HIGH-LEVEL REQUIREMENTS

SAN MATEO COUNTY SMART CORRIDORS PROGRAM

FOR

SMCTA / CALTRANS / C/CAG

Prepared by:

URS

SEPTEMBER 28, 2009

VERSION: 13000.004

1.0 Introduction and Background

1.1 Introduction and Background

The City/County Association of Governments of San Mateo County (C/CAG) and the San Mateo County Transportation Authority (SMCTA) in conjunction with the California Department of Transportation (Caltrans) has initiated an effort to address the operation of the freeway and arterial roadway network in San Mateo County. The San Mateo County Smart Corridor Program is intended to benefit a variety of users including commuters, local traffic, and commercial vehicle and transit operators.

The mitigation of the impacts of non-recurring traffic congestion on local streets within San Mateo County during major freeway incidents on US-101 was identified as a high-priority project in the Smart Corridor Program. A Project Report (PR) was written that proposes the deployment of integrated Intelligent Transportation System (ITS) elements to provide local agencies and Caltrans the tools to manage this congestion. The project includes the installation of the following ITS elements:

- Directional signs (trailblazer and turn prohibition) to direct traffic;
- Fixed or pan-tilt-zoom closed-circuit television cameras at intersections and midblock locations to monitor traffic congestion and end-of-queue location;
- Communications to provide interconnect between local agency traffic signals on local streets and State operated traffic signals on State routes;
- Upgraded traffic signal controllers and/or cabinets and signal operation software systems;
- Arterial changeable message signs to inform motorists of traffic conditions (also referred to as Arterial Dynamic Message Signs in this document);
- Center-to-center communications between the proposed San Mateo County Hub (SMCHub) and the Caltrans District 4 Transportation Management Center (D4TMC) (note where TMC is used in a general manner in this document, it refers to the SMCHub, the D4TMC and local TMCs);
- Vehicle detector stations (non-intrusive or intrusive technology) on non-freeway state routes (El Camino Real) and local streets at mid-block locations.

Many of these same elements can also be used to manage traffic along the corridor during recurrent congestion. In addition to the ITS elements noted above, the following ITS elements were identified for possible deployment on future projects:

- Transit priority service at intersections;
- Emergency vehicle preemption at intersections;
- Highway Advisory Radio (HAR) transmitters and signs;
- Advance warning signs at Caltrain at-grade crossings;
- Changeable message signs for arterial travel times.

A Concept of Operations (ConOps) was prepared in October 2008 and updated in September 2009, with input from local agencies and Caltrans, and direction from the Federal Highway Administration (FHWA). This is an initial step in the Systems

Engineering process defined by the FHWA. This document identifies the stakeholders, their roles and responsibilities, their coordination with each other, and how the system will be developed.

1.2 Relevant Documents

Relevant documents include:

- FHWA/Caltrans Systems Engineering Guidebook for ITS, version 2.0, January 2007
- Final Draft ITS Infrastructure Improvement Plan, San Mateo County Alternative Route Plan, January 2008
- Draft Project Report in San Mateo County on US-101 and SR-82 from I-380 to the Santa Clara County Line, San Mateo County Smart Corridors, EA 4A9200, October 2008
- Project Study Report to Request Programming in the STIP for Phase 1of the San Mateo County Smart Corridors, March 2008
- San Mateo County Smart Corridors Projects Traffic Light Synchronization Program Funding Application March 2008
- San Mateo County Arterial Route for Traffic Incident Guide, February 2009
- San Mateo County Smart Corridors Program Concept of Operations, September 2009
- System Engineering Management Plan, San Mateo County Smart Corridors Program, version 10000.004, September 2009
- Functional Requirements, San Mateo County Smart Corridors Program, version 12000.007, September 2009

Definitions and acronyms in this document are defined in the System Engineering Management Plan noted above.

2.0 Scope of Project

The goals of the project identified in the Concept of Operations have been modified as shown in **Table 1**.

Table 1 – Project Goals

Goal Area	Smart Corridors Program Goals
Traffic Incident Management	• Proactively manage traffic already diverted from the freeway to minimize impacts on local arterials, and return regional traffic back to the freeway as soon as possible by: o Actively managing traffic signal operations on selected routes to maximize traffic flow around a major incident and minimize delays caused by diverted freeway traffic. o Improving collection of current travel condition information along local arterials on the alternate routes. (Future) o Providing accurate and timely route guidance information about the corridors to agency transportation managers.

