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DEPARTMENT OF TRANSPORTATION

Business, Transportation and Housing Agency

M e m o r a n d u m

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Ref: **TOLLING TECHNOLOGIES**

Attached, for review and comment by the California Transportation Commission (Commission), is a summary on tolling technology developed by the Department of Transportation (Department).

A brief presentation will be given at the April 26-27, 2006 Commission meeting. The purpose of the presentation is to brief the Commission on the opportunities made possible by tolling technology as well as to inform the Commission on the Department's direction regarding this issue.

Attachment

TOLLING TECHNOLOGY DISCUSSION

Introduction

Electronic Toll Collection or ETC has proven to be an effective operational tool as well as a sound methodology for the collection of additional revenue to be used for operations and capital improvements in transportation. Recent advances in tolling technologies present a unique opportunity for improved transportation mobility in California.

The following inventory of existing and future electronic toll collection technologies is an overview designed to be the basic framework of a discussion among state agencies, private sector infrastructure development companies, and investment banks and financing organizations on how tolling could be further integrated into the California transportation landscape. These technologies also offer public private partnership opportunities for development and delivery of the actual technologies in addition to serving as methods for paying for development of physical infrastructure.

Electronic toll collection systems detect the presence and classification of vehicles, deduct the appropriate toll fees from the user's account, and, if necessary, enforce non-payment. The following inventory of existing and future tolling technology is based on present application and research. It is likely that non-transportation focused technologies will emerge in the future that will become new platforms for electronic tolling.

In-Vehicle Transponders

Current Transponder Technology: Passive Transponders

Electronic "passive" transponders are typically mounted in the windshield of the vehicle and are encoded with an identification number unique to a single user. Roadside antennas placed along the road, on overhead structures, or in conjunction with an existing tollbooth emit radio frequency signals in order to communicate with vehicle transponders. A passive transponder becomes active and provides its unique identification number when probed by the roadside antennas. Passive transponders use Backscatter Radio Frequency Identification technology at 900 MHz to provide one-way transmission of information. This technology can be used in an open-road tolling configuration (no actual toll plaza is required and the traffic is free to move unimpeded at freeway speeds).

Current Technology: Passive Transponders for High Occupancy Toll (HOT) Lanes

Current passive transponders are used for dynamic toll collection (variable pricing) on the HOT lanes on Interstate 15 in San Diego. This facility uses an open road toll configuration, and fares vary based upon time of day of facility usage. Passive transponders have been used for other purposes including the collection of vehicle-based travel time information. The San Francisco Bay Area is currently conducting a pilot project that uses the FasTrak toll facility transponders from volunteer subscribers as anonymous data collection devices. The city of San Antonio has provided thousands of inactivated, anonymous transponders to travelers free of charge in order to obtain a much richer set of available travel time data.

Future Technology: Dedicated Short Range Communication (DSRC)

The Federal Communications Commission (FCC) has recently set aside 75 MHz of bandwidth at the request of the U.S. Department of Transportation to be used solely for transportation purposes. The 5.9 GHz band for DSRC has seven channels capable of two-way communication between the vehicle and infrastructure. Channel 1 has been set aside for transportation safety while the remaining six channels are likely to be dedicated to a wide variety of public and private uses including electronic toll collection. DSRC requires active vehicle transponders that are likely to be imbedded directly into vehicles by manufacturers, as well as communication beacons placed at a predefined frequency in the roadside right-of-way.

Future Technology: Vehicle Infrastructure Integration (VII)

The Vehicle Infrastructure Integration (VII) Program is a major national effort aimed at establishing a sustainable and consistent two-way information exchange between the vehicle and the infrastructure that can be conducted at freeway speeds. The VII Program is likely to use a portion of the available DSRC bandwidth for a wide variety of services including the use of vehicles as traffic probes and incident detectors, early intersection collision warning, and real-time information regarding pending vehicle malfunctions to name a few examples. With this electronic exchange in place, toll collection may simply become one of many new services provided under VII.

