BRIEFING BOOK FOR THE CALIFORNIA ROAD CHARGE TECHNICAL ADVISORY COMMITTEE

Pre-Meeting Background Reading for TAC Meeting #3

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March 27, 2015

BRIEFING BOOK FOR TAC MEETING #3

Table of Contents

SECTION 1
TAC DECISION SCHEDULE

To be discussed during Agenda Item #4

Summary of the TAC Decision Schedule

This section constitutes a comprehensive summary of the decision points that the TAC needs to address to fulfill its responsibilities under SB 1077, organized by the remaining meetings to be held in 2015 and informed by ongoing work streams being conducted by CTC staff, Caltrans, and the consulting team. The remaining pages of this section present three distinct but consistent presentations of the TAC decision points, summarized as follows:

- First, the page that follows is a one-page summary table providing an overview of all of the questions the TAC needs to address, organized chronologically according to when the question will be raised and discussed at TAC meetings, and indicating which work streams will inform the TAC's discussion.
- Secondly, following the summary table, we present a detailed look at each of the 10 remaining TAC meetings, from March through December. These pages include topic areas that each meeting will cover; statutory language associated with each topic area; and any corresponding TAC decision points to address in the meeting.
- Finally, at the end of this section, we present an index of the portions of SB 1077 that directly relate to the TAC's responsibilities (Section 3090), along with an outline of the corresponding work streams that the TAC will incorporate into its deliberations and decisions related to each item in the statute.

This Decision Schedule will be updated each month to reflect decisions made. Although CTC staff, Caltrans, and the consulting team recommend that the TAC achieve consensus and direction on the questions presented here in the timeframes presented, this Decision Schedule will be a living document. Any changes, such as moving questions up or down on the schedule or adding new questions will be reflected in the briefing materials each month and discussed at each meeting.

MONTH	TOPICS	TAC DECISION POINTS TO BE RAISED	PAGE
March	**Technical Design**	**Should both manual and automated recording and reporting be offered?**	**6**
		Should a GPS-based option for recording mileage be offered in the pilot?	
		Should road charging use open or closed systems?	
	Communications	**Input to TAC communications process.**	
April	Technical Design	What mileage measurement and reporting method(s) are most promising?	7
		What technologies should be further studied to pursue those measurement and reporting methods?	
		Should the pilot assess road charges on out-of-state vehicle owners driving on California roads?	
	Organizational Design	Should the pilot test interoperability with other states considering road charges? Interoperability with toll systems?	
		Should the pilot test offer multiple account managers?	
	Communications	Feedback on survey questions and focus group plan.	
May	Policy	What types of participants should be included in the pilot?	8
		Are there any exemptions from road charging?	
		What specific personal privacy protections should be used for the pilot?	
	Business Case Analysis	What vehicles are included in the pilot?	
		Should the per-mile rate differ by vehicle type?	
June	Technical Design	What system data security requirements should be used for the pilot?	9
		How many participants should be involved in the pilot?	
		How should participants be distributed throughout the state?	
July	Evaluation Strategy	What evaluation criteria does the TAC recommend for the pilot?	10
August	Technical Design	What type of enforcement and compliance activities should be demonstrated during the pilot?	11
September	Evaluation Strategy	Finalize evaluation criteria.	12
	Policy	Address additional questions raised during the course of TAC meetings.	
	Communications	Has the TAC adequately gathered, considered, and addressed public comment on pilot issues?	
October	Report to CalSTA	Feedback on report outline.	13
	Policy	Address additional questions raised during the course of TAC meetings.	
November	Report to CalSTA	Feedback on draft report.	14
December	Report to CalSTA	Adopt final report on recommendations to CalSTA.	15

March: Meeting #3

FOCUS TOPICS	RELATED SB 1077 STATUTE	TAC DECISION POINTS
Technical Design: Road charge operational concepts	3090(e): The TAC shall study road charge alternatives to the gas tax… and shall make recommendations on the design of a pilot program.	• Should both manual and automated distance recording and reporting be offered?
Technical Design: Enabling technologies	3090(f) 1-7: In studying the road charge alternatives... the TAC shall take the following into consideration: availability, adaptability, reliability, security, protection of PII, ease of recording and reporting, ease of administering collection of charges, effective methods of maintaining compliance, ease of re-identifying location data, and privacy concerns when using location data with other technologies. 3091(b)1: At a minimum, the pilot program shall… analyze alternative means of collecting road usage data, including at least one alternative that does not rely on electronic vehicle location data.	• Should a GPS-based option for recording mileage be offered in the pilot?
Technical Design: System architecture	3090(e): The TAC shall study road charge alternatives to the gas tax…and shall make recommendations on the design of a pilot program…	• Should road charging use open or closed systems?
Communications and Public Engagement: TAC communications framework	3090(e): The TAC shall gather public comment on issues and concerns related to the pilot program…	• Input to TAC communications process.