Goal Area	Smart Corridors Program Goals
	(Future) o Minimizing the intrusion of freeway traffic on local streets due to major freeway incidents.
Interagency Coordination	• Provide the capability for shared control and operation of the Smart Corridors components by the agencies. • Improve sharing of resources between agencies for more unified transportation management operations across jurisdictions . • Improve communications between the agencies during major freeway incidents
Traffic Operations and Management	• Improve traffic flow within the corridor during normal operation • Share traffic information between the agencies to improve coordination and management of traffic during normal operations

3.0 Purpose of Document

3.1 Identify the high level requirements of the ITS Subsystems and system comprising the San Mateo County Smart Corridors Program

3.2 Expand the functional requirements previously developed

3.3 Identify the methods of verifying the high level requirements

3.4 Trace the requirements from the ConOps and the functional requirements to the high-level requirements

4.0 Requirements

4.1 Overall System Requirements

4.1.1 The System shall be able to collect and display data to support the following functions at local and interjurisdictional levels:

- Traffic Operations
- Recurrent Congestion Management
- Non-recurrent Congestion/Incident Management
- Special Event Management
- Seasonal Traffic Management
- Emergency/Disaster Management

4.1.2 The System shall work with different makes and models of equipment intended for the same purpose.

4.1.3 The System shall provide compatibility with the Bay Area C2C Interface Control Document.

4.1.4 Field elements shall be NTCIP compliant.

4.1.5 The System shall conform to current Caltrans policies, practices and standards including:

4.1.5.1 2006 Standard Plans

4.1.5.2 2006 Standard Specs

4.1.5.3 2009 TEES

4.1.6 Software and hardware shall be reliable. Reliability shall be measured by the following methods:

4.1.6.1 Mean time between failure (MTBF)

4.1.6.2 Percentage of time that the System is functioning

4.1.6.3 Number of times the System or any Subsystem stop functioning within a given time period.

4.1.6.4 Amount of time required for the System to resume normal functions after a power failure or other ITS element failure.

4.1.7 The System and each Subsystem shall have predetermined methods of operation during power failures or other ITS element failures.

4.1.8 The System shall include alarms to notify operators and maintenance personnel of System and device failures.

4.1.9 The System shall be capable of interfacing with existing and planned ITS elements at the local and regional levels.

4.1.10 The System shall be expandable through the following methods:

4.1.10.1 Adding ITS elements

4.1.10.2 Expanding geographically

4.1.11 System expansion shall meet the following conditions:

4.1.11.1 Expansion shall not result in a decrease in System performance

4.1.11.2 Expansion shall not be dependent on redesign of any components

4.1.12 The System shall allow a hierarchy of users with the following privileges:

4.1.12.1 Administrative User - overall control of all System functions and settings, including determining access rights for other levels of users

4.1.12.2 Primary Users - ability to control and monitor all System functions

4.1.12.3 Secondary Users - ability to control and monitor a limited subset of all System functions

4.1.12.4 Tertiary Users - ability to monitor but not control a limited subset of System functions

4.1.13 Administrative users shall have the ability to add/modify/delete users.

4.1.14 Administrative users shall have the ability to assign command-specific access to specific users.

4.1.15 Users shall be able to control and operate the System if they have the proper privileges. Other users shall be able to monitor the available information from the field elements.

4.1.16 The System shall support the ability for multiple users to monitor the same data item.

4.1.17 The System shall have security and access control systems to prevent any unauthorized user from accessing the System.

4.1.18 The System shall allow each Agency to exercise full control over field elements owned by that Agency.

4.1.19 The System shall be capable of collecting and displaying the following information:

- Data on intersection operation including timing plans and intersection status.
- Volume and occupancy data
- CCTV images from all cameras
- CMS and directional sign information
- Historical detector and signal timing data
- Maintenance information

4.1.20 The SMCHub shall serve as the central local control point of the Smart Corridor and serve as back-up for Caltrans D4TMC operations.
4.1.21 Data shall be based on a common geographic reference.
4.1.22 The System shall have the ability to create reports.
4.1.23 The System shall support authorized user access via the internet
4.1.24 The System shall be standalone.
4.1.25 The System shall support compliance with all interagency agreements.
4.1.26 The System shall be capable of being controlled and monitored from local TMCs, the SMCHub and the D4TMC.
4.1.27 The System, each Subsystem and the associated field equipment shall allow unattended operation.
4.1.28 Each Subsystem shall be able to perform the same functions as a standalone system that it will perform within the integrated system.
4.1.29 The System and all field elements shall be protected against power outages.
4.1.30 A demarcation point shall be established for defining the limits of maintenance responsibility for communication lines, all field equipment and all TMC equipment.
4.1.31 Upon confirmation of a major incident on US 101, Caltrans shall have the ability to take over control of all ITS devices on affected local roadways.
4.1.31.1 The initial response to a major incident will involve the automatic implementation (following Caltrans user approval) of a predetermined response plan.
4.1.31.2 Caltrans shall have the ability to select response plans manually and to manually change all timing plans.
4.1.31.3 Local TMCs and the SMCHub will maintain the ability to monitor ITS devices in a manner identical to that prior to their takeover by Caltrans.
4.1.31.4 Local agencies will not be able to control any System elements once Caltrans has implemented a response plan.
4.1.31.5 Local agencies will have the ability to view the signal timing plans in effect and any changes made to them by Caltrans.
4.1.32 Performance measures shall be established for each System, Subsystem and individual ITS element.
4.1.33 Within the System, the various components shall be time synchronized.

