



SACOG  
**ITS SOLUTIONS TOOLBOX**  
**FOR MAINSTREAMING ITS**  
 PROJECT TYPES AND ITS SOLUTIONS

Project Type	Possible ITS Enhancements
<b>Arterial</b>	
Traffic Calming	Traffic Signal Interconnect Conduit Traffic Signal Interconnect Cable (SIC) Pedestrian Improvements (in-pavement lighting, countdown pedestrian heads, animated pedestrian heads)
Roadway Widening	Closed Circuit Television (CCTV) Camera Traffic Signal Interconnect Conduit Traffic Signal Interconnect Cable (SIC) Bus Rapid Transit (BRT) Technology/Queue Jump Lanes Vehicle Detection
Roadway Construction	Closed Circuit Television (CCTV) Camera Changeable Message Sign (CMS) Highway Advisory Radio (HAR) Traffic Signal Interconnect Conduit Traffic Signal Interconnect Cable (SIC) Bus Rapid Transit (BRT) Technology/Queue Jump Lanes Vehicle Detection
Streetscaping	Traffic Signal Interconnect Conduit Traffic Signal Interconnect Cable (SIC) Vehicle Detection Pedestrian Improvements (in-pavement lighting, countdown pedestrian heads, animated pedestrian heads)
Utility Work	Traffic Signal Interconnect Conduit Traffic Signal Interconnect Cable (SIC)
Traffic Signal	Closed Circuit Television (CCTV) Camera Emergency Vehicle Preemption/Transit Signal Priority (EVP/TSP) Traffic Signal Interconnect Conduit Traffic Signal Interconnect Cable (SIC) Vehicle Detection Bus Rapid Transit (BRT) Technology/Queue Jump Lanes Wireless Hot Spots for Field Crews Pedestrian Improvements (in-pavement lighting, countdown pedestrian heads, animated pedestrian heads)
Pavement Overlay	Traffic Signal Interconnect Conduit Traffic Signal Interconnect Cable (SIC) Vehicle Detection
Traffic Signal Interconnect	Closed Circuit Television (CCTV) Camera



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Project Type	Possible ITS Enhancements
<b>Arterial</b>	
Grade Separation	Closed Circuit Television (CCTV) Camera Ramp Meter Traffic Signal Interconnect Conduit
<b>Transit</b>	
Transit Stop Installation or Improvement	Power for future equipment Transit Arrival Signs Traveler Information Kiosk Closed Circuit Television (CCTV) Camera Communications for future equipment
Light Rail Extension	Power for future equipment (i.e., kiosk, surveillance, signs) Transit Arrival Signs Traveler Information Kiosk Closed Circuit Television (CCTV) Camera Automatic Vehicle Location (AVL) System Transit Signal Priority (TSP) Electronic Payment Railroad Collision Avoidance System Communications for future equipment
Transit Village	Transit Arrival Signs Traveler Information Kiosk Closed Circuit Television (CCTV) Camera
Transit Fleet Addition or Upgrade (BRT)	Closed Circuit Television (CCTV) Camera (on-board) Automatic Vehicle Location (AVL) System Transit Signal Priority (TSP) Electronic Payment Bus Rapid Transit (BRT) Technology/Queue Jump Lanes Railroad Collision Avoidance System Communications for future equipment
Dispatch-related (software, hardware)	Automatic Vehicle Location (AVL) System Communications for future equipment
At-grade Railroad Crossing	Automatic Vehicle Location (AVL) System Railroad Collision Avoidance System Communications for future equipment
Grade Separation	Communications for future equipment
Paratransit	Automatic Vehicle Location (AVL) System Communications for future equipment

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Project Type	Possible ITS Enhancements
<b>Emergency Management Systems</b>	
Emergency Vehicles – Fleet Addition or Upgrade	Emergency Vehicle Preemption (EVP) Automatic Vehicle Location (AVL) System
Communication System Installation or Upgrade, including servers, towers, dispatch	Integrate with Public Broadcasting Dynamic Route Guidance Automatic Vehicle Location (AVL) System Integration with Traffic Management Center (TMC) Integration with 511
Emergency Operations Center	Integrate with Public Broadcasting Dynamic Route Guidance Automatic Vehicle Location (AVL) System Integration with Traffic Management Center (TMC) Collocate with Traffic Management Center (TMC) Integration with 511
<b>Commercial Vehicle Operations</b>	
Truck Scales – Installation or Upgrade	Weigh-In-Motion Electronic Credentials Transponder/Reader Closed Circuit Television (CCTV) Camera
Fleet Upgrades	Automatic Vehicle Location (AVL) System
Rest Areas	Traveler Information Kiosk



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Project Type	Possible ITS Enhancements
<b>Bicycle</b>	
Bicycle Lane	Bicycle Detection Signal Retiming Automated Enforcement
At-Grade Trail Crossing	Bicycle Detection Signal Retiming Automated Enforcement
Bike Storage	Surveillance (Closed Circuit Television Camera) Smart Parking
<b>Pedestrian</b>	
Pedestrian Crossing	In-pavement lighting Signalization Pedestrian Detection Enhanced pedestrian heads Wireless Hot Spot (only if signalized)
Sidewalk	Traffic Signal Interconnect Conduit Traffic Signal Interconnect Cable (SIC)
Pedestrian Mall	Traveler Information Kiosk Wireless Hot Spots
<b>Ports</b>	
Port access and circulation projects	Automatic Vehicle Location (AVL) System Dynamic Route Guidance
<b>Other</b>	
Parking facility or structure	Parking Reservation System Parking Guidance Information System
Rideshare or carpool program	Ridesharing software/website (see <a href="http://www.sacregion511.org">www.sacregion511.org</a> )



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<b>Project Type</b>	<b>Possible ITS Enhancements</b>
<b>Freeway</b>	
<b>HOV Lane and/or HOT Lane</b>	Transponder/Reader (for HOT Lanes) Closed Circuit Television (CCTV) Camera Communications Conduit Communications Cable (or wireless) Vehicle Detection Portable Traffic Management Devices
<b>Freeway Widening</b>	Closed Circuit Television (CCTV) Camera Changeable Message Sign (CMS) Highway Advisory Radio (HAR) Communications Conduit Communications Cable (or wireless) Vehicle Detection Roadway Weather Information System (RWIS) Portable Traffic Management Devices
<b>Freeway Construction</b>	Closed Circuit Television (CCTV) Camera Changeable Message Sign (CMS) Ramp Meter Highway Advisory Radio (HAR) Communications Conduit Communications Cable (or wireless) Detection Roadway Weather Information System (RWIS) Portable Traffic Management Devices
<b>Interchange Reconfiguration or Construction</b>	Closed Circuit Television (CCTV) Camera Ramp Meters Communications Conduit Communications Cable (or wireless) Vehicle Detection
<b>Auxiliary Lane</b>	Closed Circuit Television (CCTV) Camera Changeable Message Sign (CMS) Communications Conduit Communications Cable (or wireless) Vehicle Detection
<b>Grade Separation (Bridge Structure)</b>	Closed Circuit Television (CCTV) Camera Communications Conduit Communications Cable (or wireless)



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<h1>Arterial</h1>							
<b>CCTV cameras</b>	<ul style="list-style-type: none"> <li>Roadway Construction</li> <li>Roadway Widening</li> <li>Traffic Signal</li> <li>Traffic Signal Interconnect Cable</li> </ul>	Includes pan-tilt-zoom (PTZ) or fixed camera, enclosure, cabling, pole/mounting, foundation, power, communications, communications device for traffic surveillance	<ul style="list-style-type: none"> <li>Pan-tilt-zoom (PTZ) or fixed camera?</li> <li>New or existing structure?</li> <li>Is there an existing video system?</li> <li>Leased line or agency-owned communications?</li> <li>Communications medium.</li> <li>Is there an existing communications infrastructure?</li> <li>Structure needs to support a camera</li> <li>Where to draw power for the camera and any associated electronics?</li> </ul>	<p>\$8,000-40,000 each</p> <p><i>O&amp;M Cost</i> \$2,000-3,000 per camera per year</p>	Cost depends on installation on existing or new structure and other design considerations, and includes equipment and installation. Does not include communications and power installation.	<ul style="list-style-type: none"> <li>Cost savings in construction (traffic control, mobilization)</li> <li>Camera provides faster identification and response to incidents</li> <li>Improve performance of traffic signal system by monitoring conditions remotely</li> <li>Cost savings could lead to additional transportation projects</li> <li>Improved staff efficiency when troubleshooting or verifying field issues</li> </ul>	<ul style="list-style-type: none"> <li>Minimize disruption to traffic</li> <li>Improved traffic flow from proactive use of cameras</li> <li>Improved information for travel planning using real-time images</li> </ul>
<b>Changeable Message Sign (CMS)</b>	<ul style="list-style-type: none"> <li>Roadway Construction</li> </ul>	Sign, structure, foundation, power, communications infrastructure, communications device for displaying traveler information	<ul style="list-style-type: none"> <li>Size of the sign.</li> <li>Sign technology.</li> <li>Communications medium.</li> <li>Is there an existing central system or will this be stand-alone?</li> <li>Where to draw power?</li> </ul>	<p>\$75,000-250,000 each</p> <p><i>O&amp;M Cost</i> \$3,000-6,000 per sign per year</p>	Depends on technology, size of sign, type of structure. Does not include communications and power installation.	<ul style="list-style-type: none"> <li>Cost savings in construction (traffic control, mobilization)</li> <li>With CMS, have ability to disseminate traffic condition information</li> <li>Cost savings could lead to additional transportation projects</li> </ul>	<ul style="list-style-type: none"> <li>Minimize disruption to traffic</li> <li>Travel information made available to public</li> </ul>