April: Meeting #4

FOCUS TOPICS	RELATED SB 1077 STATUTE	TAC DECISION POINTS
Technical Design: Road charging operational concepts & enabling technologies	3090(e): The TAC shall study road charge alternatives to the gas tax…and shall make recommendations on the design of a pilot program… 3090(f) 1-7: In studying the road charge alternatives... the TAC shall take the following into consideration: availability, adaptability, reliability, security, protection of PII, ease of recording and reporting, ease of administering collection of charges, effective methods of maintaining compliance, ease of re-identifying location data, and privacy concerns when using location data with other technologies.	• What mileage measurement and reporting method(s) (i.e., Operational Concepts) are most promising? • What technologies should be further studied to pursue those measurement and reporting methods? • Should the pilot assess road charge on out-of-state vehicle owners driving on California roads?
Organizational Design: Introduction to inter-agency work group and other organizational issues	3090(f) 4,8: In studying the road charge alternatives… the TAC shall take the following into consideration: the ease… of administering the collection of taxes and fees as an alternative to the current system of taxing highway use through motor vehicle fuel taxes.	• Should the pilot test interoperability with other states considering road charges? • Should the pilot test interoperability with California toll systems? • Should the pilot test offer multiple account managers, including commercial providers, to offer varying participant experiences?
Communications: Telephone survey questions	3090(e): The TAC shall gather public comment on issues and concerns related to the pilot program…	• Feedback on survey questions.
Communications: Focus group planning	3090(e): The TAC shall gather public comment on issues and concerns related to the pilot program…	• Feedback on focus group plan.

May: Meeting #5

FOCUS TOPICS	RELATED SB 1077 STATUTE	TAC DECISION POINTS
Technical Design: Pilot draft Concept of Operations	3090(e): The TAC shall study road charge alternatives to the gas tax…and shall make recommendations on the design of a pilot program…	Informational item only
Policy: Equity considerations	3090(e): The TAC shall study road charge alternatives to the gas tax…and shall make recommendations on the design of a pilot program…	• What types (households, businesses, etc.) of participants should be included in the pilot? • Are there any exemptions from road charging?
Policy: Privacy measures	3090(f) 2, 6, 7, and 8: In studying the road charge alternatives… the TAC shall take the following into consideration: the necessity of protecting all personally identifiable information used in reporting highway use… the ease of re-identifying location data… increased privacy concerns when location data are used in conjunction with other technologies… and public and private agency access.	• What specific personal privacy protections should be used for the pilot?
Business Case Analysis: Introduction and preliminary results	3090(f) 3-4: In studying the road charge alternatives… the TAC shall take the following into consideration: the cost of recording and reporting highway use… and the cost of administering the collection of taxes and fees as an alternative to the current system of taxing highway use through motor vehicle fuel taxes.	• What vehicles are included in the pilot—all vehicles or passenger vehicles only? • Should the per-mile rate differ by vehicle type?

June: Meeting #6

FOCUS TOPICS	RELATED SB 1077 STATUTE	TAC DECISION POINTS
Technical Design: Revised draft pilot Concept of Operations	3090(e): The TAC shall study road charge alternatives to the gas tax…and shall make recommendations on the design of a pilot program… 3090(f) 8: In studying the road charge alternatives… the TAC shall take the following into consideration: and public and private agency access… to data collected and stored for purposes of road charging.	• What system data security requirements should be used for the pilot?
Technical Design: Other pilot test design parameters	3090(e): The TAC shall study road charge alternatives to the gas tax…and shall make recommendations on the design of a pilot program…	• How many participants should be involved in the pilot? • How should participants be distributed throughout the state?
Business Case Analysis: Updated results based on initial TAC pilot design recommendations	3090(f) 3-4: In studying the road charge alternatives… the TAC shall take the following into consideration: the cost of recording and reporting highway use… and the cost of administering the collection of taxes and fees as an alternative to the current system of taxing highway use through motor vehicle fuel taxes.	Informational item only
Evaluation Strategy: Introduction, alternative approaches, and possible criteria	3090(e): The TAC may also make recommendations on the criteria to be used to evaluate the pilot program. 3092(a) 1-11: … The [CalSTA] report [on the results of the pilot program] shall include… a discussion of [various evaluation criteria].	Informational item only

July: Meeting #7

FOCUS TOPICS	RELATED SB 1077 STATUTE	TAC DECISION POINTS
Evaluation Strategy: Evaluation criteria	3090(e): The TAC may also make recommendations on the criteria to be used to evaluate the pilot program. 3092(a) 1-11: … The [CalSTA] report [on the results of the pilot program] shall include… a discussion of [various evaluation criteria].	• What evaluation criteria does the TAC recommend for the pilot?
Communications: Telephone survey update	3090(e): The TAC shall gather public comment on issues and concerns related to the pilot program…	Informational item only
Communications: Focus groups update	3090(e): The TAC shall gather public comment on issues and concerns related to the pilot program…	Informational item only