4.2 Traffic Control Subsystem

4.2.1 The Subsystem shall support security measures that protect the hierarchy of users.
4.2.2 Within a jurisdiction, the Subsystem shall be capable of the following modes of operation on a system-wide basis, a group basis or as individual intersections:
4.2.2.1 Time-of-day operation
4.2.2.2 Traffic responsive operation
4.2.2.3 Manual operation
4.2.2.4 Flash operation
4.2.2.5 Free actuated operation

4.2.3 The Subsystem shall allow coordination across jurisdictional boundaries.

4.2.4 In the event of a loss of communications to a Subsystem being controlled at the SMCHub or D4TMC level, the Traffic Control Subsystem shall revert to local agency control.

4.3 Traffic Signal Controllers

4.3.1 Controllers shall be capable of operating under the following modes:

- 4.3.1.1 Time-of-day operation
- 4.3.1.2 Traffic responsive operation
- 4.3.1.3 Manual operation
- 4.3.1.4 Flash operation
- 4.3.1.5 Free actuated operation

4.3.2 Controllers shall be able to receive and implement timing plans from the System that alter the following parameters:

- 4.3.2.1 Splits
- 4.3.2.2 Cycle lengths
- 4.3.2.3 Green extensions
- 4.3.2.4 Offsets
- 4.3.2.5 Lead/Lag
- 4.3.2.6 Recalls

4.4 Directional Sign Subsystem

4.4.1 The Directional Sign Subsystem shall be composed of signs noting the direction of travel (trailblazers) and signs prohibiting specified directions of travel.

4.4.2 Trailblazer signs shall direct the motoring public to designated routes.

4.4.3 Turn prohibition signs shall prohibit turn movements.

4.4.4 The Subsystem shall be able to report the status of all sign hardware.

4.4.5 The Subsystem trailblazer signs shall be capable of displaying static and flashing arrows.

4.4.6 Trailblazer signs shall have a dynamic arrow capable of showing multiple directions either singly or concurrently.

4.4.7 Signs shall conform to the Manual of Uniform Traffic Control Devices (MUTCD).

4.5 Arterial Dynamic Message Signs (ADMS) Subsystem

4.5.1 ADMS on non-State Routes shall be designed to meet local agency standards.

4.5.2 The Subsystem shall allow sign messages to be centrally validated.

4.5.3 The Subsystem shall be able to report the status of all sign hardware.

4.5.4 The System shall be capable of displaying messages for different lengths of time.

4.5.5 The Subsystem shall be able to display multiple messages.

4.5.6 Remote users shall be able to monitor messages.

4.5.7 Each ADMS shall display 2 lines of text with 12 12-inch high characters per line.

4.6 CCTV Subsystem

4.6.1 The Subsystem shall support the video monitoring of selected arterial locations and midblock locations to provide information regarding flow and queue length.
4.6.2 Each CCTV camera shall transmit a color image.
4.6.3 Camera images shall conform to National Television System Committee (NTSC) standards.
4.6.4 The Subsystem shall support individual CCTV cameras, expandable to the limits of the Subsystem hardware.
4.6.5 All video shall be a minimum of 10 frames per second.
4.6.6 If there is a conflict between secondary users, viewing priority shall be assignable on a first-come first-served basis.

4.7 Detection Subsystem

4.7.1 The Subsystem shall provide for measurement of traffic parameters at selected locations.
4.7.2 The Subsystem shall report data at a minimum of once per cycle length.
4.7.3 Each detection station shall report volume and occupancy for each lane.

4.8 Communications Subsystem

4.8.1 The Communications Subsystem shall be capable of supporting a combination of fiber, wireless, and copper media.
4.8.2 The Subsystem shall include concentrators at selected locations along the corridor to aggregate communications network data from ITS field devices and provide transport to the System.
4.8.3 The Subsystem shall support all existing and future video and data bandwidth requirements.
4.8.4 The Subsystem shall provide communications network redundancy.
4.8.5 The Subsystem shall support industry standards.
4.8.6 The SMCHub shall serve as the central local control point of the Smart Corridor and serve as back-up for Caltrans D4TMC operations.
4.8.7 The Subsystem shall be able to interface and integrate with the proposed Caltrans ATMS.
4.8.8 The Subsystem shall include a SONET node at the SMCHub to connect to existing Caltrans SONET backbone network.