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<h1>Arterial</h1>							
<b>Highway Advisory Radio (HAR)</b>	<ul style="list-style-type: none"> <li>Roadway Construction</li> </ul>	Antenna, pole, sign, power, broadcast equipment for broadcasting traveler advisories	<ul style="list-style-type: none"> <li>Need to do a frequency evaluation.</li> <li>Consider the area of coverage.</li> </ul>	\$25,000-50,000 per location  <i>O&amp;M Cost</i> \$1,500-2,000 per location per year	Depends primarily on signal strength. Does not include communications and power installation.	<ul style="list-style-type: none"> <li>Resource for disseminating traveler information</li> <li>Can easily broadcast traffic advisories</li> <li>Low construction and maintenance costs</li> </ul>	<ul style="list-style-type: none"> <li>Real-time traveler information made available to public</li> <li>Can receive localized travel information with a standard radio</li> </ul>
<b>Emergency Vehicle Preemption (EVP)/Transit Signal Priority (TSP)</b>	<ul style="list-style-type: none"> <li>Traffic Signal</li> </ul>	Device on existing structure, cabling to signal cabinet, emitter on vehicle to allow emergency preemption or transit vehicle priority	<ul style="list-style-type: none"> <li>If for Transit Signal Priority (TSP), can existing controller support the function?</li> <li>Which approaches are required?</li> </ul>	\$6,000-18,000 per intersection  <i>O&amp;M Cost</i> \$1,000 per intersection per year	Includes on-board equipment	<ul style="list-style-type: none"> <li>Cost savings in construction (traffic control, mobilization)</li> <li>Provide ability to improve response time of emergency vehicles to incidents</li> <li>Provide opportunity to offer enhanced transit service</li> <li>Improved travel time for transit vehicles</li> <li>Potential to reduce fleet size</li> </ul>	<ul style="list-style-type: none"> <li>Faster response to incidents</li> <li>Enhance reliability of transit schedules</li> </ul>
<b>Traffic Signal Interconnect Conduit</b>	<ul style="list-style-type: none"> <li>Roadway Construction</li> <li>Traffic Calming</li> <li>Roadway Widening</li> <li>Streetscaping</li> <li>Utility Work</li> <li>Traffic Signal</li> </ul>	Minimum 3" conduit, pull boxes, splice vault at key locations for future interconnect cable to coordinate traffic signal timing	<ul style="list-style-type: none"> <li>Adequate conduit sweeps if fiber is used</li> <li>Other design elements may be different depending on medium.</li> <li>Placement in roadway or behind curb?</li> <li>Are multiple conduits needed?</li> </ul>	\$65,000 per mile  <i>O&amp;M Cost</i> Minimal	Costs vary depending on number of conduit and frequency of pull boxes	<ul style="list-style-type: none"> <li>Major cost savings in construction (traffic control, mobilization, installation) – costs are substantial if done separately</li> <li>Provides private infrastructure with the ability to coordinate traffic signals to improve traffic flow along a corridor</li> <li>Provides a private infrastructure for communications to other equipment</li> <li>Cost effective when combined with other larger projects and savings could lead to additional transportation projects</li> <li>Little to no recurring costs</li> </ul>	<ul style="list-style-type: none"> <li>Minimize disruption to traffic</li> </ul>



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<h1>Arterial</h1>							
<b>Traffic Signal Interconnect Cable</b>	<ul style="list-style-type: none"> <li>Roadway Construction</li> <li>Traffic Calming</li> <li>Roadway Widening</li> <li>Streetscaping</li> <li>Utility Work</li> <li>Traffic Signal</li> </ul>	Copper twisted pair cable, fiber optic cable, or wireless antennas; communications transmitter/receiver; termination panels to coordinate traffic signal timing	<ul style="list-style-type: none"> <li>Communications medium (copper, fiber, wireless, Ethernet...)</li> <li>Tie to existing system?</li> <li>Ability of end equipment to use the technology.</li> </ul>	\$9,000-20,000 per mile  <i>O&amp;M Cost</i> \$1,000 per mile per year	Depends on communications medium, does not include conduit (see above) Additional O&M costs if leased lines are used	<ul style="list-style-type: none"> <li>Major cost savings in construction (traffic control, mobilization, installation) – costs are substantial if done separately</li> <li>Provides private infrastructure with the ability to coordinate traffic signals to improve traffic flow along a corridor</li> <li>Provides a private infrastructure for communications to other equipment</li> <li>Cost effective when combined with other larger projects and savings could lead to additional transportation projects</li> <li>Little to no recurring costs</li> </ul>	<ul style="list-style-type: none"> <li>Improved traffic flow along a corridor</li> <li>Minimize disruption to traffic</li> <li>Improved traffic flow along corridor</li> </ul>
<b>Mid-block Vehicle Detection</b>	<ul style="list-style-type: none"> <li>Roadway Construction</li> <li>Roadway Widening</li> <li>Streetscaping</li> <li>Traffic Signal</li> </ul>	Detection device, cabling to signal cabinet, power to measure traffic volume and flow along corridors	<ul style="list-style-type: none"> <li>Detection technology (in-pavement vs. non-intrusive).</li> </ul>	\$3,000-20,000 per location  <i>O&amp;M Cost</i> \$1,000-2,000 per location	Depends on technology and installation/ mounting requirements	<ul style="list-style-type: none"> <li>If added to another project, disruption to traffic is minimized</li> <li>Reliable source of traffic data</li> </ul>	<ul style="list-style-type: none"> <li>Real-time traffic flow data could be available</li> <li>No privacy issues compared with other technologies</li> </ul>
<b>Wireless Hotspots at traffic signals</b>	<ul style="list-style-type: none"> <li>Traffic Signal</li> </ul>	Equipment in signal cabinet to allow city staff (field personnel) to access city network	<ul style="list-style-type: none"> <li>Is there adequate space in the cabinet?</li> <li>Is solution desirable?</li> <li>Proximity to other hotspots</li> <li>Place exterior equipment to avoid vandalism.</li> </ul>	\$1,000-2,000 per installation  <i>O&amp;M Cost</i> \$500 per year		<ul style="list-style-type: none"> <li>Cost effective method of providing communications</li> <li>Can be either public (leased) or private (owned)</li> <li>Opportunities for shared infrastructure with multiple agencies</li> </ul>	<ul style="list-style-type: none"> <li>Public/Private partnerships can result in added coverage for wireless access to the Internet</li> </ul>



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<h1>Arterial</h1>							
<b>Bus Rapid Transit / Queue Jump</b>	<ul style="list-style-type: none"> <li>Roadway Widening</li> <li>Roadway Construction</li> <li>Traffic Signal</li> </ul>	Device on existing structure, cabling to signal cabinet, emitter on vehicle, signal heads, signs for enhanced bus service	<ul style="list-style-type: none"> <li>Can existing controllers support the function?</li> <li>Will the geometry support a queue jump lane?</li> </ul>	\$10,000-25,000 per intersection  <i>O&amp;M Cost</i> \$1,000 per intersection	Includes on-board equipment, does not include integration or upgrade of existing equipment, does not include geometric improvements	<ul style="list-style-type: none"> <li>Enhances performance of transit</li> </ul>	<ul style="list-style-type: none"> <li>Enhance reliability and performance of transit operations</li> </ul>
<b>Pedestrian Improvements</b>	<ul style="list-style-type: none"> <li>Traffic Calming</li> <li>Streetscaping</li> <li>Traffic Signal</li> </ul>	Raised crosswalks, countdown pedestrian heads, animated pedestrian heads, in-pavement lighting to raise awareness of pedestrians	<ul style="list-style-type: none"> <li>Americans with Disabilities Act (ADA) compliance.</li> </ul>	\$500-15,000  <i>O&amp;M Cost</i> \$500-1,000 per year	Depends on extent of improvements, but typically more cost effective if part of a larger project	<ul style="list-style-type: none"> <li>Reduces the cost of installing advanced technology at a later date.</li> </ul>	<ul style="list-style-type: none"> <li>Improves visibility of pedestrians</li> </ul>