August: Meeting #8

FOCUS TOPICS	RELATED SB 1077 STATUTE	TAC DECISION POINTS
Technical Design: Draft final pilot Concept of Operations	3090(e): The TAC shall study road charge alternatives to the gas tax…and shall make recommendations on the design of a pilot program…	• What type of enforcement and compliance activities should be demonstrated during the pilot?
Business Case Analysis: Updated results based on updated TAC pilot design recommendations	3090(f) 3-4: In studying the road charge alternatives… the TAC shall take the following into consideration: the cost of recording and reporting highway use… and the cost of administering the collection of taxes and fees as an alternative to the current system of taxing highway use through motor vehicle fuel taxes.	Informational item only
Organizational Design: Update from inter-agency work group	3090(f) 4: In studying the road charge alternatives… the TAC shall take the following into consideration: the ease… of administering the collection of taxes and fees as an alternative to the current system of taxing highway use through motor vehicle fuel taxes.	Informational item only

September: Meeting #9

FOCUS TOPICS	RELATED SB 1077 STATUTE	TAC DECISION POINTS
Evaluation Strategy: Evaluation criteria selection and strategy guidance	3090(e): The TAC may also make recommendations on the criteria to be used to evaluate the pilot program. 3092(a) 1-11: … The [CalSTA] report [on the results of the pilot program] shall include… a discussion of [various evaluation criteria].	• Finalize evaluation criteria
Policy: Review of parking lot items	3090(e): The TAC shall study road charge alternatives to the gas tax…and shall make recommendations on the design of a pilot program…	• Address additional questions raised during course of TAC meetings
Communications: Review of TAC public engagement efforts	3090(e): The TAC shall gather public comment on issues and concerns related to the pilot program…	• Has the TAC adequately gathered and considered public comment on issues related to the pilot program and addressed them?
Report to CalSTA: Outline of recommendations report to CalSTA	3090(e): The TAC shall study road charge alternatives to the gas tax…and shall make recommendations on the design of a pilot program. The TAC may also make recommendations on the criteria to be used to evaluate the pilot program.	Informational item only

October: Meeting #10

FOCUS TOPICS	RELATED SB 1077 STATUTE	TAC DECISION POINTS
Report to CalSTA: Review of draft recommendations report to CalSTA	3090(e): The TAC shall study road charge alternatives to the gas tax…and shall make recommendations on the design of a pilot program. The TAC may also make recommendations on the criteria to be used to evaluate the pilot program.	• Feedback on report outline
Policy: Review of parking lot items	3090(e): The TAC shall study road charge alternatives to the gas tax…and shall make recommendations on the design of a pilot program…	• Address additional questions raised during course of TAC meetings

November: Meeting #11

FOCUS TOPICS	RELATED SB 1077 STATUTE	TAC DECISION POINTS
Report to CalSTA: Draft final recommendations report to CalSTA	3090(e): The TAC shall study road charge alternatives to the gas tax…and shall make recommendations on the design of a pilot program. The TAC may also make recommendations on the criteria to be used to evaluate the pilot program.	• Feedback on draft report

December: Meeting #12

FOCUS TOPICS	RELATED SB 1077 STATUTE	TAC DECISION POINTS
Report to CalSTA: CalSTA review and comments on recommendations report	3090(e): The TAC shall study road charge alternatives to the gas tax…and shall make recommendations on the design of a pilot program. The TAC may also make recommendations on the criteria to be used to evaluate the pilot program. Section 3091: Based on the recommendations of the [TAC], [CalSTA] shall implement a pilot program to identify and evaluate issues related to the potential implementation of a [road charge] program.	• Adopt final report on recommendations to CalSTA

Summary of Topics that Satisfy Statutory TAC Requirements

3090 SECTION	TOPICS THAT WILL INFORM TAC DISCUSSION AND DECISIONS
(e) Study road charge alternatives	Policy, Technical Design, Business Case Analysis, Organizational Design
(e) Recommend pilot design alternatives	Policy, Technical Design, Report to CalSTA
(e) Gather public comment on issues & concerns	Communications and Public Engagement
(e) Recommend evaluation criteria	Evaluation Strategy, Report to CalSTA
(f) (1) Availability	Technical Design
(f) (1) Adaptability	Technical Design
(f) (1) Reliability	Technical Design
(f) (1) Security	Technical Design
(f) (2) Necessity of protecting PII	Policy, Technical Design
(f) (3) Ease of recording & reporting highway use	Technical Design, Communications & Public Engagement
(f) (3) Cost of recording & reporting highway use	Business Case Analysis
(f) (4) Ease of administering collection of charges	Organizational Design, Technical Design
(f) (4) Cost of administering collection of charges	Business Case
(f) (5) Effective methods of maintaining compliance	Technical Design, Organizational Design
(f) (6) Ease of re-identifying location data	Technical Design, Policy
(f) (7) Privacy concerns when using location data with other technologies	Technical Design, Policy
(f) (8) Public & private agency access to data	Organizational Design, Technical Design, Policy