Appendix 1
Traceability Matrix

Traceability follows a requirement throughout the life of the System. It is a key cross-cutting process that helps to ensure that all requirements are met. Traceability also supports impact analysis and configuration management for long term maintenance, changes, upgrades and replacements. The attached matrix traces requirements from the planning phase to the design phase in the following order:

- Concept of Operations
- Functional Requirements
- High Level Requirements
- High Level Test Plans

TRACEABILITY MATRIX-SAN MATEO COUNTY SMART CORRIDORS PROGRAM-SYSTEM ENGINEERING

Concept of Operations Sept 2009 Reference Section	ConOps Description	Functional Requirements #12000.007 Reference Section	Functional Requirements Description	High Level Requirements #13000.003 Reference Section	High Level Requirements Description	Detailed Design Requirements #13500.XXX Reference Section	Detailed Design Requirements Description	Test Procedure	Comments
3.1	**Incident Management**								
3.1.1	Install trailblazers on designated routes to guide traffic	5.3.1	Direction information on alternate routes shall be provided to motorists.	4.1.31	Upon confirmation of a major incident on US 101, Caltrans shall have the ability to take over control of all ITS devices on affected local roadways.				
				4.4.1	The Directional Sign Subsystem shall be composed of signs noting the direction of travel (trailblazers) and signs prohibiting specified directions of travel.				
				4.4.3	Turn prohibition signs shall prohibit turn movements.				
				4.4.5	The Subsystem trailblazer signs shall be capable of displaying static and flashing arrows.				
				4.4.6	Trailblazer signs shall have a dynamic arrow capable of showing multiple directions either singly or concurrently.				
		5.3.3	Signage shall be used to help manage the surface transportation system	4.4.1	The Directional Sign Subsystem shall be composed of signs noting the direction of travel (trailblazers) and signs prohibiting specified directions of travel.				
		5.3.4	Enroute traveler information shall be provided to the motorist	4.4.2	Trailblazer signs shall direct the motoring public to designated routes.				
				4.5.4	The System shall be capable of displaying messages for different lengths of time.				
				4.5.5	The Subsystem shall be able to display multiple messages.				
3.1.2	Integrate traffic incident management strategies across multiple local agencies and Caltrans	5.1.4	The System shall support operation by multiple concurrent users/operators	4.1.16	The System shall support the ability for multiple users to monitor the same data item.				
				4.1.18	The System shall allow each Agency to exercise full control over ITS elements owned by that Agency.				
				4.1.23	The System shall support authorized user access via the internet				
				4.1.25	The System shall support compliance with all interagency agreements.				
		5.2.2	The Subsystem shall be capable of controlling and monitoring the operation of traffic signal equipment at selected intersections.	4.1.26	The System shall be capable of being controlled and monitored from local TMCs, the SMCTMS and the D4TMC				
				4.3.1	Controllers shall be capable of operating under the following modes: time of day, traffic responsive, manual, flash, and free actuated.				

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				4.3.2	Controllers shall be able to receive and implement timing plans from the System that alter the following parameters: splits, cycle lengths, green extensions, offsets, lead/lag, and recalls.				
		5.1.15	Control during incidents shall be from the D4TMC	4.1.5	The System shall conform to current Caltrans policies, practices and standards.				
3.1.3	Implement devices to manage freeway traffic that diverts around major incidents	5.3.1	Direction information on alternate routes shall be provided to motorists.	4.1.31	Upon confirmation of a major incident on US 101, Caltrans shall have the ability to take over control of all ITS devices on affected local roadways.				
				4.4.1	The Directional Sign Subsystem shall be composed of signs noting the direction of travel (trailblazers) and signs prohibiting specified directions of travel.				
				4.4.3	Turn prohibition signs shall prohibit turn movements.				
				4.4.5	The Subsystem trailblazer signs shall be capable of displaying static and flashing arrows.				
				4.4.6	Trailblazer signs shall have a dynamic arrow capable of showing multiple directions either singly or concurrently.				
		5.3.2	Signs shall be clearly distinguishable from other signage.						
3.1.4	Proactively manage diverted traffic to minimize local congestion	5.1.2	The System shall deploy ITS field elements to support the following functions: Traffic control Motorist information Traffic monitoring	4.1.1	The System shall be able to collect and display data to support the following functions at local and interjurisdictional levels: Traffic Operations, Recurrent Congestion Management, Non-recurrent Congestion/Incident Management, Special Event Management, Seasonal Traffic Management, Emergency/Disaster Management				
		5.2.2	The Subsystem shall be capable of controlling and monitoring the operation of traffic signal equipment at selected intersections.	4.1.26	The System shall be capable of being controlled and monitored from local TMCs, the SMCTMS and the D4TMC				
				4.3.1	Controllers shall be capable of operating under the following modes: time of day, traffic responsive, manual, flash, and free actuated.				
				4.3.2	Controllers shall be able to receive and implement timing plans from the System that alter the following parameters: splits, cycle lengths, green extensions, offsets, lead/lag, and recalls.				

