5. Authorized users shall be able to specify the data detection interval that is appropriate for use by the management application.
6. Authorized users shall be able to specify the time interval between successive Action Plan calculations.
7. Authorized users shall be able to select symbols to publish on a LUS, via a list available on the Graphical User Interface.

### ***VSL***

1. Authorized users shall be able to specify each VSL freeway segment length.
2. Authorized users shall be able to specify each VSL freeway segment starting point.
3. Authorized users shall be able to specify each mainline vehicle detection station that map to a VSL sign station.
4. Authorized users shall be able to specify each Freeway onramp and offramps included in a VSL freeway segment.
5. Authorized users shall be able to specify which speed limit values are permitted to be displayed.
6. Authorized users shall be able to specify the minimum distance between successive speed limit reductions.
7. Authorized users shall be able to specify the maximum speed reduction that can occur on a sign in a single event.
8. Authorized users shall be able to specify the maximum speed reduction that can occur between adjacent VSL sign.

9. Authorized users shall be able to specify the minimum distance between locations where the speed limit is increased.
10. Authorized users shall be able to specify the maximum speed increase that can occur on a sign in a single event.
11. Authorized users shall be able to specify the maximum speed increase that can occur between adjacent VSL sign

#### **ARM**

1. Authorized users shall be able to specify the maximum allowable ramp metering rate.
2. Authorized users shall be able to specify the minimum allowable ramp metering rate.
3. Authorized users shall be able to define the freeway congestion level that activate the signals.
4. Authorized users shall be able to define the freeway congestion level that deactivate the signals.

#### **Lane Use System**

1. Authorized users shall be able to specify a lane use configuration for an event.

#### **Variable Message Sign System**

1. Authorized users shall be able to publish a message to the VMS from a library of approved messages.

#### **Highway Advisory Radio**

1. Authorized users shall be able to define a list of approved messages that may be used by the Action Plan.

#### **Traffic Control System**

1. Authorized users shall be able to specify a signal timing flush plan for each incident route.

#### **Trailblazer System**

1. Authorized users shall be able to define a trailblazer operation plan for an incident event.
2. Authorized users shall be able to define the minimum time interval between trailblazer sign modification.

#### **Traffic Surveillance System**

1. Authorized users shall have restricted access to control CCTV camera's owned by other agencies.
2. Authorized users shall have unrestricted access to its own CCTV camera's.
3. Authorized users shall have a user level that can override control from any other user level.

#### **Congestion Detection**

1. Authorized users shall be able to define incident routes.
2. Authorized user shall be able to select an incident route.

3. Incident categories shall be user defined
4. The system shall have multiple diversion routes along the corridor to choose from, so that impact on the local arterial is minimized.
5. The trailblazer system shall suggest the appropriate incident route to the authorized user based on the input of the congestion detection system.
6. Incident categories shall be used to trigger incident action plans.
7. The congestion detection system shall require an authorized user to confirm that an incident has occurred. The congestion detection system will request confirmation from the authorized user. The authorized user will state Yes or No.
8. Confirmed incidents shall be categorized by the authorized users at the time of confirming incidents.
9. Authorized users shall be able to define the prioritization of vehicles that are on the freeway verses the vehicles that are entering the freeway.

#### **Action Plan**

1. The I-80 ICM Management Application shall analyze the current traffic conditions, the calculation of the congestion algorithm, the calculation of the variable speed limit algorithm and the adaptive ramp metering algorithm and the Authorized User defined rules and schedules, then define the operational settings for the:
  - a. VSL to display a specific speed
  - b. ARM to operate with a specific metering rate
  - c. LUS to display a specific lane use signal pattern
  - d. VMS to display a specific message
  - e. SMS to display a specific message
  - f. HAR to broadcast a specific message
  - g. Traffic Control System to operate a specific timing plan
  - h. Trailblazer Sign System to display a specific message
  - i. CCTV camera to move to a specific setting.
2. The operational setting will be selected from a list of approved actions for the existing conditions.
3. Authorized users shall be able to override the system recommended actions and instruct a field device to perform an alternate action.

#### **Sub System Control**

1. The I-80 ICM Management Application shall instruct each of the following subsystems to modify its operation based on the selected Action Plan:
  - a. VSL to display a specific speed
  - b. ARM to operate with a specific metering rate

- c. LUS to display a specific lane use signal pattern
  - d. VMS to display a specific message
  - e. SMS to display a specific message
  - f. HAR to broadcast a specific message
  - g. Traffic Control System to operate a specific timing plan
  - h. Trailblazer Sign System to display a specific message.
  - i. CCTV camera to move to a specific setting.
2. The I-80 ICM Management Application shall have the capability to require Authorized user approval of the Action Plan prior to sending instructions to each sub system.