SECTION 2
POLICY OVERVIEW

To be discussed during Agenda Item #10

Policy Overview for Meeting #3

In the subsequent sections of this briefing book, and in presentations at the March meeting, we will introduce methods and technologies available for vehicles to measure and report mileage information that forms the foundation of a road charging system. As the discussion progresses from future automotive technologies to open versus closed system architectures, interoperability, and various ways of measuring and reporting distance driven, it is critical to consider each of the technical possibilities with respect to the tasks laid out in SB 1077, Section 3090.

As shown in the Decision Schedule, this month, we would like to reach consensus on three high-level policy questions:

1. **Should both manual and automated distance recording and reporting be offered?**
2. **Should a GPS-based option for recording mileage be offered in the pilot?**
3. **Should road charging use open or closed systems?**

Please note that at this point the questions are still very generalized, and the answers we would like to arrive at now take the form of yes/no, one/all, either/or. This is in recognition that we are early in the process of discussing all the options available to the TAC in formulating its recommendations for the structure and evaluation of the pilot. The goal is to begin to sharpen the focus on the operational, technical, and organizational concepts that most interest the TAC and best support the pilot. We will revisit many of these questions with greater specificity in the coming months, and they remain open to revision, as necessary.

Question 1: Should both manual and automated distance recording and reporting be offered?

A variety of operational concepts exists for road charging, ranging from purchasing and displaying paper mileage permits to periodic odometer readings to fully automated measurement and reporting that distinguishes between in-state travel and out-of-state travel without intervention by the driver. These options are discussed in subsequent sections of this document. They all fall into one of two general classes: (1) electronic and (2) non-electronic.

Other road charging programs have found that offering choice of distance reporting methods is key to gaining public acceptance of the program, and SB 1077 endorses that principle as well. This is an important question for the TAC for the following reasons:

- The range of road charging options (odometer reading, UBI devices, GPS, flat fee, mileage or time-based permits) break down broadly into automated and manual categories of options for taxpayers to choose based on their individual preferences.
- When considering road charging implementation across the entire vehicle fleet, it is important to consider whether the methods offered will be feasible for the fleet of vehicles on which it is envisioned to apply (i.e., older vehicles may not be equipped to comply with some automated methods).
- In New Zealand, motorists are offered the choice of an automated system operated through a commercial service provider, or a manual system operated by the government.
- Experience from research and pilot projects in the U.S. shows that some motorists will prefer highly automated options, while others will prefer manual approaches.
- There is a tradeoff between cost and user acceptance: manual options are typically desirable to satisfy some segment of the public, but depending upon the administrative process and requirements, their operations may be comparatively costly.

Question 2: Should a GPS-based option for recording mileage be offered in the pilot?

If the decision is taken to consider automated distance recording and reporting methods, it becomes necessary to decide whether to include GPS-based technologies as one (or more) of the automated options.

The decision whether to offer a GPS-based option for the pilot involves trade-offs:

- While often the focal point of privacy concerns, GPS-based technologies can offer some conveniences to motorists who do a significant portion of their driving outside California or on private roads, and recent in-vehicle technology developments minimize or even eliminate the transmission of location data outside the vehicle.
- On the other hand, the most important step forward in road charging policy in the U.S. in the past decade has been the recognition that GPS is not required.

Question 3: Should road charging use open or closed systems?

A critical element of the pilot program design has to do with the system architecture adopted for it. While there are virtually limitless combinations of the various technical details, they can all be grouped into either closed or open systems. You can find a detailed discussion of the characteristics of open and closed systems in Section 4 of this document. This decision has far reaching impacts on system cost, adaptability, customer friendliness, state agency procurement flexibility, and resources devoted to developing standardized interfaces.

What does it mean when a system is “closed” or “open”?

- Closed System: An internally integrated system controlled by a single entity with essential components that cannot be substituted by other external components, which could perform the same functions.
- Open System: An integrated system based on common standards and an operating system accessible to the marketplace whereby components performing the same function can be readily substituted or provided by multiple providers.

SECTION 3
OPERATIONAL CONCEPTS

To be discussed during Agenda Item #11

Introduction to Operational Concepts and their Relationships to Enabling Technologies

Before technologies to support road charges can be meaningfully discussed, it is important to understand the possible methods by which roadway usage can be reported and paid for. We call the various methods for recording and reporting usage **operational concepts**. In the following pages, we present seven basic operational concepts for road charging.