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		5.3.3	Signage shall be used to help manage the surface transportation system	4.4.1	The Directional Sign Subsystem shall be composed of signs noting the direction of travel (trailblazers) and signs prohibiting specified directions of travel.				
				4.4.7	Signs shall conform to the Manual of Uniform Traffic Control Devices standards.				
				4.5.1	Dynamic Message Signs within local jurisdictions shall be designed to meet local agency standards.				
				4.5.7	Each ADMS shall display 2 lines of text with 12 12-inch high characters per line.				
		5.3.4	Enroute traveler information shall be provided to the motorist.	4.5.2	The Subsystem shall allow sign messages to be centrally validated.				
				4.5.4	The System shall be capable of displaying messages for different lengths of time.				
				4.5.5	The Subsystem shall be able to display multiple messages.				
		5.4.3	Data from the monitoring system shall be transmitted to the TMC for analysis within the traffic control system.	4.1.5	The System shall conform to current Caltrans policies, practices and standards.				
				4.1.21	Data shall be based on a common geographic reference.				
3.1.5	Integrate SM Smart Corridors via the Bay Area Center-to-Center Network	5.5.2	Provide capability for center to center (C2C) communications.	4.1.3	The System shall provide compatibility with the Bay Area C2C Interface Control Document				
3.1.6	Provide for remote monitoring of local street traffic flow through the use of video cameras	5.4.1	Surveillance shall be used to view the surface transportation system.	4.6.1	The Subsystem shall support the video monitoring of selected arterial locations and midblock locations to provide information regarding flow and queue length.				
				4.6.2	CCTV cameras should record in color.				
				4.6.3	Camera images shall conform to NTSC standards.				
				4.6.5	All video shall be a minimum of 10 frames per second.				
				4.8.3	The Subsystem shall support all existing and future video and data bandwidth requirements.				
		5.4.2	The Subsystem shall support the monitoring of traffic at selected locations.	4.1.19	The System shall be capable of collecting and displaying the following information: data on intersection operation, volume,				

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					occupancy, and speed, CCTV images, CMS and directional sign information, historical detector and signal timing data, maintenance information.				
3.1.7	Maximize green phasing along alternate routes	5.2.2	The Subsystem shall be capable of controlling and monitoring the operation of traffic signal equipment at selected intersections.	4.1.26	The System shall be capable of being controlled and monitored from local TMCs, the SMCTMS and the D4TMC				
				4.3.1	Controllers shall be capable of operating under the following modes: time of day, traffic responsive, manual, flash, and free actuated.				
				4.3.2	Controllers shall be able to receive and implement timing plans from the System that alter the following parameters: splits, cycle lengths, green extensions, offsets, lead/lag, and recalls.				
3.1.8	Provide local site for monitoring and operations	5.1.4	The System shall support operation by multiple concurrent users/operators	4.1.16	The System shall support the ability for multiple users to monitor the same data item.				
				4.1.18	The System shall allow each Agency to exercise full control over ITS elements owned by that Agency.				
				4.1.23	The System shall support authorized user access via the internet				
				4.1.25	The System shall support compliance with all interagency agreements.				
				4.5.6	Remote users shall be able to monitor messages.				
		5.1.5	The System shall support non-incident operation by multiple jurisdictions	4.1.18	The System shall allow each Agency to exercise full control over ITS elements owned by that Agency.				
3.1.9	Provide a Hub in San Mateo County for central monitoring and management of traffic on local streets and as a backup to the D4TMC	5.1.4	The System shall support operation by multiple concurrent users/operators	4.1.16	The System shall support the ability for multiple users to monitor the same data item.				
				4.1.18	The System shall allow each Agency to exercise full control over ITS elements owned by that Agency.				
				4.1.20	The SMCHub shall serve as the central local control point of the Smart Corridor and serve as back-up for Caltrans D4TMC operations.				
				4.1.23	The System shall support authorized user access via the internet				
				4.1.25	The System shall support compliance				