### **Failure Settings**

1. Authorized users shall be able to define the time period between communications outage and:
  - a. The trailblazer sign going dark.
  - b. The HAR stopping broadcasting.
  - c. The VSL going dark.
  - d. The LUS going dark.
  - e. The VMS going dark.
  - f. The SMS going dark.
2. Authorized users shall be able to define the time period between communications restoration and the resumption of:
  - a. Trailblazer sign operation.
  - b. HAR operation.
  - c. VSL operation.
  - d. LUS operation.
  - e. VMS operation.
  - f. SMS operation.

### **1.1.2 System User Requirements**

#### **Graphical User Interface**

1. Operators shall be able to set signs and signals using user friendly methods which provide guidance and prompt the operator as well as ensuring that the operator does not set signs or signals erroneously.
2. I-80 ICM Management Application shall be accessible via Caltrans Delcan Application.
3. I-80 ICM Management Application shall aggregate the control and management of all I-80 ICM systems into a single user interface.

4. I-80 ICM Management Application shall be able to control all I-80 ICM systems.
5. The system shall include as a minimum prompting and guidance techniques to assist operators to use the system safely.
6. The I-80 ICM Management Application shall be capable safely and efficiently without any user interaction.
7. Via the I-80 Management Application, an authorized user shall be able to specify how the sub system will react in the event of lost connectivity between the field device and the I-80 ICM Management Application.
8. Via the I-80 ICM Management Application, an authorized user shall be able to specify the operational settings for a specific field device or group of field devices.

#### **System Functions for Administration**

1. The I-80 ICM Management Application shall allow the user to carry out all necessary administration functions effectively, efficiently and without danger of corrupting or willfully changing records within the system.
2. The I-80 ICM Management Application administrative functions for printing and reporting shall include but not be limited to producing a wide range of reports for operational purposes and other system anomalies including system and equipment failures.
3. The I-80 ICM Management Application administrative functions for printing and reporting shall include but not be limited to producing standard sets of reports at particular times of year as batch print outs, e.g., monthly report, quarterly report, yearly report. It shall be possible to predefine these reports in a template format and then print them for date ranges at the appropriate time. Batches, which have been defined, shall be able to be named and called up by the system administrator. It shall be possible for the system administrator to change the content of each batch and to define and name new batches.
4. The I-80 ICM Management Application administrative functions shall include registration of staff on the system and production / modification of authentication passwords.
5. The I-80 ICM Management Application administrative functions shall include definition of users and levels of access and limitations to functions in different parts of the system.
6. The I-80 ICM Management Application administrative functions shall include system housekeeping functions including archive and backup, database optimization, etc.

#### **Reporting**

1. System shall provide standard reports for managing the system effectively and efficiently.
2. The system shall be able to report on all logged system data.
3. Software shall be able to generate reports, derived from the archived records and system data collected through the life of the project.
4. The system shall allow the reports to be generated from the data, using predetermined and/or adjustable time periods.

5. The system shall allow for raw data to be exported to other analysis programs, such as Microsoft Excel.
6. System shall provide the ability for the user to generate a report based on user defined requirements.
7. Authorized users shall be able to view logs and reports.
8. Authorized users shall be able to print logs, reports and screen displays.
9. System shall generate reports based on current real time activity.
10. System shall generate reports based on logged data.
11. All log data shall be capable of being reported.
12. System shall allow authorized user to specify date range for a report.

### **Logging**

1. The I-80 ICM Management Application logged events shall be time-stamped.
2. The I-80 ICM Management Application shall log all field device errors and faults.
3. The I-80 ICM Management Application shall log all system and subsystem faults.
4. The I-80 ICM Management Application shall log all communications outages and restorations.
5. The I-80 ICM Management Application shall log all unauthorized access attempts.
6. The I-80 ICM Management Application shall log each system and subsystem action.
7. The I-80 ICM Management Application shall log and archive the speed/volume and occupancy level for each vehicle detector in the corridor.

### **Alerts**

1. The I-80 ICM Management Application shall be capable of alerting designated users or group of users within one minute of any logged event being recorded.
2. The I-80 ICM Management Application shall be capable of filtering logged events so that only events that meet a user defined criteria trigger an alert.
3. The I-80 ICM Management Application shall be capable of storing multiple stored queries, each of which can generate an alert to a designated user or group of users.
4. The I-80 ICM Management Application shall be capable of assigning different users or groups of users for each stored alert query.
5. The I-80 ICM Management Application shall be capable of sending alerts by SMS.
6. The I-80 ICM Management Application shall be capable of sending alerts by pager.
7. The I-80 ICM Management Application shall be capable of sending alerts by email.

### **Control, Configuration and Troubleshooting**

1. The I-80 ICM Management Application shall provide remote functions and facilities that enable remote control, configuration and troubleshooting of the field devices.

2. The I-80 ICM Management Application shall monitor and report the operational status of all roadside devices and elements of the system.

### **Backup strategy**

1. Log file backup intervals shall be user defined.
2. The system shall carry out functions to permit its day to day operation including housekeeping such as routine backups.