Each of the seven operational concepts is supported by various technology components. In the appendix, we present details on these technologies. Some technologies support one operational concept, while others can support multiple concepts.

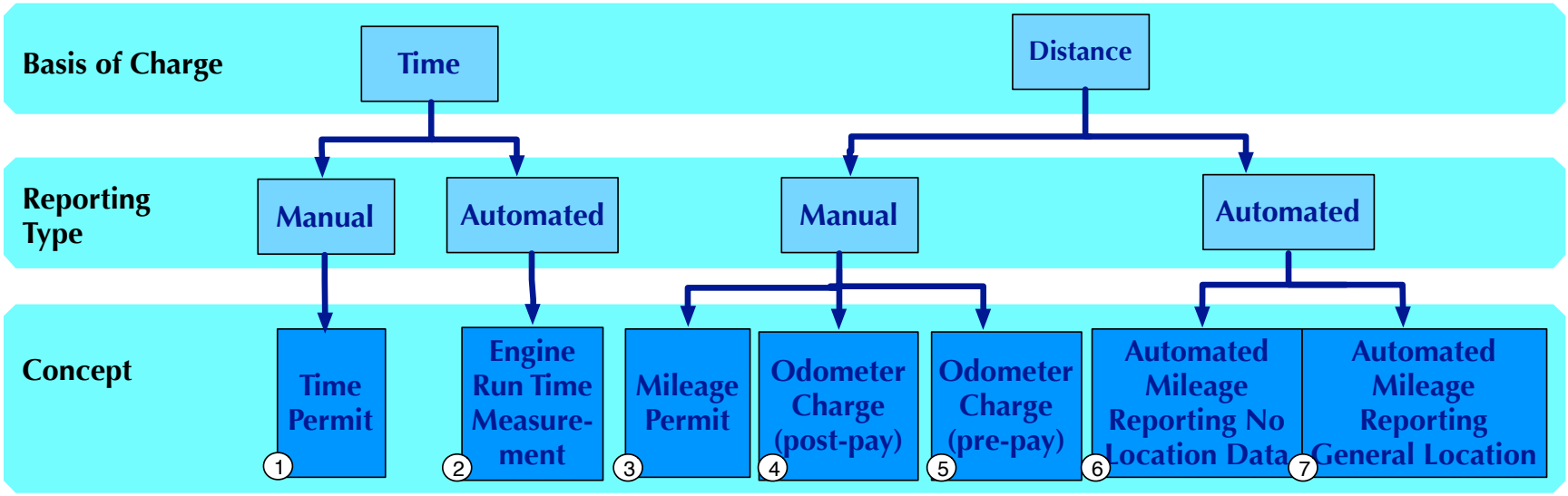
Roadway use can be measured in both time and distance. The operational concepts presented here include two that use time as a basis for road charges, and five that use distance as a basis for road charges. Reporting road use can be done manually by the motorist (or user), or it can be automated. With four of the concepts, the reporting responsibility falls on the user, while three of the concepts are automated.

To fulfill user choice as required under SB 1077, we expect that more than one operational concept would be deployed in a California road charge pilot program: motorists could choose one of the various operational concepts supported. Indeed, it is relatively straightforward to create a program that supports any combination of the operational concepts, except concept 2 (Engine Run Time Charge), which has a structure that is difficult to combine with other operational concepts.

The diagram on the next page illustrates the classification of the seven operational concepts by basis of charge (time or distance) and reporting type (manual or automated).

Breakdown of Operational Concepts

The figure below illustrates a typology of road charge operational concepts, based on various combinations of the basis of charge (time or distance) and reporting type (manual or automated). In total, there are seven operational concepts. The following pages describe each concept in turn.



Questions to Consider in Reviewing this Section

Should both electronic and non-electronic distance recording and reporting be offered?

- Concepts 1, 3, 4, and 5 can be operationalized using either electronic or non-electronic means to record and report road use.
- Concepts 2, 6, and 7 can only be operationalized using electronic means to both record and report road use.
- Many of the concepts are easily combined. This means it is possible to offer both electronic and non-electronic options.

Should a GPS-based option for recording mileage be offered in the pilot?

- Concepts 1, 2, 4, 5, and 6 do not allow for any location information (e.g., GPS data) to be collected as part of the recording and reporting of road use.
- Concept 3 could be accomplished without location data, but some motorists could choose an electronic, GPS-enabled commercial service to comply with Concept 3.
- Only Concept 7 requires GPS.

Concept 1: Time Permit

Concept 1 is a permit issued by the state that allows a motorist unlimited road use in California for a specific period, such as a year, month, or week. A common way to operationalize time permits is using stickers or decals.