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<h1>Transit</h1>							
<b>Power</b>	<ul style="list-style-type: none"> <li>Bus Stop Improvements or Installations</li> <li>Light Rail Extension</li> </ul>	Identify service point, install service conduit for future equipment installation	<ul style="list-style-type: none"> <li>120/240V power available?</li> <li>Will solar power be adequate for anticipated usage?</li> </ul>	\$8,000-15,000 per location  <i>O&amp;M Cost</i> \$0-500 per location	Depends on distance to service, does not include PG&E costs or cost of solar equipment	<ul style="list-style-type: none"> <li>Reduces cost of installing power at a later date</li> </ul>	<ul style="list-style-type: none"> <li>Reduces disruption to traffic</li> </ul>
<b>Real-Time Information Signs</b>	<ul style="list-style-type: none"> <li>Bus Stop Improvements or Installations</li> <li>Light Rail Extension</li> <li>Transit Villages</li> </ul>	Sign, post, power, communications cabling for displaying vehicle arrival times or other information	<ul style="list-style-type: none"> <li>Is there an existing system to disseminate information to signs?</li> <li>How many signs are needed?</li> <li>Is there power near the locations of the signs?</li> </ul>	\$12,000-25,000 per sign  <i>O&amp;M Cost</i> \$500-1,000 per sign per year	Depends on sign technology, size, quantity, power and communications. Does not include the real-time information system (hardware and software).	<ul style="list-style-type: none"> <li>Provides a mechanism to inform passengers of arrivals/departures</li> <li>Improves system reliability</li> </ul>	<ul style="list-style-type: none"> <li>Reduces passenger frustration</li> </ul>
<b>Traveler Information Kiosks</b>	<ul style="list-style-type: none"> <li>Bus Stop Improvements or Installations</li> <li>Light Rail Extension</li> <li>Transit Villages</li> </ul>	Kiosk equipment, power, communications for displaying traveler information	<ul style="list-style-type: none"> <li>What information will be displayed?</li> <li>Most effective location to place the signs</li> </ul>	\$10,000-50,000 per kiosk  <i>O&amp;M Cost</i> \$1,000 per kiosk per year	Depends on how much information is made available, interface development requirements.	<ul style="list-style-type: none"> <li>Better integration with other facilities versus a stand-alone installation</li> </ul>	<ul style="list-style-type: none"> <li>Provides a mechanism for passengers to gain information and plan their trips accordingly</li> </ul>
<b>Bus Rapid Transit / Queue Jump</b>	<ul style="list-style-type: none"> <li>Transit Fleet Addition or Upgrade (BRT)</li> </ul>	Device on existing structure, cabling to signal cabinet, emitter on vehicle, signal heads, signs for enhanced bus service	<ul style="list-style-type: none"> <li>Can existing controllers support the function?</li> <li>Will the geometry support a queue jump lane?</li> </ul>	\$10,000-25,000 per intersection  <i>O&amp;M Cost</i> \$1,000 per intersection	Includes on-board equipment, does not include integration or upgrade of existing equipment, does not include geometric improvements	<ul style="list-style-type: none"> <li>Enhances performance of transit</li> </ul>	<ul style="list-style-type: none"> <li>Enhance reliability and performance of transit operations</li> </ul>



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<h1>Transit</h1>							
<b>Electronic Payment</b>	<ul style="list-style-type: none"> <li>• Light Rail Extension</li> <li>• New Fleet</li> </ul>	Fare cards, fare reader equipment, power for expedited fare collection	<ul style="list-style-type: none"> <li>• Will relevant transit agencies participate?</li> </ul>	\$250,000-600,000  <i>O&amp;M Cost</i> \$1,000-2,000	Depends on extent of integration and deployment	<ul style="list-style-type: none"> <li>• Equipment on vehicles can be done during initial vehicle production rather than after-market</li> </ul>	<ul style="list-style-type: none"> <li>• Improves coordination across multiple modes</li> </ul>
<b>CCTV cameras</b>	<ul style="list-style-type: none"> <li>• Bus Stop Improvements or Installations</li> <li>• Light Rail Extension</li> <li>• Transit Villages</li> <li>• New Fleet</li> <li>• At-Grade Railroad Crossings</li> <li>• Grade Separations</li> </ul>	Includes pan-tilt-zoom (PTZ) or fixed camera, enclosure, cabling, pole/mounting, foundation, power, communications, communications device for vehicle surveillance	<ul style="list-style-type: none"> <li>• PTZ or fixed camera?</li> <li>• New or existing structure?</li> <li>• Is there an existing video system?</li> <li>• Leased line or agency-owned communications?</li> <li>• Communications medium.</li> <li>• Is there an existing communications infrastructure?</li> <li>• Structure needs to support a camera</li> <li>• Consider power for the camera and any associated electronics?</li> </ul>	\$8,000-40,000 each  <i>O&amp;M Cost</i> \$2,000-3,000 per camera per year	Cost depends on installation on existing or new structure and other design considerations, and includes equipment and installation. Does not include communications.	<ul style="list-style-type: none"> <li>• Cost savings in construction (traffic control, mobilization)</li> <li>• Camera provides faster identification and response to incidents</li> <li>• Improve performance of traffic signal system by monitoring conditions remotely</li> <li>• Cost savings could lead to additional transportation projects</li> <li>• Improved staff efficiency when troubleshooting or verifying field issues</li> </ul>	<ul style="list-style-type: none"> <li>• Minimize disruption to traffic</li> <li>• Improved traffic flow from proactive use of cameras</li> <li>• Improved information for travel planning using real-time images</li> </ul>



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<h1>Transit</h1>							
<b>Transit Signal Priority</b>	<ul style="list-style-type: none"> <li>Light Rail Extension</li> <li>New Fleet</li> </ul>	Device on existing structure, cabling to signal cabinet, emitter on vehicle to allow transit vehicles priority phasing (not preemption) in the event the vehicle is not on schedule	<ul style="list-style-type: none"> <li>Can existing controllers support the function?</li> <li>Integration with an existing transit management/scheduling system.</li> </ul>	\$6,000-18,000 per intersection  <i>O&amp;M Cost</i> \$1,000 per intersection per year	Includes on-board equipment, does not include integration or upgrade of existing equipment, nor does it include communications to a central system.	<ul style="list-style-type: none"> <li>Cost savings in construction (traffic control, mobilization)</li> <li>Provide opportunity to offer enhanced transit service</li> <li>Improved travel time for transit vehicles</li> <li>Potential to reduce fleet size</li> </ul>	<ul style="list-style-type: none"> <li>Enhance reliability and performance of transit operations</li> </ul>
<b>Automated Vehicle Location (AVL)</b>	<ul style="list-style-type: none"> <li>Light Rail Extension</li> <li>New Fleet</li> <li>Dispatch</li> <li>Paratransit</li> </ul>	AVL unit on vehicles, central equipment to identify location of vehicles for real-time arrival or location status	<ul style="list-style-type: none"> <li>Is there an existing system to support the collection and distribution of data?</li> <li>Communications network available?</li> </ul>	\$300,000 per system  <i>O&amp;M Cost</i> \$20,000 per year	Will vary depending on the number of transit vehicles. Cost does not include a comprehensive communications infrastructure.	<ul style="list-style-type: none"> <li>Provides an automated mechanism to track vehicles, on-time performance and data for schedule adjustments</li> <li>Can process real-time monitoring data on status of transit vehicle elements for operations and maintenance</li> <li>Provides efficient use of communications system (voice and data)</li> <li>Enables greater degree of security for drivers/passengers with emergency alarms</li> <li>Provides a mechanism for schedule-based transit priority</li> </ul>	<ul style="list-style-type: none"> <li>Provides an accurate means for real-time information</li> <li>Improved security with emergency alarm capabilities</li> </ul>