### **Performance monitoring**

1. The system shall carry out functions, including self checking and fault reporting, to assist with maintaining fault free operation.

## **1.2 Performance Requirements**

### **1.2.1 Congestion Detection System**

1. The Traffic Monitoring subsystem shall centrally detect incidents using centrally operated algorithms such that the congestion detection alarm is cleared within five seconds of the trigger event clearing.
2. The system integrator shall employ expert advice and resources to set up the system for congestion detection such that it achieves the performance requirements by the contract completion date for this contract and will provide support on site as necessary during the warranty period for any necessary development or tuning of the system.
3. The Traffic Monitoring subsystem shall centrally detect incidents using centrally operated algorithms that have a false alarm rate of less than two percent.
4. The Traffic Monitoring subsystem shall centrally detect incidents using centrally operated algorithms that have a detection rate of better than 95 percent.
5. The Traffic Monitoring subsystem shall centrally detect incidents using centrally operated algorithms such that the location of an incident is identified with a measurement error better than plus or minus five percent.
6. The Traffic Monitoring subsystem shall receive congestion detection alarms from the outstations and present them to operators and other subsystems within one second of their transmission by the outstation.
7. Local congestion detection algorithms shall detect stationary or slow moving vehicles within two seconds of the trigger event occurring on the freeway (i.e., the presence of stationary or slow moving vehicles being in the detection zone of the outstation).
8. Local congestion detection algorithms shall clear a congestion detection alarm within five seconds of the trigger event clearing.
9. Local congestion detection algorithms shall have a false alarm rate of less than two percent.
10. Local congestion detection algorithms shall have a detection rate of better than 95 percent.
11. Traffic monitoring devices shall detect the presence of objects (including disabled vehicles) in the freeway travel lanes within 2 minutes of the event.

12. Traffic monitoring devices used to detect the presence of stationary vehicles or other objects in the freeway travel lanes shall report a change in detection status within 10 seconds of the event.
13. Traffic monitoring devices used to detect the presence of stationary vehicles or other objects shall have an accuracy rate of at least 98%.

#### **1.2.2 Variable Speed Limit System**

1. VSL shall be recalculated for the entire corridor within 5 seconds after the boundaries of a single freeway segment are altered.
2. VSL sign system shall recalculate the VSL within the corridor within 5 seconds after a user changes a VSL sign display.
3. VSL calculation shall improve the average corridor travel time by 2 percent.
4. VSL sign application shall adjust speed limit assignments within 5 seconds after a change in freeway traffic conditions are received.
5. VSL sign control application shall transmit a speed limit assignment within one-half second of an operator issuing the command.

#### **1.2.3 Adaptive Ramp Metering System**

1. Ramp metering rate calculation shall improve the average corridor travel time by 2 percent.
2. Ramp metering rate calculation shall reduce speed variations across the corridor.
3. Ramp metering rate calculation shall gradually reduce vehicle speeds upstream of a bottleneck or incident.
4. Ramp metering rate calculation shall reduce instances of sudden vehicle deceleration.
5. Ramp metering rate calculation shall improve the average corridor travel time.
6. Ramp metering rate calculation shall improve the travel time reliability.

#### **1.2.4 Lane Use Signal System**

1. The Lane Use Signal subsystem shall set signals within two seconds of confirmation by the operator or automatic setting.
2. The Lane Use Signal subsystem shall show the new status of the sign within one second of it changing on the road.

#### **1.2.5 Changeable Message Sign System**

1. The Changeable Message Sign system shall set signs within two seconds of confirmation by an operator or automatic setting.
2. The Changeable Message Sign system shall show the new status of a sign within one second of it changing on the road.
3. The CMS control application shall transmit a message within one-half second of an operator issuing the command.

4. The CMS control application shall display CMS status and fault information within 2 seconds after receipt.

#### **1.2.6 Traffic Monitoring System**

1. The Traffic Monitoring subsystem shall collect real time data from detector stations such that it is available at the TMC within two seconds.

#### **1.2.7 Traffic Surveillance System**

1. The CCTV system shall enable selection of cameras such that images are presented to operators within 0.5 seconds of their selection.
2. The CCTV system shall enable instantaneous switching of images between monitors.

#### **1.2.8 Trailblazer Sign System**

1. The trailblazer sign shall be updated within 10 seconds after a command is issued from the I-80 ICM Management Application.

#### **1.2.9 Highway Advisory Radio System**

1. The performance of the HAR field devices shall meet or exceed the performance of the existing HAR field devices deployed elsewhere within Caltrans District 4.