- European vignette systems require visitors to pay for highway use by purchasing windshield stickers (see Slovenian vignette at right).
- California requires nonresident commuters from Oregon, Nevada, and Arizona to purchase and display stickers valid for up to two years if they work in California within 35 miles of the border.

Stickers are not the only way to operationalize a time permit. Some European countries have transitioned to electronic vignettes, which works as follows:

1. Vehicles register their license plates with a country's road charge database
2. Drivers can purchase time permits via smartphone apps, in-vehicle telematics, websites, or telephone; their payment status is immediately reflected in the database.
3. An enforcement officer can look up the payment status of any vehicle by typing the license plate number into a computer connected to the database.

The time permit is straightforward to combine with other operational concepts as part of a package.

- Time permits represent one way for out-of-state travelers entering California to pay for a road charge in lieu of fuel taxes.
- If time permits are offered for California residents, it is important to consider the rate to be charged, for example to avoid impacting low-income residents with a large one-time fee. It is also important to consider combinability with other fees such as vehicle registration.

Concept 2: Engine Run Time

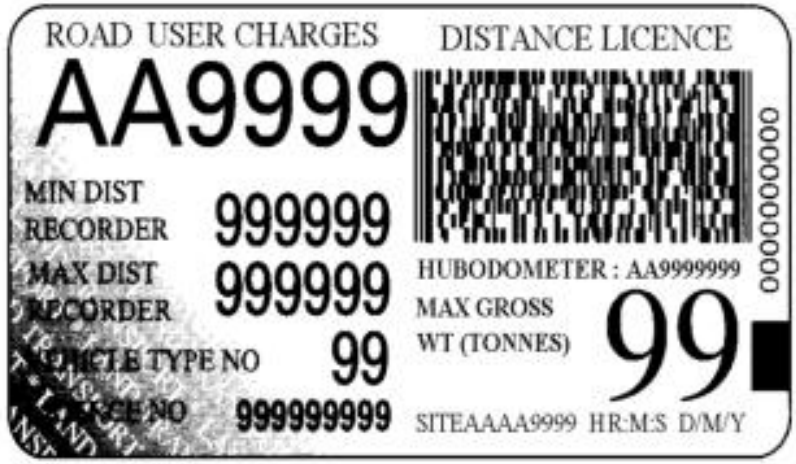
If a vehicle's engine is running, it is likely using the road system. Because of this, engine run time is a proxy for road use. Like charging based on distance, engine run time charges people based on distance traveled. However, motorists also pay more when they sit in congestion or travel on slower roads.

- For most conventional vehicles, engine vibration sensors could be installed to record time as the engine runs. While vibration sensors exist, the technology to connect a sensor to the vehicle and transmit data to a billing entity would need to be developed. An off-the-shelf, turnkey solution is not available today. Moreover, software would need to be developed to filter vibration data to ensure that other ambient vibrations (e.g., a jackhammer) are not mistaken for a running engine.
- For electric vehicles, whose engines do not vibrate, an algorithm would need to be developed to compute engine run time based on other data generated by the vehicle. The simplest algorithm would be to check if the vehicle speed is greater than 0. However, this would mean that electric vehicles would not pay for roadway use while stopped at traffic lights, for example, while conventional vehicles would pay in this case, a possible inequity.

This concept has never been implemented. One concern is that this concept may negatively impact safety if motorists drive faster in hopes of paying less in road charges. Moreover, motorists may complain that people who live in areas with better transportation infrastructure sit in traffic less and thus pay less. People who warm or cool their cars before they drive would also pay for the time that their engines are running to heat or cool the vehicle, but not driving. These possible inequities would need to be addressed.

Concept 3: Mileage Permit (pre-pay)

A mileage permit is a user-reporting concept, similar to Concept 1, the time permit—except that its basis is distance traveled instead of time. Motorists purchase blocks of miles in this concept, instead of blocks of time. The license system in New Zealand for diesel vehicles is an example of a mileage permit system.



- Motorists could choose to buy mileage blocks in an amount that best suits their needs, habits, and ability to pay. For example, motorists with cash constraints may choose to purchase only 1,000 miles at a time, while those with more money available could purchase larger blocks of miles (e.g., 10,000) to reduce the number of times that they have to return to purchase new blocks.
- Motorists choosing this method would need to obtain an official, certified odometer reading of their vehicles at the outset of a mileage permit program. After that, they would be responsible for purchasing additional blocks of miles before all previously purchased miles have been used.
- This concept could be combined with other concepts as part of a menu of choices for motorists to comply with road charge requirements.

Concept 4: Odometer Charge (post-pay)

Both this concept and Concept 5, odometer charge (pre-pay), mean road charge payment based on miles traveled as measured by the vehicle odometer. The odometer can be read by a state official or representative. Alternatively, the motorist could self report the odometer reading, and random audits and other enforcement methods can be used to maintain compliance.