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					with all interagency agreements.				
				4.8.8	The Subsystem shall include a SONET node at the SMCHub to connect to the existing Caltrans SONET backbone network.				
		5.1.5	The System shall support non-incident operation by multiple jurisdictions	4.1.18	The System shall allow each Agency to exercise full control over ITS elements owned by that Agency.				
3.2	**Arterial Management**								
3.2.1	Implement traffic responsive and time of day signal timing from a remote location	5.2.2	The Subsystem shall be capable of controlling and monitoring the operation of traffic signal equipment at selected intersections.	4.1.26	The System shall be capable of being controlled and monitored from local TMCs, the SMCTMS and the D4TMC				
				4.3.1	Controllers shall be capable of operating under the following modes: time of day, traffic responsive, manual, flash, and free actuated.				
				4.3.2	Controllers shall be able to receive and implement timing plans from the System that alter the following parameters: splits, cycle lengths, green extensions, offsets, lead/lag, and recalls.				
3.2.2	Maximize green phasing along major corridors	5.2.2	The Subsystem shall be capable of controlling and monitoring the operation of traffic signal equipment at selected intersections.	4.1.26	The System shall be capable of being controlled and monitored from local TMCs, the SMCTMS and the D4TMC				
				4.3.1	Controllers shall be capable of operating under the following modes: time of day, traffic responsive, manual, flash, and free actuated.				
				4.3.2	Controllers shall be able to receive and implement timing plans from the System that alter the following parameters: splits, cycle lengths, green extensions, offsets.				
3.2.3	Upgrade controllers and communications infrastructure	5.1.3	The System shall be capable of interfacing with existing and planned ITS elements at all TMC levels.	4.1.2	The System shall work with different makes and models of equipment intended for the same purpose.				
				4.8.7	The Subsystem shall be able to interface and integrate with the proposed Caltrans ATMS.				
		5.5.1	Provide capability for center-to-field (C2F) communications.		Requirement was deleted as the interface may be NTCIP and/or proprietary				

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3.2.4	Improve data collection of real-time travel conditions through system detection. Dissemination of real-time travel conditions is a possible future enhancement.	5.4.2	The Subsystem shall support the monitoring of traffic at selected locations.	4.1.19	The System shall be capable of collecting and displaying the following information: data on intersection operation, volume, occupancy, and speed, CCTV images, CMS and directional sign information, historical detector and signal timing data, maintenance information.				
				4.7.1	The Subsystem shall provide for detection of vehicles at selected locations.				
				4.7.2	The Subsystem shall report data at a minimum of once per cycle length.				
3.2.5	Enable remote monitoring of real-time travel conditions	5.2.1	The Subsystem shall collect and maintain all data required for monitoring and displaying traffic information from selected intersections.	4.1.22	The System shall have the ability to create reports.				
				4.8.1	The Communications Subsystem shall be capable of supporting a combination of fiber, wireless, and copper media.				
				4.8.2	The Subsystem shall include concentrators at selected locations along the corridor to aggregate communications network data from ITS field devices and provide transport to the System.				
		5.1.7	The System shall be capable of collecting, displaying and sharing information.	4.2.3	The Subsystem shall allow coordination across jurisdictional boundaries.				
		5.1.9	The System shall be secure.	4.1.17	The System shall have security and access control systems to prevent any unauthorized user from accessing the System.				
				4.2.1	The Subsystem shall support security measures that protect the hierarchy of users.				
3.2.6	Integrate traffic signals across jurisdictions	5.2.2	The Subsystem shall be capable of controlling and monitoring the operation of traffic signal equipment at selected intersections.	4.1.26	The System shall be capable of being controlled and monitored from local TMCs, the SMCTMS and the D4TMC				
				4.3.1	Controllers shall be capable of operating under the following modes: time of day, traffic responsive, manual, flash, and free actuated.				
				4.3.2	Controllers shall be able to receive and implement timing plans from the System that alter the following parameters: splits, cycle lengths, green extensions, offsets, lead/lag, and recalls.				

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3.2.7	Improve traffic management for normal traffic operations	5.1.5	The System shall support non-incident operation by multiple jurisdictions.	4.1.18	The System shall allow each Agency to exercise full control over ITS elements owned by that Agency.				
		5.1.1	The System shall be able to collect and display data to support traffic management.	4.1.21	Data shall be based on a common geographic reference.				
				4.1.33	Within the System, the various components shall be time synchronized.				
				4.2.2	Within a jurisdiction, the Subsystem shall be capable of the following modes of operation on a system-wide basis, a group basis, or as individual intersections: time of day operation, traffic responsive operation, manual operation, flash operation, free actuated operation.				
				4.7.1	The Subsystem shall provide for detection of vehicles at selected locations.				
				4.7.2	The Subsystem shall report data at a minimum of once per cycle length.				
3.2.8	Maintain functionality of existing legacy systems	5.1.3	The System shall be capable of interfacing with existing and planned ITS elements at all TMC levels.	4.1.2	The System shall work with different makes and models of equipment intended for the same purpose.				
				4.1.9	The System shall be capable of interfacing with existing and planned ITS elements at the local and regional levels.				
				4.8.7	The Subsystem shall be able to interface and integrate with the proposed Caltrans ATMS.				
3.3	**Traveler Information**								
3.3.1	Provide travel times on local streets by using system detection or other technology	Future							
3.3.2	Use C2C between the System and Caltrans	5.5.2	Provide capability for center to center (C2C) communications.	4.1.3	The System shall provide compatibility with the Bay Area C2C Interface Control Document				
		5.1.12	The System as a whole and each Subsystem should support industry standards to allow multiple types of field equipment from multiple manufacturers to operate as an integrated system.	4.1.2	The System shall work with different makes and models of equipment intended for the same purpose.				
				4.1.4	Field elements shall be NTCIP compliant.				
				4.1.33	Within the System, the various components shall be time synchronized.				
				4.8.5	The Subsystem shall support industry standards.				