#### **1.2.10 Emergency Vehicle Preemption System**

1. No performance requirements specified.

#### **1.2.11 Transit Signal Priority System**

1. No performance requirements specified.

#### **1.2.12 Traffic Control System**

1. No performance requirements specified.

#### **1.2.13 Vehicle Location System**

1. No performance requirements specified.

#### **1.2.14 Personalized 511**

1. No performance requirements specified.

#### **1.2.15 Parking Information System**

1. No performance requirements specified.

#### **1.2.16 Travel Time System**

1. No performance requirements specified.

#### **1.2.17 Comparative Travel Time System**

1. No performance requirements specified.

### **1.3 Security Requirements**

1. Access to the I-80 ICM Management Application shall be restricted to just authorized users.
2. The I-80 ICM Management Application shall have at least three access levels - Administrator, Caltrans User, and Local Agency User.
3. The I-80 ICM Management Application shall be hosted at the Caltrans District 4 TMC data room.
4. Access to the I-80 ICM Management Application shall be physically secured.

### **1.4 Scalability Requirements**

1. The I-80 ICM Management Application shall be designs such that it can accommodate an increase in geographic size of the corridor, by a factor of three, without a significant modification to the system design.
2. The I-80 ICM Management Application shall be capable of accommodating three times more field elements without a significant redesign.
3. I-80 ICM Management Application shall be capable of accommodating new subsystems without a significant modification to the system design.

### **1.5 Compliance Requirements**

1. I-80 ICM Management Application shall comply with the selected regional and national ITS standards.
2. I-80 ICM Management Application shall communicate with field elements via a communications network utilizing the NTCIP standard sets or TCP/IP communications protocols.

### **1.6 Reliability and Availability Requirements**

1. I-80 ICM Management Application shall have a Mean Time Between Failure of three years.

### **1.7 Disaster Recovery and Business Continuity Planning Requirements**

1. I-80 ICM Management Application shall be integrated into the current Caltrans D4 TMC Disaster Recovery Plan and Business Continuity Plan.

### **1.8 Maintainability Requirements**

1. The system integrator shall not impose any license or rights restrictions on the I-80 ICM Management Application.

### **1.9 Spares and Consumable Requirements**

1. No requirements specified

## **1.10 Location Requirements**

1. I-80 ICM Management Application shall be located at the Caltrans District 4 TMC.

## **2 TRAFFIC CONTROL SYSTEM**

### **2.1 Functional Requirement**

#### **2.1.1 Field Equipment**

1. Shall integrate with the TSP system at intersections where TSP system is specified.
2. Shall use model 2070 or model 170 controllers.
3. Shall upgrade the signal controllers for Berkeley and Richmond to 2070L controllers.
4. Existing controllers within WestCAT service area, the project limits, and in cities other than Oakland, Berkeley and Richmond, will be upgraded to Type 170E controllers.

#### **2.1.2 Agency TMC Equipment**

1. Shall upgrade the Agency TMC's as per the following table.

Agency	Primary TMC Upgrades	Secondary TMC Upgrades
Caltrans	New Signal System Upgrade (TBD)	None
AC Transit	None	None
Contra Costa County	QuicNet Upgrade	None
City of Albany	New QuicNet	None
City of Berkeley	Flat panel display QuicNet Upgrade	A flat panel display (assuming accessing data through a password-enabled Internet portal)
City of El Cerrito	Computer hardware Flat panel screen for video monitoring New QuicNet	Flat-panel screen for video monitoring (assuming accessing data through Internet or server at City Hall if possible)
City of Emeryville	Data Monitoring System	None
City of Hercules	New QuicNet	None
City of Pinole	New QuicNet	None
City of Richmond	QuicNet Upgrade	Police Department: One flat panel display which will continuously show the traffic camera views. Corp Yard One computer monitor which will continuously show the traffic camera views. (Limited access to Richmond's QuicNet data at this location)
City of Oakland	Web Access Only (Existing TMC and Signal System Upgrade TBD by City directly)	None
City of San Pablo	QuicNet Upgrade	Two computer monitors which will continuously show the traffic cameras.

2. Each agency Traffic Control System shall be able to be controlled, for the purpose of implementing a timing plan, by the I-80 ICM Management Application.
3. Shall run stored coordination plans suitable to accommodate predefined traffic condition scenarios.
4. Shall Run stored coordination plans suitable to accommodate predefined incident condition scenarios.
5. Traffic Control System shall be able run an appropriate stored traffic plan based on current traffic conditions.
6. The Traffic Control System shall be able to receive commands from the I-80 ICM Management Application to implement a flush plan along an incident route.
7. Shall permit the city to control the city owned trailblazer signals.
8. Shall permit the I-80 ICM Management Application to operate the city owned trailblazers signs.
9. Shall permit the city to override the I-80 ICM Management Application operation of the city owned trailblazer signs.