- In a post-pay concept, the motorist provides an odometer reading at the start of the year
- At the end of the year, the motorist provides another odometer reading and pays the effective per-mile rate times the number of miles elapsed.
- The second reading serves as the baseline reading for the following year.
- It should be noted that the dates of the odometer readings cannot be guaranteed to be precisely 12 months apart, as this would be too burdensome to require. Realistically, the state may only be able to require that a reading be taken within a given 30-day window. In this case, any given payment could represent a week or two more or less than a full year. However, such minor variations will likely not have a meaningful impact on overall revenues.

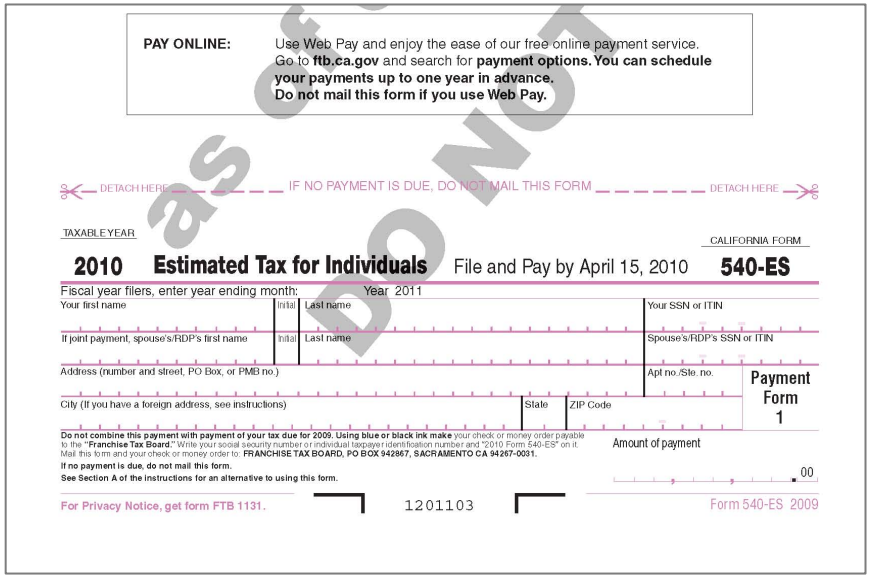
Despite the relative simplicity from a motorist perspective, post-pay has several potential disadvantages.

- Payment of the tax for road use does not occur until the end of a 12-month period. By comparison, fuel taxes are collected and remitted monthly or quarterly, typically within a few weeks of the time the fuel was used to power a vehicle on the road. This postponement could lead to cash flow issues for the state.
- There are several opportunities for fraud and evasion, including odometer rollback, under-reporting of miles, and attempting to move out of state or sell the vehicle before paying the road charge. Consequently, odometer charges, particularly post-pay charges, require a robust compliance and enforcement effort.

Concept 5: Odometer Charge (pre-pay)

This concept is similar to Concept 4, except that in a pre-pay concept, motorists pay up front. It is similar to estimated income taxes, whereby taxpayers pay in advance based on estimated income.

- First, motorists would pay a road charge based on an estimate of how many miles they expect to drive in the year ahead, or perhaps (for the first year at least) based on a fixed number of miles the state prescribes.
- At the end of the year, motorists reconcile the difference between the prepaid road charge and the amount owed based on miles actually driven. If motorists drove fewer miles than they paid for at the start of the year, they would receive a refund or account credit toward the next year. If they drove more miles than estimated, an additional payment would be due.
- Finally, the estimate of miles to be traveled in the next year might be based on the amount of miles reported in the previous year.



PAY ONLINE: Use Web Pay and enjoy the ease of our free online payment service. Go to **ftb.ca.gov** and search for **payment options. You can schedule your payments up to one year in advance. Do not mail this form if you use Web Pay.**

DETACH HERE — IF NO PAYMENT IS DUE, DO NOT MAIL THIS FORM — DETACH HERE

TAXABLE YEAR **2010** **Estimated Tax for Individuals** File and Pay by April 15, 2010 CALIFORNIA FORM **540-ES**

Fiscal year filers, enter year ending month: Year 2011

Your first name | Initial | Last name | Your SSN or ITIN

If joint payment, spouse's/RDP's first name | Initial | Last name | Spouse's/RDP's SSN or ITIN

Address (number and street, PO Box, or PMB no.) | Apt no./Ste. no.

City (If you have a foreign address, see instructions) | State | ZIP Code

Payment Form 1

Do not combine this payment with payment of your tax due for 2009. Using blue or black ink make your check or money order payable to the "**Franchise Tax Board.**" Write your social security number or individual taxpayer identification number and "2010 Form 540-ES" on it. Mail this form and your check or money order to: **FRANCHISE TAX BOARD, PO BOX 942867, SACRAMENTO CA 94267-0031.**

If no payment is due, do not mail this form.