Future Technology: Active, Two-Way Transponders

Future transponders will likely incorporate active technology, such as Dedicated Short Range Communication described above. Active, two-way transponders will provide a variety of opportunities not available with the current passive transponders. Services such as retail purchasing of both transportation (parking, gas, downloadable music) and on-board, real-time information exchange (crash assistance, hotel and restaurant information, and other services described under Vehicle Infrastructure Integration) will provide value-added services that would be incentives for motorists to adopt vehicle-based toll transponders.

In-Vehicle Global Positioning System (GPS)

Current Satellite-Based Technology: On-Star Satellite-Based System

The On-Star communication system (now available on many General Motors vehicle models) is likely the most recognizable satellite system used for vehicle to infrastructure-based communication available today. On-board electronic units obtain their location through Global Positioning System (GPS) satellites. Two-way communication between the user/vehicle and operator is provided through cellular technology. Offered as a subscription service, the On-Star system is dedicated to driver assistance. The potential exists to use vehicle-based satellite communication systems, such as the On-Star system, for toll collection. The use of accurate satellite technology may reduce the need for roadside tolling equipment. Since the vehicle's position is accurately known, the vehicle's entry and exit points from the toll facility can be precisely determined.

Future Satellite-Based Technology: Satellite-Based Tolling

A prototype satellite based truck tolling system has recently been deployed in Germany and Austria. Similar to On-Star in function, the system determines that the user is near the toll facility, based on location provided by the on-board GPS, and begins to search for roadside units to communicate and validate the entry to the toll facility. After verification of the location, tolling is carried out using the Global System for Mobile communication (GSM) network. GSM is a European standard for mobile phone communications. The prototype German system may be deployed once the more accurate European GPS satellites, called Galileo, become fully functional.

In the state of Washington, the Puget Sound Regional Council has initiated a pilot project with 500 voluntary participants using satellite based tolling to charge variable fees. Passenger vehicles are tracked by on-board GPS, and GSM technology is used to maintain contact between the vehicles and a control center. For every trip that is recorded, a fee will be charged, depending on the road that is used and the time of day. The objective of this pilot study is to find out what effects road-use fees, which vary according to time and distance, have on driving behavior.

Transponder to Back Room Operations (Backhaul)

Current Technology: Wide Area Networks (WAN)

The toll facility roadside antennas pass user information from vehicle transponders to a central data management system via a wide area network. The WAN is comprised of a number of communication services, such as telephone data systems, fiber, and wireless services. The central data management system processes the information (user identification, vehicle class, etc.) and passes the relevant information to a separate accounting system for user rating, billing, invoicing and accounting. The central data management system can also be used to monitor the status of roadside communication, enforcement, customer relationship management, and reporting and statistics. The data management system also provides a mechanism for the user to access account information through the Internet for various services. These services include the establishment of accounts, monitoring account activity, and bill payment.

Future Technology: Wireless Connectivity

The future holds significant opportunity for the wireless backhaul option including the newly developed Worldwide Interoperability for Microwave Access (WiMAX) backhaul communication system. WiMAX is a wireless metropolitan area network technology that can connect via the Wi-Fi spectrum (IEEE 802.11) to the Internet. Another future option, IEEE 802.16, provides up to 31 miles of linear service area range and allows users connectivity without a direct line of sight to a base station.

Future Technology: Satellite Connectivity

The potential exists for backhaul operations using satellite communications. It will provide a direct connection between the vehicle and the central data management system, thus eliminating the need

for any roadside equipment. Using GPS, the vehicle's position data is collected and forwarded to a centralized data management center where the appropriate toll is determined and billed to the user.

Conclusion

A key consideration in the deployment of these new technologies is that Federal standards will be needed to attract the investment of vehicle manufacturers. Another consideration is that development of public private partnerships may be achieved more rapidly if flexibility can be provided for more than one tolling technology to be employed, depending on the type of facility built.