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ITS Solutions	Project Types	Solution Descriptions	Deployment Considerations	Cost	Cost Considerations	Benefits to Project or Agency (of Concurrent ITS Deployment)	Benefits to Public (of ITS Deployment)
<h1>Transit</h1>							
Communications Infrastructure	<ul style="list-style-type: none"> <li>• Bus Stop Improvements or Installations</li> <li>• Light Rail Extension</li> <li>• New Fleet</li> <li>• At-Grade Railroad Crossings</li> <li>• Grade Separations</li> <li>• Para-transit</li> </ul>	Copper, fiber, or wireless communications link, end equipment	<ul style="list-style-type: none"> <li>• Is there an existing system to interface with?</li> <li>• Is conduit infrastructure needed?</li> <li>• If conduit exists and fiber is used, will the conduit accommodate fiber?</li> <li>• What is the desired topology (i.e., Ethernet, ring)</li> <li>• Ability of end equipment to use the technology.</li> <li>• Lease or own?</li> </ul>	<p>\$65,000 per mile for conduit</p> <p><i>O&amp;M Cost</i> \$9,000-20,000 per mile for communications per year</p> <p>Minimal for conduit</p>	Depends on communications medium, does not include conduit. Additional O&M costs if leased lines are used	<ul style="list-style-type: none"> <li>• Major cost savings in construction (traffic control, mobilization, installation) – costs are substantial if done separately</li> <li>• Provides private infrastructure with the ability to communicate with field equipment</li> <li>• Savings could lead to additional transportation projects</li> <li>• Little to no recurring costs compared to leasing communications</li> </ul>	<ul style="list-style-type: none"> <li>• Reduces disruption to traffic over communications being installed at a later date</li> </ul>
	Railroad Collision Avoidance	<ul style="list-style-type: none"> <li>• Light Rail Extension</li> <li>• New Fleet</li> <li>• At-Grade Railroad Crossings</li> <li>• Grade Separations</li> </ul>	In-vehicle and on-board equipment, crossing equipment for collision avoidance	<ul style="list-style-type: none"> <li>• What detection technology will be used?</li> </ul>	<p>\$100,000-150,000 per crossing</p> <p><i>O&amp;M Cost</i> \$2,000-3,000 per crossing per year</p>	Includes equipment at crossing and on vehicles. Does not include communications to a central facility	<ul style="list-style-type: none"> <li>• Equipment on vehicles can be installed during initial vehicle production rather than after-market</li> <li>• Operate safer crossings</li> </ul>



## SACRAMENTO AREA COUNCIL OF GOVERNMENTS (SACOG) SOLUTIONS TOOLBOX FOR MAINSTREAMING ITS

ITS Solutions	Project Types	Solution Descriptions	Deployment Considerations	Cost	Cost Considerations	Benefits to Project or Agency (of Concurrent ITS Deployment)	Benefits to Public (of ITS Deployment)
<h1>Emergency Management Systems</h1>							
<b>Emergency Vehicle Preemption</b>	<ul style="list-style-type: none"> <li>New Emergency Vehicles</li> </ul>	Device on existing structure, cabling to signal cabinet, emitter on vehicle to allow emergency vehicles to preempt a traffic signal for a green phase	<ul style="list-style-type: none"> <li>Which approaches are required?</li> <li>Which vehicles are to be equipped?</li> <li>Utilize encoding to prevent unauthorized use?</li> </ul>	\$6,000-18,000 per intersection  <i>O&amp;M Cost</i> \$1,000 per intersection per year	Includes on-board equipment	<ul style="list-style-type: none"> <li>Cost savings in construction (traffic control, mobilization)</li> <li>Provide ability to improve response time of emergency vehicles to incidents</li> </ul>	<ul style="list-style-type: none"> <li>Improved emergency response</li> </ul>
<b>Media Integration (for example with Public Broadcasting)</b>	<ul style="list-style-type: none"> <li>Communications System Upgrades</li> <li>Emergency Operations Center</li> </ul>	Identification of communications link, end equipment to allow public broadcasting of traveler information	<ul style="list-style-type: none"> <li>Need to establish agreements with media companies?</li> <li>What are the limitations of access (viewing only)?</li> </ul>	\$100,000-150,000  <i>O&amp;M Cost</i> \$5,000 per year	Depending on extent of integration, number of connections, and information made available	<ul style="list-style-type: none"> <li>Traveler information can be disseminated to public via radio or television</li> </ul>	<ul style="list-style-type: none"> <li>Easier access to traveler information</li> <li>Overall quantity and quality of traveler information is improved</li> </ul>
<b>TMC Co-location and Integration</b>	<ul style="list-style-type: none"> <li>Emergency Operations Center</li> </ul>	Physical cabling, end equipment, software development to enhance sharing of information	<ul style="list-style-type: none"> <li>Where will the combined center reside?</li> <li>Need to establish agreements between agencies involved.</li> </ul>	\$20,000-1,000,000  <i>O&amp;M Cost</i> \$100,000 per year	Depending on extent of integration, assumes use of existing facility. Assumes that labor is already accounted for.	<ul style="list-style-type: none"> <li>Potential for substantial savings of equipment costs by requiring less equipment</li> <li>Recurring facility costs are reduced</li> <li>Better coordination during emergency situations</li> </ul>	<ul style="list-style-type: none"> <li>Improved emergency response</li> </ul>
<b>511 Integration</b>	<ul style="list-style-type: none"> <li>Communications System Upgrades</li> <li>Emergency Operations Center</li> </ul>	Software development to allow incidents and emergency services to access and provide information to 511 to enhance information available through 511	<ul style="list-style-type: none"> <li>What is the extent of information disseminated?</li> <li>To what extent will the systems be integrated?</li> </ul>	\$100,000-500,000  <i>O&amp;M Cost</i> \$0	Depending on extent of integration to existing emergency operations databases. O&M costs are already accounted for through existing 511 Program.	<ul style="list-style-type: none"> <li>Able to adjust 511 information dynamically to account for emergency situations</li> </ul>	<ul style="list-style-type: none"> <li>Enhanced traveler information services by including impacts of emergency situations</li> </ul>



SACRAMENTO AREA COUNCIL OF GOVERNMENTS (SACOG)  
SOLUTIONS TOOLBOX FOR MAINSTREAMING ITS

ITS Solutions	Project Types	Solution Descriptions	Deployment Considerations	Cost	Cost Considerations	Benefits to Project or Agency (of Concurrent ITS Deployment)	Benefits to Public (of ITS Deployment)
<b>Emergency Management Systems</b>							
<b>Dynamic Route Guidance</b>	<ul style="list-style-type: none"> <li>• Communication System Upgrades</li> <li>• Emergency Operations Center</li> </ul>	Integrated system of field equipment and information dissemination to provide alternate real-time information in response to traffic flow impacts	<ul style="list-style-type: none"> <li>• Is there an existing system to interface with?</li> <li>• What physical means of providing the information is desired?</li> </ul>	\$100,000-150,000  <i>O&amp;M Cost</i> \$1,000-5,000 per year	Depending on extent of integration	<ul style="list-style-type: none"> <li>• Enhanced use of traveler information by public</li> </ul>	<ul style="list-style-type: none"> <li>• Dynamic traveler information that responds to current conditions</li> </ul>
<b>Automatic Vehicle Location (AVL)</b>	<ul style="list-style-type: none"> <li>• New Emergency Vehicles</li> <li>• Communication System Upgrades</li> <li>• Emergency Operations Center</li> </ul>	AVL unit on vehicles, central equipment to identify location of vehicles for real-time arrival or location status	<ul style="list-style-type: none"> <li>• Is there an existing system to support the collection and distribution of data?</li> <li>• Communications network available?</li> </ul>	\$300,000 per system  <i>O&amp;M Cost</i> \$20,000 per year	Will vary depending on the number of vehicles. Cost does not include a comprehensive communications infrastructure.	<ul style="list-style-type: none"> <li>• Provides an automated mechanism to track vehicles, on-time performance and data for schedule adjustments</li> <li>• Can process real-time monitoring data on status of transit vehicle elements for operations and maintenance</li> <li>• Provides efficient use of communications system (voice and data)</li> <li>• Enables greater degree of security for drivers/passengers with emergency alarms</li> <li>• Provides a mechanism for schedule-based transit priority</li> </ul>	<ul style="list-style-type: none"> <li>• Provides an accurate means for real-time information</li> <li>• Improved security with emergency alarm capabilities</li> </ul>