## **3 ADAPTIVE RAMP METERING**

### **3.1 Functional Requirements**

1. ARM signals shall use the metering rate specified by the ARM central application.
2. ARM signals shall use the local vehicle detectors to determine the ramp meter conditions.
3. Each ARM controller shall be capable of reporting operational status to the I-80 ICM Management Application.
4. Each field device shall transmit data in a format suitable for use by I-80 ICM Management Application.
5. Ramp meters shall operate in a local adaptive mode when connectivity to the I-80 ICM Management Application is terminated.
6. Each ARM controller shall have a unique IP address.
7. The ramp meter shall use either a Model 170 controller or a Model 2070 controller as the ramp meter controller.
8. ARM system shall report status and fault information to the I-80 ICM Management Application within 2 seconds of a request being made.
9. Authorized user shall be able to configure the frequency of ARM controller transmissions.
10. The ARM controller shall provide functions and facilities that enable remote control, configuration and troubleshooting of the field devices.
11. Systems shall provide functions and facilities that enable local control, configuration and troubleshooting of the field devices.
12. ARM controller shall transmit data in a format suitable for use by I-80 ICM Management Application.
13. ARM system shall be capable of operating safely and efficiently without user input.

### **3.2 Security Requirements**

1. ARM controllers shall be secured against unauthorized network access.
2. The ARM system shall be secure against intrusion and interference from any unauthorized source outside the system architecture.

### **3.3 Scalability Requirements**

1. The ARM system shall be designed to accommodate an geographic increase in size of the corridor, by a factor of three, without a significant modification to the system design.
2. The system shall be capable of accommodating three times more ARM sites without a significant modification to the system design.

### **3.4 Compliance Requirements**

1. All ARM components shall meet Caltrans/MUTCD requirements.

2. All firmware shall support applicable NTCIP communications protocol standards.
3. The ARM system shall comply with the selected regional and national ITS standards.

### **3.5 Reliability and Availability Requirements**

1. The Mean Time Between Failure shall be three years for the ARM system.

### **3.6 Maintainability Requirements**

1. The system integrator shall not impose any license or rights restrictions on the ARM system.
2. Maintenance staff shall have system access to make all required system configuration changes.
3. Maintenance staff shall be able to carry out diagnostic functions to assist in determining the type, nature and location of faults and identify what modules within roadside devices shall require replacement or repair without having to visit the roadside to carry out such diagnostics.
4. Maintenance staff shall be able to view detailed internal information about the performance of the system and all roadside devices.

## **4 LANE USE SIGNAL**

### **4.1 Functional Requirements**

1. LUS shall be individually controlled by the I-80 ICM Management Application and display a message within two seconds of receiving the message command.
2. LUS shall adjust sign illumination intensity to suit ambient lighting conditions within two seconds.
3. All LUS on a given overhead sign structure shall have a consistent level of illumination.
4. LUS shall detect display faults and attempt to mitigate them by adjusting the display characteristics within two seconds.
5. If power to a LUS fails, the LUS shall go dark.
6. In the event communications are lost between the LUS and the I-80 ICM Management Application for greater than a specified time, the LUS sign shall go dark.
7. If communications between the LUS and the I-80 ICM Management Application is restored, the LUS shall remain dark until communications have been established for a specified time period.
8. LUS shall use either a Model 170 controller or a Model 2070 controller as the signal controller.
9. Each controller shall have a unique IP address.
10. LUS Sign data to be continuously logged shall be:
  - a. Beginning of lane closure (milepost and lane)
  - b. End of lane closure (milepost and lane)
  - c. Event that caused lane closure (operator input)
  - d. Date of LUS sign change (MM DD YYYY)
  - e. Day of week of LUS sign change
  - f. Time of LUS sign change (HH:MM:SS 24 HR)
  - g. Who modified LUS (automatic, Operator)
11. LUS system shall log when a message cannot be displayed.
12. LUS system shall log when a symbol is displayed with errors.
13. LUS system shall report status and fault information to the I-80 ICM Management Application within two seconds of the request being made by the I-80 ICM Management Application..
14. Authorized user shall be able to configure the frequency of LUS controller transmissions.
15. Authorized users shall be able to specify the time between communications outage and the LUS going dark.

16. Authorized users shall be able to specify the time between communications restoration and the resumption of LUS display.

#### **4.2 Security Requirements**

1. LUS controllers shall be secured against unauthorized network access.
2. The LUS system shall be secure against intrusion and interference from any unauthorized source outside the system architecture.

#### **4.3 Scalability Requirements**

1. LUS system shall be designed to accommodate an increase in geographic size of the corridor, by a factor of three, without a significant modification to the system design.
2. LUS system shall be capable of accommodating three times more field elements without a significant modification to the system design.

#### **4.4 Compliance Requirements**

1. LUS shall be a type approved by Caltrans and/or CCTCD, as appropriate.
2. LUS displays shall meet Caltrans/MUTCD requirements.
3. All firmware shall support applicable NTCIP communications protocol standards.
4. LUS system shall comply with the selected regional and national ITS standards.