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3.3.3	Integrate with Bay Area 511 (future)	Through Caltrans							
3.4	**Transit Management**								
3.4.1	Implement transit signal priority	Future							
3.4.2	Disseminate transit travel times	Future							
3.4.3	Provide advance warning and clearance of at-grade crossings.	Future							
3.4.4	Utilize transit GPS to acquire travel time information	Future							
3.5	**System Operations and Maintenance**								
3.5.1	Clear notation of which agency owns and operates each element	5.1.10	All field and TMC equipment shall be readily accessible in a safe manner for maintenance.	4.1.30	A demarcation point shall be established for defining the limits of maintenance responsibility for communication lines, all field equipment and all TMC equipment.				
		5.1.16	The System shall be designed to delineate maintenance responsibility.	4.1.25	The System shall support compliance with all interagency agreements.				
				4.1.30	A demarcation point shall be established for defining the limits of maintenance responsibility for communication lines, all field equipment and all TMC equipment.				
				4.4.4	The Subsystem shall be able to report the status of all sign hardware.				
				4.5.3	The Subsystem shall be able to report the status of all sign hardware.				
3.5.2	Utilize technology that will not require substantial software development. Provide device status and failure notification	5.1.11	The System as a whole and each Subsystem shall maximize use of commercial off the shelf (COTS) software and hardware products and applications.	4.1.2	The System shall work with different makes and models of equipment intended for the same purpose.				
3.5.3	Not dependent on other systems for operability	5.1.14	The System and each Subsystem shall have high availability.	4.1.6	Software and hardware shall be reliable. Reliability shall be measured by the following methods: Mean time between failure, percentage of time that the System is functioning, number of times the System or any Subsystem stop functioning within a given time period, Amount of time required for the System to resume normal functions after a				

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					power failure or other ITS element failure.				
				4.1.8	The System shall include alarms to notify operators and maintenance personnel of System and device failures.				
				4.1.24	The System shall be standalone.				
				4.1.27	The System, each Subsystem and the associated field equipment shall allow unattended operation.				
				4.1.28	Each Subsystem shall be able to perform the same functions as a standalone system that it will perform within the integrated system.				
				4.8.4	The Subsystem shall provide communications network redundancy.				
3.5.4	All Caltrans elements operate during power outages using back-up power sources	5.1.13	The System each Subsystem and the associated field equipment shall have a fail safe mode.	4.1.7	The System and each Subsystem shall have predetermined methods of operation during power failures or other ITS element failures.				
				4.1.29	The System and all field elements shall be protected against power outages.				
				4.2.4	In the event of a loss of communications to a Subsystem being controlled at the SMCHub or D4TMC level, the Traffic Control Subsystem shall revert to local agency control.				
5.2	**Operational Strategies**								
5.2.1	Under normal operations, each agency will be responsible for operating their own equipment	5.1.5	The System shall support non-incident operation by multiple jurisdictions.	4.1.18	The System shall allow each Agency to exercise full control over ITS elements owned by that Agency.				
5.2.2	SMCHub will serve as local agency control point during normal operations and as backup for the Caltrans TMC	5.1.4	The System shall support operation by multiple concurrent users/operators	4.1.16	The System shall support the ability for multiple users to monitor the same data item.				
				4.1.18	The System shall allow each Agency to exercise full control over ITS elements owned by that Agency.				
				4.1.23	The System shall support authorized user access via the internet				
				4.1.25	The System shall support compliance with all interagency agreements.				
				4.8.6	The SMCHub shall serve as the central local control point of the Smart Corridor and serve as back-up for Caltrans D4TMC operations.				
		5.1.6	The System shall allow a hierarchy of users.	4.1.12	The System shall allow a hierarchy of users with the following privileges: Administrative, Primary, Secondary, &				