SACRAMENTO AREA COUNCIL OF GOVERNMENTS (SACOG)  
SOLUTIONS TOOLBOX FOR MAINSTREAMING ITS

ITS Solutions	Project Types	Solution Descriptions	Deployment Considerations	Cost	Cost Considerations	Benefits to Project or Agency (of Concurrent ITS Deployment)	Benefits to Public (of ITS Deployment)
<b>Commercial Vehicle Operations</b>							
<b>Weigh-in-motion</b>	<ul style="list-style-type: none"> <li>Truck Scales</li> </ul>	In-pavement equipment, transponder, in-vehicle equipment, central equipment to allow CV to be weighed in motion without stopping at the truck scales	<ul style="list-style-type: none"> <li>Is there an existing system that will support the collection of this data?</li> </ul>	\$15,000-25,000  <i>O&amp;M Cost</i> \$1,500-2,500 per year	Depending on distance from facility	<ul style="list-style-type: none"> <li>Improved efficiency at truck scales</li> </ul>	<ul style="list-style-type: none"> <li>For truck drivers, reduced delay at truck scales</li> </ul>
<b>Electronic Credentialing (with transponders or tags)</b>	<ul style="list-style-type: none"> <li>Truck Scales</li> </ul>	Transponder, in-vehicle equipment, central equipment for certifying permitting of CV	<ul style="list-style-type: none"> <li>Is there an existing system that will support the collection of this data?</li> </ul>	\$60,000-140,000  <i>O&amp;M Cost</i> \$1,000-3,000 per year	Costs do not include any integration into an existing system	<ul style="list-style-type: none"> <li>Improved efficiency at truck scales</li> </ul>	<ul style="list-style-type: none"> <li>For truck drivers, reduced delay at truck scales</li> </ul>
<b>Traveler Information Kiosks</b>	<ul style="list-style-type: none"> <li>Rest Areas</li> </ul>	Kiosk equipment, power, communications for displaying traveler information	<ul style="list-style-type: none"> <li>What information will be displayed?</li> <li>Where to draw power?</li> <li>Americans with Disabilities Act (ADA) requirements</li> </ul>	\$10,000-50,000 per kiosk  <i>O&amp;M Cost</i> \$1,000 per kiosk per year	Depends on how much information is made available, interface development requirements.	<ul style="list-style-type: none"> <li>Better integration with other facilities versus a stand-alone installation</li> </ul>	<ul style="list-style-type: none"> <li>Provides a mechanism for passengers to gain information and plan their trips accordingly</li> </ul>
<b>Commercial Vehicle Operations (CVO) – specific info for 511</b>	<ul style="list-style-type: none"> <li>Truck information</li> </ul>	Software development and integration to interface with 511 to provide traveler information or route guidance information for CVO	<ul style="list-style-type: none"> <li>What is the extent of information disseminated?</li> <li>Is there any integration into an existing system?</li> </ul>	\$100,000-300,000  <i>O&amp;M Cost</i> \$0	Depending on extent of integration. O&M costs are already accounted for.	<ul style="list-style-type: none"> <li>Create a full service 511 system</li> <li>Ability to impact and improve goods movement</li> </ul>	<ul style="list-style-type: none"> <li>Give truck drivers the opportunity to change routes in response to an incident</li> </ul>



## SACRAMENTO AREA COUNCIL OF GOVERNMENTS (SACOG) SOLUTIONS TOOLBOX FOR MAINSTREAMING ITS

ITS Solutions	Project Types	Solution Descriptions	Deployment Considerations	Cost	Cost Considerations	Benefits to Project or Agency (of Concurrent ITS Deployment)	Benefits to Public (of ITS Deployment)
<h1>Commercial Vehicle Operations</h1>							
<b>Automatic Vehicle Location (AVL)</b>	<ul style="list-style-type: none"> <li>Fleet Upgrades</li> </ul>	AVL unit on vehicles, central equipment to identify location of vehicles for real-time arrival or location status	<ul style="list-style-type: none"> <li>Is there an existing system to support the collection and distribution of data?</li> <li>Communications network available?</li> </ul>	\$300,000 per system  <i>O&amp;M Cost</i> \$20,000 per year	Will vary depending on the number of vehicles. Cost does not include a comprehensive communications infrastructure.	<ul style="list-style-type: none"> <li>Provides an automated mechanism to track vehicles, on-time performance and data for schedule adjustments</li> <li>Can process real-time monitoring data on status of transit vehicle elements for operations and maintenance</li> <li>Provides efficient use of communications system (voice and data)</li> <li>Enables greater degree of security for drivers/passengers with emergency alarms</li> <li>Provides a mechanism for schedule-based transit priority</li> </ul>	<ul style="list-style-type: none"> <li>Provides an accurate means for real-time information</li> <li>Improved security with emergency alarm capabilities</li> </ul>



## SACRAMENTO AREA COUNCIL OF GOVERNMENTS (SACOG) SOLUTIONS TOOLBOX FOR MAINSTREAMING ITS

ITS Solutions	Project Types	Solution Descriptions	Deployment Considerations	Cost	Cost Considerations	Benefits to Project or Agency (of Concurrent ITS Deployment)	Benefits to Public (of ITS Deployment)
<h1>Commercial Vehicle Operations</h1>							
<b>CCTV Camera</b>	<ul style="list-style-type: none"> <li>Truck Scales</li> </ul>	Includes pan-tilt-zoom (PTZ) or fixed camera, enclosure, cabling, pole/mounting, foundation, power, communications, communications device for surveillance	<ul style="list-style-type: none"> <li>PTZ or fixed camera?</li> <li>New or existing structure?</li> <li>Is there an existing video system?</li> <li>Leased line or agency-owned communications?</li> <li>Communications medium.</li> <li>Is there an existing communications infrastructure?</li> <li>Structure needs to support a camera</li> <li>Where to draw power for the camera and any associated electronics?</li> </ul>	\$8,000-40,000 each  <i>O&amp;M Cost</i> \$2,000-3,000 per camera per year	Cost depends on installation on existing or new structure and other design considerations, and includes equipment and installation. Does not include communications and power installation.	<ul style="list-style-type: none"> <li>Cost savings in construction (traffic control, mobilization)</li> <li>Camera provides faster identification and response to incidents</li> <li>Improve performance of traffic signal system by monitoring conditions remotely</li> <li>Cost savings could lead to additional transportation projects</li> <li>Improved staff efficiency when troubleshooting or verifying field issues</li> </ul>	<ul style="list-style-type: none"> <li>Minimize disruption to traffic</li> <li>Improved traffic flow from proactive use of cameras</li> <li>Improved information for travel planning using real-time images</li> </ul>



## SACRAMENTO AREA COUNCIL OF GOVERNMENTS (SACOG) SOLUTIONS TOOLBOX FOR MAINSTREAMING ITS

ITS Solutions	Project Types	Solution Descriptions	Deployment Considerations	Cost	Cost Considerations	Benefits to Project or Agency (of Concurrent ITS Deployment)	Benefits to Public (of ITS Deployment)
<h1>Bicycle</h1>							
<b>Surveillance (Closed Circuit Television cameras)</b>	<ul style="list-style-type: none"> <li>Bicycle storage</li> </ul>	Includes pan-tilt-zoom (PTZ) or fixed camera, enclosure, cabling, pole/mounting, foundation, power, communications, communications device for vehicle surveillance	<ul style="list-style-type: none"> <li>PTZ or fixed camera?</li> <li>New or existing structure?</li> <li>Is there an existing video system?</li> <li>Leased line or agency-owned communications?</li> <li>Communications medium.</li> <li>Is there an existing communications infrastructure?</li> <li>Structure needs to support a camera</li> <li>Where to draw power for the camera and any associated electronics?</li> </ul>	\$8,000-40,000 each  <i>O&amp;M Cost</i> \$2,000-3,000 per camera per year	Cost depends on installation on existing or new structure and other design considerations, and includes equipment and installation. Does not include communications and power installation.	<ul style="list-style-type: none"> <li>Cost savings in construction (traffic control, mobilization)</li> <li>Camera provides faster identification and response to incidents</li> <li>Improve performance of traffic signal system by monitoring conditions remotely</li> <li>Cost savings could lead to additional transportation projects</li> <li>Improved staff efficiency when troubleshooting or verifying field issues</li> </ul>	<ul style="list-style-type: none"> <li>Minimize disruption to traffic</li> <li>Improved traffic flow from proactive use of cameras</li> <li>Improved information for travel planning using real-time images</li> </ul>
<b>Bicycle Parking (lockers, storage)</b>	<ul style="list-style-type: none"> <li>Bicycle storage</li> </ul>	Advanced technology to increase security of bicycle parking	<ul style="list-style-type: none"> <li>What technology is desired?</li> </ul>	\$10,000-50,000 per site <i>O&amp;M Cost</i> \$1,000-5,000 per location	Depending on technology and extent of deployment	<ul style="list-style-type: none"> <li>Promotes bicycling</li> <li>Improves safety of leaving bicycles in a secured location</li> <li>Encourages a greater use of bicycles</li> </ul>	<ul style="list-style-type: none"> <li>Greater feeling of safety when parking bicycles</li> <li>Convenience</li> <li>Cost effective</li> </ul>
<b>Bicycle Detection</b>	<ul style="list-style-type: none"> <li>Bicycle Lanes</li> <li>At-Grade Trail Crossings</li> </ul>	Detection device, cabling to signal cabinet, power to detect bicycles at intersections	<ul style="list-style-type: none"> <li>Detection technology (in-pavement vs. non-intrusive).</li> </ul>	\$3,000-10,000 per location <i>O&amp;M Cost</i> \$1,000 per location	Depends on technology and installation/ mounting requirements	<ul style="list-style-type: none"> <li>If added to another project, disruption to traffic is minimized</li> <li>Reliable source of traffic data</li> </ul>	<ul style="list-style-type: none"> <li>Real-time traffic flow data could be available</li> <li>No privacy issues compared with other technologies</li> </ul>