#### **4.5 Maintainability Requirements**

1. LUS roadside equipment shall be able to be procured from independent and competitive sources.
2. The system integrator shall not impose any license or rights restrictions on the LUS system.
3. Maintenance staff shall be able to make all required system configuration changes.
4. Maintenance staff shall be able to carry out diagnostic functions to assist in determining the type, nature and location of faults and identify what modules within roadside devices shall require replacement or repair without having to visit the roadside to carry out such diagnostics.
5. Maintenance staff shall be able to view detailed internal information about the performance of the system and all roadside devices.

## **5 VARIABLE SPEED LIMIT SIGN**

### **5.1 Functional Requirements**

1. VSL sign shall be controlled by the VSL central application and display a message within two seconds of receiving the message command.
2. VSL sign shall detect display faults and attempt to mitigate them by adjusting the display characteristics within two seconds.
3. VSL shall adjust sign illumination intensity to suit ambient lighting conditions within two seconds.
4. VSL system shall be capable of operating safely and efficiently without user input.
5. In the event communications are lost between the VSL sign and the I-80 ICM Management Application for greater than a specified time, the VSL sign shall go dark.
6. In the event of restored communications between the VSL sign and the I-80 ICM Management Application, the VSL sign shall remain dark until communications have been established for a specified time period.
7. In the event that power to a VSL sign fails, the VSL sign shall go dark.
8. Each controller shall have a unique IP address.
9. VSL sign shall use either a Model 170 controller or a Model 2070 controller as the sign controller.
10. Data to be continuously logged shall be:
  - a. posted speed (mph, per zone)
  - b. speed limit recommended by the system (mph, per zone)
  - c. speed limit change (including date and time, per zone)
11. VSL controller shall transmit data in a format suitable for use by I-80 ICM Management Application.
12. Authorized user shall be able to configure the frequency of VSL controller transmissions.
13. Authorized users shall be able to specify the time between communications outage and the VSL sign going dark.
14. Authorized users shall be able to specify the time between communications restoration and the resumption of speed limit display.

### **5.2 Scalability Requirements**

1. The VSL system shall be designed to accommodate an increase in geographic size of the corridor, by a factor of three, without a significant modification to the system design.
2. The system shall be capable of accommodating three times more VSL sites without a significant modification to the system design.

### **5.3 Compliance Requirements**

1. All VSL signs shall meet Caltrans/MUTCD requirements.
2. All firmware shall support applicable NTCIP communications protocol standards.
3. The VSL system shall comply with the selected regional and national ITS standards.

### **5.4 Reliability and Availability Requirements**

1. The Mean Time Between Failure shall be at least three years for the VSL sign.

### **5.5 Maintainability Requirements**

1. The system integrator shall not impose any license or rights restrictions on the VSL system that preclude maintenance operations.
2. Maintenance staff shall have system access to make all required VSL system configuration changes.
3. Maintenance staff shall be able to carry out diagnostic functions on the VSL system to assist in determining the type, nature and location of faults and identify what modules within roadside devices shall require replacement or repair without having to visit the roadside to carry out such diagnostics.
4. Maintenance staff shall be able to view detailed internal information about the performance of the VSL system and all roadside devices.

## **6 STATUS MAP SIGN AND VARIABLE MESSAGE SIGN**

### **6.1 Functional Requirements**

1. VMS and Status Map Signs shall be individually controlled and display a message within two seconds of receiving a message command.
2. VMS and Status Map Signs shall be capable of reporting to the I-80 ICM Management Application what is being displayed on the sign by interrogating the VMS or Status Map Sign pixels.
3. VMS and Status Map Signs shall detect faults when displaying messages and attempt to mitigate them by adjusting the display characteristics within two seconds.
4. VMS and Status Map Signs shall monitor the light output of the sign and modify it automatically to suit ambient lighting conditions locally within two seconds.
5. VMS and Status Map Signs shall be capable of displaying the image or message specified by the I-80 ICM Management Application.
6. VMS and Status Map Signs shall have a hierarchical list of stored messages that can be displayed.
7. In the event communications are lost between a VMS or Status Map Sign and I-80 ICM Management Application, the VMS shall continue to display the most recent message received from the central control application.
8. In the event communications are lost between a VMS or Status Map Sign and I-80 ICM Management Application for greater than a specified time, the VMS shall go dark.
9. In the event communications are lost between a VMS or Status Map Sign and I-80 ICM Management Application, the VMS or Status Map Sign shall remain dark until communications have been established for a specified time period.
10. VMS and Status Map Sign system shall report status and fault information to the I-80 ICM Management Application within two seconds..
11. Authorized user shall be able to configure the frequency of VMS and Status Map Sign controller transmissions.
12. The VMS and Status Map Sign controller shall provide functions and facilities that enable remote control, configuration and troubleshooting of the field devices.
13. The VMS and Status Map Sign systems shall provide functions and facilities that enable local control, configuration and troubleshooting of the field devices.
14. VMS and Status Map Sign controller shall transmit data in a format suitable for use by I-80 ICM Management Application.
15. VMS and Status Map Sign system shall be capable of operating safely and efficiently without user input.