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					Tertiary				
				4.1.13	Administrative users shall have the ability to add/modify/delete users				
				4.1.14	Administrative users shall have the ability to assign command-specific access to specific users.				
				4.1.15	Users shall be able to control and operate the System if they have the proper privileges. Other users shall be able to monitor the available information from the field elements.				
				4.6.6	If there is a conflict between secondary users, viewing priority shall be assignable on a first-come first-served basis.				
5.2.3	Cameras will be accessible for control and viewing by all agencies	5.1.4	The System shall support operation by multiple concurrent users/operators	4.1.16	The System shall support the ability for multiple users to monitor the same data item.				
				4.1.18	The System shall allow each Agency to exercise full control over ITS elements owned by that Agency.				
				4.1.23	The System shall support authorized user access via the internet				
				4.1.25	The System shall support compliance with all interagency agreements.				
5.2.3	A control hierarchy will be established	5.1.6	The System shall allow a hierarchy of users.	4.1.12	The System shall allow a hierarchy of users with the following privileges: Administrative, Primary, Secondary, & Tertiary				
				4.1.13	Administrative users shall have the ability to add/modify/delete users				
				4.1.14	Administrative users shall have the ability to assign command-specific access to specific users.				
				4.1.15	Users shall be able to control and operate the System if they have the proper privileges. Other users shall be able to monitor the available information from the field elements.				
				4.6.6	If there is a conflict between secondary users, viewing priority shall be assignable on a first-come first-served basis.				
5.3	**Special Operational Considerations**								
5.3.1	Video images accessible to agencies	5.1.4	The System shall support operation by multiple concurrent users/operators	4.1.16	The System shall support the ability for multiple users to monitor the same data item.				
				4.1.18	The System shall allow each Agency to exercise full control over ITS elements owned by that Agency.				

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				4.1.23	The System shall support authorized user access via the internet				
				4.1.25	The System shall support compliance with all interagency agreements.				
5.3.1	Prohibit video recording		In HLR						
5.3.1	Block camera fields of view		In HLR						
5.3.2	Share joint control of cameras	5.1.4	The System shall support operation by multiple concurrent users/operators	4.1.16	The System shall support the ability for multiple users to monitor the same data item.				
				4.1.18	The System shall allow each Agency to exercise full control over ITS elements owned by that Agency.				
				4.1.23	The System shall support authorized user access via the internet				
				4.1.25	The System shall support compliance with all interagency agreements.				
		5.1.5	The System shall support non-incident operation by multiple jurisdictions.	4.1.18	The System shall allow each Agency to exercise full control over ITS elements owned by that Agency.				
		5.4.1	Surveillance shall be used to help view the surface transportation system.	4.6.1	The Subsystem shall support the video monitoring of selected arterial locations and midblock locations to provide information regarding flow and queue length.				
				4.6.2	CCTV cameras should record in color.				
				4.6.3	Camera images shall conform to NTSC standards.				
				4.6.5	All video shall be a minimum of 10 frames per second.				
5.3.3	Allow video use by public	Through Caltrans							
5.4	**Operations of Supporting Functions**								
5.4.1	Advanced At-grade crossing warning and coordination system	Future							
5.4.2	Provide bus location	Future							
5.4.2	Provide transit travel time Information	Future							
5.4.3	Provide arterial travel times	Future							
5.4.4	Overall system integration	5.1.3	The System shall be capable of interfacing with existing and planned ITS	4.1.2	The System shall work with different makes and models of equipment				

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			elements at all TMC levels.		intended for the same purpose.				
				4.1.9	The System shall be capable of interfacing with existing and planned ITS elements at the local and regional levels.				
		5.1.8	The System shall be able to be expanded	4.1.10	The System shall be expandable through the following methods: adding ITS elements, expanding geographically				
				4.1.11	System expansion shall meet the following conditions: expansion shall not result in a decrease in System performance, expansion shall not be dependent on redesign of any components.				
				4.6.4	The Subsystem shall support individual CCTV cameras, expandable to the limits of the Subsystem hardware.				
6.0	**Performance Measures**	5.1.17	The System shall be able to collect data that can be used to determine conformance with performance measures.						
	Percentage of incidents that do not require active traffic monitoring on local streets			4.1.32	Performance measures shall be established for each System, Subsystem and individual ITS element.				
	Results of user surveys on the use of the Smart Corridor tools			4.1.32	Performance measures shall be established for each System, Subsystem and individual ITS element.				
	Reduction in measured congestion			4.1.32	Performance measures shall be established for each System, Subsystem and individual ITS element.				
	Reductions in system travel time			4.1.32	Performance measures shall be established for each System, Subsystem and individual ITS element.				
	Reduction in queue clearance time			4.1.32	Performance measures shall be established for each System, Subsystem and individual ITS element.				
	Reduction in amount of traffic filtering through the local network			4.1.32	Performance measures shall be established for each System, Subsystem and individual ITS element.				
	Average time after an incident Caltrans notifies local agencies			4.1.32	Performance measures shall be established for each System, Subsystem and individual ITS element.				
	Average time to deploy an alternate route			4.1.32	Performance measures shall be established for each System, Subsystem and individual ITS element.				
	Average time required for traffic signals to transition to flush plan			4.1.32	Performance measures shall be established for each System, Subsystem and individual ITS element.				
	Percentage of time that the use of Smart Corridor devices			4.1.32	Performance measures shall be established for each System, Subsystem				

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	provides satisfactory traffic flow				and individual ITS element.				
	Amount for sources expended for managing alternate route			4.1.32	Performance measures shall be established for each System, Subsystem and individual ITS element.				