SACRAMENTO AREA COUNCIL OF GOVERNMENTS (SACOG)  
SOLUTIONS TOOLBOX FOR MAINSTREAMING ITS

ITS Solutions	Project Types	Solution Descriptions	Deployment Considerations	Cost	Cost Considerations	Benefits to Project or Agency (of Concurrent ITS Deployment)	Benefits to Public (of ITS Deployment)
<h1>Bicycle</h1>							
<b>Signal Retiming</b>	<ul style="list-style-type: none"> <li>Bicycle Lane</li> <li>At-Grade Trail Crossing</li> </ul>	Signal timing will need to be modified to accommodate the increase in bicyclist at the intersection or crossing	<ul style="list-style-type: none"> <li>Should utilize bicycle detection</li> <li>Need to provide more green time for bicyclists</li> </ul>	\$8,000	Includes retiming using an analytical or simulation tool, and detection on two approaches for bicycles	<ul style="list-style-type: none"> <li>Minimize disruption to traffic if bicycle detection is installed in conjunction with another project.</li> </ul>	<ul style="list-style-type: none"> <li>Improved safety for bicycles</li> </ul>
<b>Automated Enforcement</b>	<ul style="list-style-type: none"> <li>Bicycle Lane</li> <li>At-Grade Trail Crossing</li> </ul>	Install red-light running cameras, speed sensors, emissions monitoring or noise equipment to automatically enforce violations	<ul style="list-style-type: none"> <li>What locations are the best candidates?</li> <li>Will this be a leased service or agency owned and maintained?</li> <li>Need to define processing format.</li> </ul>	\$20,000 - \$40,000  Annual leasing costs vary depending on service	Depends on installation and equipment at each location	<ul style="list-style-type: none"> <li>Minimize disruption to traffic if bicycle detection is installed in conjunction with another project.</li> </ul>	<ul style="list-style-type: none"> <li>Improved safety for bicycles</li> </ul>



## SACRAMENTO AREA COUNCIL OF GOVERNMENTS (SACOG) SOLUTIONS TOOLBOX FOR MAINSTREAMING ITS

ITS Solutions	Project Types	Solution Descriptions	Deployment Considerations	Cost	Cost Considerations	Benefits to Project or Agency (of Concurrent ITS Deployment)	Benefits to Public (of ITS Deployment)
<h1>Pedestrian</h1>							
<b>Pedestrian Detection</b>	<ul style="list-style-type: none"> <li>• Pedestrian Crossing</li> </ul>	Detection device, cabling to signal cabinet, power to detect pedestrians at intersections	<ul style="list-style-type: none"> <li>• Detection technology (in-pavement vs. non-intrusive).</li> </ul>	\$3,000-10,000 per location <i>O&amp;M Cost</i> \$1,000 per location	Depends on technology and installation/ mounting requirements	<ul style="list-style-type: none"> <li>• Improved coordination by only servicing pedestrians when present</li> <li>• Improve safety at intersections</li> </ul>	<ul style="list-style-type: none"> <li>• Information to pedestrians on safe crossing time</li> <li>• Raise awareness of pedestrians to drivers</li> </ul>
<b>New Signal or Existing Signal Modification including Pedestrian Signal Heads</b>	<ul style="list-style-type: none"> <li>• Pedestrian Crossing</li> </ul>	Traffic signal equipment, civil modifications (ADA ramps, curb/gutter to allow for treatment of pedestrians and bicycles)	<ul style="list-style-type: none"> <li>• Is a signal warranted?</li> <li>• Is or will a developer be required to pay/construct?</li> </ul>	\$50,000-200,000  <i>O&amp;M Cost</i> \$2,000-4,000 per intersection; \$500 for existing signals	Depends on extent of improvements	<ul style="list-style-type: none"> <li>• Improved coordination by only servicing pedestrians when present</li> <li>• Improve safety at intersections</li> </ul>	<ul style="list-style-type: none"> <li>• Information to pedestrians on safe crossing time</li> <li>• Raise awareness of pedestrians to drivers</li> </ul>
<b>In-Pavement Lighting</b>	<ul style="list-style-type: none"> <li>• Pedestrian Crossing</li> </ul>	To enhance the driver's ability to see pedestrians or bicycles crossing a roadway	<ul style="list-style-type: none"> <li>• What is the condition of the pavement to support these devices?</li> </ul>	\$25,000-45,000  <i>O&amp;M Cost</i> \$3,000-5,000 per year	Does not include new service. Does not include street improvements (striping or decorative crosswalk)	<ul style="list-style-type: none"> <li>• Improve safety at intersections</li> </ul>	<ul style="list-style-type: none"> <li>• Improve safety at pedestrian crossings</li> </ul>
<b>Traveler Information Kiosk</b>	<ul style="list-style-type: none"> <li>• Pedestrian Mall</li> </ul>	Kiosk equipment, power, communications for displaying traveler information	<ul style="list-style-type: none"> <li>• What information will be displayed?</li> </ul>	\$10,000-50,000 per kiosk <i>O&amp;M Cost</i> \$1,000 per kiosk per year	Depends on how much information is made available, interface development requirements.	<ul style="list-style-type: none"> <li>• Better integration with other facilities versus a stand-alone installation</li> </ul>	<ul style="list-style-type: none"> <li>• Provides a mechanism for passengers to gain information and plan their trips accordingly</li> </ul>
<b>Wireless Hotspot (only if signalized)</b>	<ul style="list-style-type: none"> <li>• Pedestrian Crossing</li> </ul>	Equipment in signal cabinet to allow city staff (field personnel) to access city network	<ul style="list-style-type: none"> <li>• Is there adequate space in the cabinet?</li> <li>• Is this a desirable solution?</li> </ul>	\$1,000-2,000 per installation  <i>O&amp;M Cost</i> \$500 per year	Does not include central equipment for integration	<ul style="list-style-type: none"> <li>• Cost effective method of providing communications</li> <li>• Can be either public (leased) or private (owned)</li> <li>• Opportunities for shared infrastructure with multiple agencies</li> </ul>	<ul style="list-style-type: none"> <li>• Public/Private partnerships can result in added coverage for wireless access to the Internet</li> </ul>



## SACRAMENTO AREA COUNCIL OF GOVERNMENTS (SACOG) SOLUTIONS TOOLBOX FOR MAINSTREAMING ITS

ITS Solutions	Project Types	Solution Descriptions	Deployment Considerations	Cost	Cost Considerations	Benefits to Project or Agency (of Concurrent ITS Deployment)	Benefits to Public (of ITS Deployment)
<h1>Pedestrian</h1>							
<b>Traffic Signal Interconnect Conduit</b>	<ul style="list-style-type: none"> <li>• Sidewalk</li> </ul>	Minimum 3" conduit, pull boxes, splice vault at key locations for future interconnect cable to coordinate traffic signal timing	<ul style="list-style-type: none"> <li>• Adequate conduit sweeps if fiber is used</li> <li>• Other design elements may be different depending on medium.</li> <li>• Placement in roadway or behind curb?</li> <li>• Are multiple conduits needed?</li> </ul>	\$65,000 per mile  <i>O&amp;M Cost</i> Minimal	Costs vary depending on number of conduit and frequency of pull boxes	<ul style="list-style-type: none"> <li>• Major cost savings in construction (traffic control, mobilization, installation) – costs are substantial if done separately</li> <li>• Provides private infrastructure with the ability to coordinate traffic signals to improve traffic flow along a corridor</li> <li>• Provides a private infrastructure for communications to other equipment</li> <li>• Cost effective when combined with other larger projects and savings could lead to additional transportation projects</li> <li>• Little to no recurring costs</li> </ul>	<ul style="list-style-type: none"> <li>• Minimize disruption to traffic</li> </ul>
<b>Traffic Signal Interconnect Cable</b>	<ul style="list-style-type: none"> <li>• Sidewalk</li> </ul>	Copper twisted pair cable, fiber optic cable, or wireless antennas; communications transmitter/receiver; termination panels to coordinate traffic signal timing	<ul style="list-style-type: none"> <li>• Communications medium (copper, fiber, wireless, Ethernet...)</li> <li>• Tie to existing system?</li> </ul>	\$9,000-20,000 per mile  <i>O&amp;M Cost</i> \$500-1,000 per mile per year	Depends on communications medium, does not include conduit (see above). Additional costs if leased lines are used	<ul style="list-style-type: none"> <li>• Major cost savings in construction (traffic control, mobilization, installation) – costs are substantial if done separately</li> <li>• Provides private infrastructure with the ability to coordinate traffic signals to improve traffic flow along a corridor</li> <li>• Provides a private infrastructure for communications to other equipment</li> <li>• Cost effective when combined with other larger projects and savings could lead to additional transportation projects</li> <li>• Little to no recurring costs</li> </ul>	<ul style="list-style-type: none"> <li>• Improved traffic flow along a corridor</li> <li>• Minimize disruption to traffic</li> <li>• Improved traffic flow along corridor</li> </ul>