## **6.2 Security Requirements**

1. VMS and Status Map Sign controllers shall be secured against unauthorized network access.
2. The VMS and Status Map Sign system shall be secure against intrusion and interference from any unauthorized source outside the system architecture.

## **6.3 Reliability and Availability Requirements**

1. The Mean Time Between Failure shall be three years for the VMS and Status Map Sign system.

## **6.4 Maintainability Requirements**

5. The system integrator shall not impose any license or rights restrictions on the VMS and Status Map Sign system that preclude maintenance operations.
6. Maintenance staff shall have system access to make all required VMS and Status Map Sign system configuration changes.
7. Maintenance staff shall be able to carry out diagnostic functions on the VMS and Status Map Sign system to assist in determining the type, nature and location of faults and identify what modules within roadside devices shall require replacement or repair without having to visit the roadside to carry out such diagnostics.
8. Maintenance staff shall be able to view detailed internal information about the performance of the VMS and Status Map Sign system and all roadside devices.



## **7 HIGHWAY ADVISORY RADIO**

1. HAR system shall permit the I-80 ICM Management Application to select, activate and deactivate a broadcast message within two seconds of receiving the command.
2. The new HAR devices shall integrate with the existing HAR system operating in the corridor.
3. The HAR system shall be compatible with the HAR system currently in operation in the corridor.

## **8 TRAILBLAZER SIGN**

### **8.1 Functional Requirements**

1. Trailblazer sign system shall permit the I-80 ICM Management Application to activate, modify or deactivate a trailblazer, making a modification within two seconds of receiving a command..
2. Trailblazer dynamic display shall detect faults when displaying messages and attempt to mitigate them by adjusting the display characteristics within two seconds.
3. Trailblazer dynamic display shall monitor the light output of the sign and modify it automatically to suit ambient lighting conditions locally within two seconds..
4. Trailblazer dynamic display shall report status and fault information to the I-80 ICM Management Application.
5. Trailblazer sign shall clearly identify to users when it is active.
6. Each trailblazer dynamic display shall be individually controlled by the I-80 ICM Management Application.
7. If communications fail, the Trailblazer dynamic display shall continue to display the most recently received instructions from I-80 ICM Management Application.
8. The Trailblazer dynamic display shall detect when connectivity to the I-80 ICM Management Application is terminated or restored.

### **8.2 Security Requirements**

1. Trailblazer sign controllers shall be secured against unauthorized network access.
2. Trailblazer sign system shall be secure against intrusion and interference from any unauthorized source outside the system architecture.

### **8.3 Reliability and Availability Requirements**

1. The Mean Time Between Failure shall be three years for the Trailblazer sign system.

### **8.4 Maintainability Requirements**

1. The system integrator shall not impose any license or rights restrictions on the Trailblazer sign system that preclude maintenance operations.
2. Maintenance staff shall have system access to make all required Trailblazer sign system configuration changes.
3. Maintenance staff shall be able to carry out diagnostic functions on the Trailblazer sign system to assist in determining the type, nature and location of faults and identify what modules within roadside devices shall require replacement or repair without having to visit the roadside to carry out such diagnostics.
4. Maintenance staff shall be able to view detailed internal information about the performance of the Trailblazer sign system and all roadside devices.



## **9 TRAFFIC MONITORING SYSTEM**

### **9.1 Functional Requirements**

1. Each vehicle detection station shall detect vehicle speed, volume, occupancy and length for each lane.
2. Each vehicle detection station shall transmit to the I-80 ICM Management Application vehicle speed, volume, occupancy and length for each lane within two seconds of a request being made by the I-80 ICM Management Application.
3. Each vehicle detection station shall be able to operate and transmit simultaneously.
4. If communication between the detection station and the central application is unavailable, the vehicle detection station shall record all detected data for up to one week.
5. If communication between the detection station and the central application is restored, the controller shall transmit all data stored during the communication outage.
6. Vehicle detection controller shall be able to store operational performance data.

### **9.2 Security Requirements**

1. Vehicle detection controllers shall be secured against unauthorized network access.
2. Vehicle detection system shall be secure against intrusion and interference from any unauthorized source outside the system architecture.

### **9.3 Reliability and Availability Requirements**

1. The Mean Time Between Failure shall be three years for the Vehicle detection system.

### **9.4 Maintainability Requirements**

1. The system integrator shall not impose any license or rights restrictions on the Vehicle detection system that preclude maintenance operations.
2. Maintenance staff shall have system access to make all required Vehicle detection system configuration changes.
3. Maintenance staff shall be able to carry out diagnostic functions on the Vehicle detection system to assist in determining the type, nature and location of faults and identify what modules within roadside devices shall require replacement or repair without having to visit the roadside to carry out such diagnostics.
4. Maintenance staff shall be able to view detailed internal information about the performance of the Vehicle detection system and all roadside devices.