## SACRAMENTO AREA COUNCIL OF GOVERNMENTS (SACOG) SOLUTIONS TOOLBOX FOR MAINSTREAMING ITS

ITS Solutions	Project Types	Solution Descriptions	Deployment Considerations	Cost	Cost Considerations	Benefits to Project or Agency (of Concurrent ITS Deployment)	Benefits to Public (of ITS Deployment)
<h1>Ports</h1>							
<b>Automatic Vehicle Location (AVL)</b>	<ul style="list-style-type: none"> <li>Port Access and Circulation Projects</li> </ul>	AVL unit on vehicles, central equipment to identify location of vehicles for real-time arrival or location status	<ul style="list-style-type: none"> <li>Is there an existing system to support the collection and distribution of data?</li> </ul>	\$300,000 per system  <i>O&amp;M Cost</i> \$20,000 per year	Will vary depending on the number of vehicles. Cost does not include a comprehensive communications infrastructure.	<ul style="list-style-type: none"> <li>Provides an automated mechanism to track vehicles, on-time performance and data for schedule adjustments</li> <li>Can process real-time monitoring data on status of transit vehicle elements for operations and maintenance</li> <li>Provides efficient use of communications system (voice and data)</li> <li>Enables greater degree of security for drivers/passengers with emergency alarms</li> <li>Provides a mechanism for schedule-based transit priority</li> </ul>	<ul style="list-style-type: none"> <li>Provides an accurate means for real-time information</li> <li>Improved security with emergency alarm capabilities</li> </ul>
<b>Dynamic Route Guidance</b>	<ul style="list-style-type: none"> <li>Port Access and Circulation Projects</li> </ul>	Integrated system of field equipment and information dissemination to provide alternate real-time information in response to traffic flow impacts	<ul style="list-style-type: none"> <li>Is the necessary equipment available to support analyzing alternate routes?</li> </ul>	\$100,000-150,000  <i>O&amp;M Cost</i> \$1,000-5,000 per year	Depending on extent of integration	<ul style="list-style-type: none"> <li>Enhanced use of traveler information by public</li> </ul>	<ul style="list-style-type: none"> <li>Dynamic traveler information that responds to current conditions</li> </ul>



## SACRAMENTO AREA COUNCIL OF GOVERNMENTS (SACOG) SOLUTIONS TOOLBOX FOR MAINSTREAMING ITS

ITS Solutions	Project Types	Solution Descriptions	Deployment Considerations	Cost	Cost Considerations	Benefits to Project or Agency (of Concurrent ITS Deployment)	Benefits to Public (of ITS Deployment)
<h1>Other</h1>							
<b>Parking reservation systems</b>	<ul style="list-style-type: none"> <li>• Parking Facility or structure</li> </ul>	Allow drivers to reserve a parking space at a specific location	<ul style="list-style-type: none"> <li>• Is there an existing parking management or guidance system to integrate with?</li> </ul>	\$15,000-100,000  <i>O&amp;M Cost</i> \$5,000-10,000 per year	Costs could vary significantly depending on level of integration and number of parking facilities participating	<ul style="list-style-type: none"> <li>• Potential to raise revenue by utilizing more parking spaces</li> <li>• Provide more efficiency for finding parking</li> </ul>	<ul style="list-style-type: none"> <li>• Reduce the amount of time driving around looking for parking</li> </ul>
<b>Ridesharing software/ website (see <a href="http://sacregion511.org">sacregion511.org</a>)</b>	<ul style="list-style-type: none"> <li>• Rideshare or Carpool program</li> </ul>	System designed to coordinate ridesharing opportunities	<ul style="list-style-type: none"> <li>• What is the extent of services and routes being offered?</li> </ul>	\$100,000-200,000  <i>O&amp;M Cost</i> \$5,000-10,000 per year	Major software development is not included	<ul style="list-style-type: none"> <li>• Provides for additional service to 511.</li> </ul>	<ul style="list-style-type: none"> <li>• Ability to coordinate rides to reduce the number of vehicles on the road</li> </ul>



## SACRAMENTO AREA COUNCIL OF GOVERNMENTS (SACOG) SOLUTIONS TOOLBOX FOR MAINSTREAMING ITS

ITS Solutions	Project Types	Solution Descriptions	Deployment Considerations	Cost	Cost Considerations	Benefits to Project or Agency (of Concurrent ITS Deployment)	Benefits to Public (of ITS Deployment)
<h1>Freeway</h1>							
<b>Transponders/ Transponder Readers</b>	<ul style="list-style-type: none"> <li>High Occupancy Vehicle (HOV) Lanes</li> </ul>	In-vehicle equipment, transponder, central equipment to allow HOV lanes to assess a toll for SOV that desire to use the HOV lane	<ul style="list-style-type: none"> <li>What is the location and frequency of devices along the roadway?</li> <li>How is the information being transmitted to a central facility?</li> <li>How is information processed?</li> </ul>	\$2,000-5,000 per site  <i>O&amp;M Cost</i> \$500-1,000 per year	Does not include communications to the devices or processing of information.	<ul style="list-style-type: none"> <li>For use with high occupancy toll lanes, agencies have the ability to collect revenue</li> <li>Can be used for travel time information</li> </ul>	<ul style="list-style-type: none"> <li>Makes the HOV lane available for single occupants</li> <li>When used for travel times, this provides another source of data collection</li> </ul>
<b>CCTV Cameras</b>	<ul style="list-style-type: none"> <li>Freeway Construction</li> <li>High Occupancy Vehicle (HOV) Lanes</li> <li>Freeway Widening</li> <li>Interchange Reconfiguration</li> <li>Auxiliary Lanes</li> <li>Grade Separation (Bridge Structure)</li> </ul>	Includes pan-tilt-zoom (PTZ) or fixed camera, enclosure, cabling, pole/mounting, foundation, power, communications, communications device for vehicle surveillance	<ul style="list-style-type: none"> <li>PTZ or fixed camera?</li> <li>New or existing structure?</li> <li>Is there an existing video system?</li> <li>Leased line or agency-owned communications?</li> <li>Communications medium.</li> <li>Is there an existing communications infrastructure?</li> <li>Structure needs to support a camera</li> <li>Where to draw power?</li> </ul>	\$8,000-40,000 each  <i>O&amp;M Cost</i> \$2,000-3,000 per camera per year	Cost depends on installation on existing or new structure and other design considerations, and includes equipment and installation. Does not include communications and power installation.	<ul style="list-style-type: none"> <li>Cost savings in construction (traffic control, mobilization)</li> <li>Camera provides faster identification and response to incidents</li> <li>Improve performance of traffic signal system by monitoring conditions remotely</li> <li>Cost savings could lead to additional transportation projects</li> <li>Improved staff efficiency when troubleshooting or verifying field issues</li> </ul>	<ul style="list-style-type: none"> <li>Minimize disruption to traffic</li> <li>Improved traffic flow from proactive use of cameras</li> <li>Improved information for travel planning using real-time images</li> </ul>