## **10 TRAFFIC SURVEILANCE SYSTEM**

### **10.1 Functional Requirements**

1. CCTV cameras shall report status and fault information to the central control application.
2. CCTV cameras shall permit the I-80 ICM Management Application to direct the camera to preset positions within two seconds of a request being made.
3. CCTV system shall permit authorized users, with a higher level of user access rights, to terminate the user session of another authorized user.
4. CCTV shall use Ethernet - based communications protocols for video image transmission and camera control.
5. CCTV system shall be capable of restricting a CCTV camera from moving to a specified position.

### **10.2 Security Requirements**

1. CCTV camera controllers shall be secured against unauthorized network access.
2. CCTV camera system shall be secure against intrusion and interference from any unauthorized source outside the system architecture.

### **10.3 Reliability and Availability Requirements**

1. The Mean Time Between Failure shall be three years for the CCTV camera system.

### **10.4 Maintainability Requirements**

1. The system integrator shall not impose any license or rights restrictions on the CCTV camera system that preclude maintenance operations.
2. Maintenance staff shall have system access to make all required CCTV camera system configuration changes.
3. Maintenance staff shall be able to carry out diagnostic functions on the CCTV camera system to assist in determining the type, nature and location of faults and identify what modules within roadside devices shall require replacement or repair without having to visit the roadside to carry out such diagnostics.
4. Maintenance staff shall be able to view detailed internal information about the performance of the CCTV camera system and all roadside devices.

## **11 EMERGENCY VEHICLE PRE EMPTION**

1. EVP system shall be the same specifications as the EVP system currently operating within the corridor.
2. Shall install emergency vehicle preemption on signals along San Pablo Avenue and crossing arterials used by the incident responders to access I-80.

## **12 TRANSIT SIGNAL PRIORITY**

1. TSP system shall be the same specifications as the TSP system currently operating within the corridor.
2. Shall install TSP firmware on existing controllers on San Pablo Avenue from Contra Costa College to Richmond Parkway
3. Shall install TSP receivers at existing intersections on San Pablo Avenue between Richmond Parkway and Willow Road, and on connecting arterials between San Pablo Avenue and I-80 used by WestCAT express and regional routes.

## 13 AUTOMATIC VEHICLE LOCATION

1. System integrator shall ensure Factory Accepting Testing (FAT) test procedures include key 'data-related' process and reporting improvements.
2. System integrator shall provide justification for partial FAT dry run test (according to 4.6.21 of the proposal).
3. System integrator shall provide thorough and vigorous FAT of all functions and modules. A few examples:
  - Stop requests
  - Door closing
  - Wheelchair stop request
  - Text message signs with CRS
  - Ability to sequence loop routes
4. System integrator shall prepare an updated list of specific software functions to be delivered with the upgrade.
5. System integrator shall develop a comparison routine of current vs. prior schedule import data and data files.
6. System integrator shall identify and document all manual entry tasks that might be converted to an interface format.
7. Shall Improved GIS base map import and export routines to ensure that the AVL system supports the Bay Area Region's digital map standard (Teleatlas/GDT).
8. All aspects of this upgrade shall comply with the standards reflected in the National or Regional IT Architecture.
9. System integrator shall provide liability from improper installation or initial use/configuration of software.
10. System integrator shall provide data migration as described in 4.4.1 of the proposal.
11. System integrator shall provide a complete revision of the original system configuration upon installation of OrbCad XP.
12. System integrator shall formalized and comprehensive training of OrbCad XP.
13. System integrator shall provide all software installation disks, including 3rd Party Software installation disks and documentation.
14. System integrator shall to provide a comprehensive list of OrbCad XP changes and enhancements.
15. System integrator shall conduct an end to end total system health check (including amdt's and radios) prior to embarking on the upgrade to identify and address problems, anomalies, and incompatibilities that might be introduced (or solved) by the new upgrade, particularly with old equipment such as amdt's.

16. System integrator shall incorporate a report process that will allow technicians to populate a repair form and send directly to Central Dispatch for a complete loop back.
17. All XP servers shall be built in the actransit.lan domain.
18. All OrbCad XP servers shall be built into the existing ACT VMware 3.5 virtual environment with Motorola integration DCC servers installed in Emeryville.
19. All client access shall be via terminal server.
20. All physical server hardware shall have remote management capability such as HP Ilo or Dell DRAC.
21. System integrator shall supply complete hardware and software documentation of AMDT's.
22. System integrator shall provide component-level documentation of AMDT's.
23. System integrator shall provide all manuals and documentation for software, including Motorola equipment and how OrbCad and Motorola interact.
24. System integrator shall provide delivery of AVA software Trigger Box Tool.
25. System integrator shall include DIS machine upgrade.
26. System integrator shall include analysis of Vehicle import and Employee import.
27. System integrator shall include complete OrbCad XP database schema and standard user training materials.
28. System integrator shall remain on site until system is stable and all workstations have been installed and are functional.