## SACRAMENTO AREA COUNCIL OF GOVERNMENTS (SACOG) SOLUTIONS TOOLBOX FOR MAINSTREAMING ITS

ITS Solutions	Project Types	Solution Descriptions	Deployment Considerations	Cost	Cost Considerations	Benefits to Project or Agency (of Concurrent ITS Deployment)	Benefits to Public (of ITS Deployment)
<h1>Freeway</h1>							
<b>Changeable Message Signs</b>	<ul style="list-style-type: none"> <li>Freeway Construction</li> <li>Freeway Widening</li> <li>Auxiliary Lanes</li> </ul>	Sign, structure, foundation, power, communications, communications device for displaying traveler information	<ul style="list-style-type: none"> <li>Sign technology.</li> <li>Communications medium.</li> <li>Is there an existing central system or will this be stand-alone?</li> <li>Where to draw power?</li> </ul>	\$75,000-250,000 each  <i>O&amp;M Cost</i> \$3,000-6,000 per sign per year	Depends on technology, size of sign, type of structure. Does not include communications and power installation.	<ul style="list-style-type: none"> <li>Cost savings in construction (traffic control, mobilization)</li> <li>With CMS, have ability to disseminate traffic condition information</li> <li>Cost savings could lead to additional transportation projects</li> </ul>	<ul style="list-style-type: none"> <li>Minimize disruption to traffic</li> <li>Travel information made available to public</li> </ul>
<b>Ramp Meters</b>	<ul style="list-style-type: none"> <li>Interchange Reconfiguration</li> </ul>	Signal heads, pole, vehicle detection, conduit, pull boxes, striping, signing, control cabinet, power, communications to allow vehicles to be metered as they enter the freeway	<ul style="list-style-type: none"> <li>Is a ramp meter warranted?</li> <li>Does the existing ramp geometry need to be modified to support the warranted ramp configuration?</li> <li>Is there an existing system to support the addition?</li> </ul>	\$30,000-50,000  <i>O&amp;M Cost</i> \$2,000-4,000 per ramp per year	Depends on length of ramp, location of cabinet, lane configuration; does not include geometric improvements or communications	<ul style="list-style-type: none"> <li>Significant cost savings when constructed with interchange modifications</li> <li>Mechanism for reducing traffic congestion freeways</li> </ul>	<ul style="list-style-type: none"> <li>Improved traffic flow on the freeway</li> <li>Reduces merge area accidents</li> </ul>
<b>Vehicle Detection</b>	<ul style="list-style-type: none"> <li>Freeway Construction</li> <li>High Occupancy Vehicle (HOV) Lanes</li> <li>Freeway Widening</li> <li>Interchange Reconfiguration</li> <li>Auxiliary Lanes</li> </ul>	Detection device, cabling to signal cabinet, power to measure traffic volume and flow along corridors	<ul style="list-style-type: none"> <li>Detection technology (in-pavement vs. non-intrusive).</li> </ul>	\$3,000-20,000 per location  <i>O&amp;M Cost</i> \$1,000-2,000 per location per year	Depends on technology and installation/ mounting requirements	<ul style="list-style-type: none"> <li>If added to another project, disruption to traffic is minimized</li> <li>Reliable source of traffic data</li> </ul>	<ul style="list-style-type: none"> <li>Real-time traffic flow data could be available</li> <li>No privacy issues compared with other technologies</li> </ul>



## SACRAMENTO AREA COUNCIL OF GOVERNMENTS (SACOG) SOLUTIONS TOOLBOX FOR MAINSTREAMING ITS

ITS Solutions	Project Types	Solution Descriptions	Deployment Considerations	Cost	Cost Considerations	Benefits to Project or Agency (of Concurrent ITS Deployment)	Benefits to Public (of ITS Deployment)
<h1>Freeway</h1>							
Communications Conduit	<ul style="list-style-type: none"> <li>Freeway Construction</li> <li>High Occupancy Vehicle (HOV) Lanes</li> <li>Freeway Widening</li> <li>Interchange Reconfiguration</li> <li>Auxiliary Lanes</li> <li>Grade Separation</li> </ul>	Minimum 2-3" conduit, pull boxes, splice vault (for fiber) for future communications between field devices and the central facility	<ul style="list-style-type: none"> <li>How many conduits are needed?</li> <li>Communications medium that will be considered (copper, fiber, wireless)</li> <li>Adequate conduit sweeps if fiber is used</li> <li>Other design elements may be different depending on medium.</li> <li>Placement in roadway or behind curb?</li> </ul>	\$65,000 per mile  <i>O&amp;M Cost</i> Minimal	Costs vary depending on number of conduit and frequency of pull boxes	<ul style="list-style-type: none"> <li>Major cost savings in construction (traffic control, mobilization, installation) – costs are substantial if done separately</li> <li>Provides a private infrastructure for communications to other equipment</li> <li>Cost effective when combined with other larger projects and savings could lead to additional transportation projects</li> <li>Little to no recurring costs</li> </ul>	<ul style="list-style-type: none"> <li>Minimize disruption to traffic</li> </ul>
Communications Cable	<ul style="list-style-type: none"> <li>Freeway Construction</li> <li>High Occupancy Vehicle (HOV) Lanes</li> <li>Freeway Widening</li> <li>Interchange Reconfiguration</li> <li>Auxiliary Lanes</li> <li>Grade Separation</li> </ul>	Copper twisted wire cable, fiber optic cable, or wireless communications between field devices and the central facility	<ul style="list-style-type: none"> <li>Communications medium (copper, fiber, wireless, Ethernet...)</li> <li>Tie to existing system?</li> </ul>	\$9,000-20,000 per mile  <i>O&amp;M Cost</i> \$500-1,000 per mile per year	Depends on communications medium, does not include conduit (see above). Additional O&M costs if leased lines are used	<ul style="list-style-type: none"> <li>Major cost savings in construction (traffic control, mobilization, installation) – costs are substantial if done separately</li> <li>Provides private infrastructure with the ability to coordinate traffic signals to improve traffic flow along a corridor</li> <li>Provides a private infrastructure for communications to other equipment</li> <li>Cost effective when combined with other larger projects and savings could lead to additional transportation projects</li> <li>Little to no recurring costs</li> </ul>	<ul style="list-style-type: none"> <li>Improved traffic flow along a corridor</li> <li>Minimize disruption to traffic</li> <li>Improved traffic flow along corridor</li> </ul>



## SACRAMENTO AREA COUNCIL OF GOVERNMENTS (SACOG) SOLUTIONS TOOLBOX FOR MAINSTREAMING ITS

ITS Solutions	Project Types	Solution Descriptions	Deployment Considerations	Cost	Cost Considerations	Benefits to Project or Agency (of Concurrent ITS Deployment)	Benefits to Public (of ITS Deployment)
<h1>Freeway</h1>							
<b>Highway Advisory Radio</b>	<ul style="list-style-type: none"> <li>Freeway Construction</li> <li>Freeway Widening</li> </ul>	Antenna, pole, power, broadcast equipment for broadcasting traveler advisories	<ul style="list-style-type: none"> <li>Need to do a frequency evaluation.</li> <li>Consider the area of coverage.</li> </ul>	\$25,000-50,000 per location <i>O&amp;M Cost</i> \$1,500-2,000 per location	Depends primarily on signal strength. Does not include communications and power installation.	<ul style="list-style-type: none"> <li>Resource for disseminating traveler information</li> <li>Can easily broadcast traffic advisories</li> <li>Low construction and maintenance costs</li> </ul>	<ul style="list-style-type: none"> <li>Real-time traveler information made available to public</li> <li>Can receive localized travel information with a standard radio</li> </ul>
<b>Roadway Weather Information System</b>	<ul style="list-style-type: none"> <li>Freeway Construction</li> </ul>	In-pavement equipment, control cabinet, power, communications cabling and equipment	<ul style="list-style-type: none"> <li>How will the information be stored?</li> <li>Where to draw power?</li> </ul>	\$25,000 per site <i>O&amp;M Cost</i> \$500-3,000 per year	Does not include communications to the site. Does not include integration into an existing system for dissemination.	<ul style="list-style-type: none"> <li>Improved efficiency in detecting potentially dangerous roadway conditions</li> <li>Offer the ability to disseminate real-time roadway conditions</li> </ul>	<ul style="list-style-type: none"> <li>Access to real-time roadway conditions</li> </ul>
<b>Portable Traffic Management Devices</b>	<ul style="list-style-type: none"> <li>Freeway Construction</li> <li>High Occupancy Vehicle (HOV) Lanes</li> <li>Freeway Widening</li> </ul>	Portable CCTV, changeable message signs traffic signal or other equipment powered by a generator, utilizing wireless communications to be used primarily during construction or special events	<ul style="list-style-type: none"> <li>How will devices communicate?</li> <li>Not the preferred solution for long term use in a single location.</li> </ul>	\$1,000-25,000 <i>O&amp;M Cost</i> \$1,000 per year	Depending on equipment. Does not include communications.	<ul style="list-style-type: none"> <li>Cost effective way to disseminate traveler information, especially during construction activities or special events</li> </ul>	<ul style="list-style-type: none"> <li>Receive traveler information during construction or special events</li> </ul>
<b>Curve Warning Systems</b>	<ul style="list-style-type: none"> <li>Freeway Construction</li> <li>Interchange Reconfiguration</li> </ul>	In-vehicle equipment, field equipment to notify a driver of an upcoming dangerous curve	<ul style="list-style-type: none"> <li>How is power being provided?</li> <li>What are the criteria for deploying at a particular location?</li> </ul>	\$1,000-5,000 <i>O&amp;M Cost</i> \$0-500 per year	Includes complete installation for one location.	<ul style="list-style-type: none"> <li>Cost efficient to install during roadway construction</li> <li>Improve safety of roadway</li> </ul>	<ul style="list-style-type: none"> <li>Provides advanced warning for drivers approaching dangerous curves</li> </ul>