See Section A of the instructions for an alternative to using this form.

Amount of payment .00

For Privacy Notice, get form FTB 1131. 1201103 Form 540-ES 2009

As with the post-pay odometer charge concept, there are several opportunities for errors and fraud including odometer rollback and underestimating of travel. In the case of gross underestimates, motorists may be required to increase their annual estimated travel in future years.

Concept 6: Automated Mileage Reporting with No Location Data

In this concept, vehicles have equipment that measures and reports mileage automatically to an account manager—either provided by a state agency or a private company. The account manager periodically (monthly or quarterly) sends the motorist an invoice for road use.

- In the case of a private account manager, the road charge invoice may be bundled with charges for other services such as insurance, in-vehicle infotainment, or roadside services.
- In the case of a government account manager, the road charge invoice may be a standalone bill, or it may be bundled with other vehicle-related charges such as registration fees, depending on the organizational design that emerges.

To reassure motorists that electronic equipment protects their privacy, no location information is needed or measured under this concept. The equipment records all miles traveled based on data from vehicle electronics, and all miles traveled are treated as equal under this concept. Credits or refunds for out-of-state travel or travel on private lands would not be possible in an automated way (although it may be possible to issue credits or refunds for miles traveled out of state or on private lands based on a paper evidence package specified by the state).

To provide especially strong reassurance to the public, equipment to support this concept may be forbidden to include any location measurement technology (i.e., no GPS chip).

Concept 7: Automated Mileage Reporting with General Location

In this concept, vehicles are charged for distance with a rate that may vary by general location. SB 1077 requires a non-variable per-mile rate within the state, so the general location information would be used to prevent charging for miles driven out-of-state or on private lands. “General location” does not provide the level of detailed that would be needed to estimate a motorist’s locations street-by-street.

- To measure the miles traveled and the general location of those miles traveled, a device that measures location is used in the vehicle. The device may allow drivers to turn location detection capabilities off and on.
- To support full compatibility with the non-location based methods, the general location zone would be the entire state of California (distinct from bordering states and provinces), and omitting private lands in California. Thus, motorists who prefer this concept would avoid paying for out-of-state travel and travel on private lands, which would be charged to users of the other options.

If the need were to ever arise for a base per-mile rate to increase in certain zones within the state, then the system would require everyone to use a location measuring option (i.e., GPS), because those without location measurement devices would not be able to accurately report or pay for miles within those smaller zones. Moreover, this would violate the provision of SB 1077 that requires a non-varying per mile rate to be used throughout the state.

Private companies might use the road charge as a platform for advertising, and offer to cover road charge costs for motorists who visit their retail locations and do a certain amount of business. For example, a retail store might run a promotion in which it pays road charges for all individuals who travel to it and share location data.

SECTION 4
ROAD CHARGE PILOT SYSTEM ARCHITECTURE

To be discussed during Agenda Item #12

Question to Consider in Reviewing this Section

Should road charging use open or closed systems?

The pages that follow provide a comparison of the characteristics of closed and open systems as well as examples from the transportation and telecommunications sectors to inform discussion and ultimately decision about this question. Closed and open systems are defined as follows:

- Closed System: An internally integrated system controlled by a single entity with essential components that cannot be substituted by other external components, which could perform the same functions.
- Open System: An integrated system based on common standards and an operating system accessible to the marketplace whereby components performing the same function can be readily substituted or provided by multiple providers.

The bullet points below characterize closed and open systems in the context of road charging.

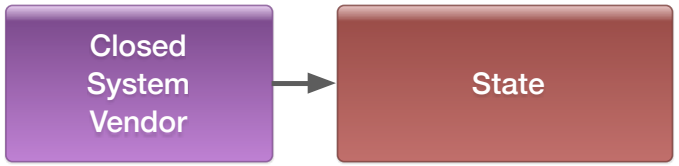
- A closed system for road charging is a self-contained system in which one organization selected by the state provides all user hardware. Another organization—a state agency or an organization selected by the state (perhaps the same organization as the hardware provider)—manages user accounts and remits collected charges to the state.
- An open system for road charging would allow multiple organizations to participate on all levels, typically in a manner that approximates a free or open market. In an open system, any qualified company could provide mileage reporting hardware, and another group of qualified companies could provide account management services to motorists. Companies are free to enter the market at any time, so long as their equipment or services meet standards set by the state.

Closed Systems are Not Uncommon in the Transportation Sector

Closed systems are used for many electronic toll collection and transit fare collection systems, with toll tags (e.g., FasTrak)[1] and smartcards (e.g., the Bay Area's Clipper) and tag/card readers provided by single vendors. The reason for this is that agencies may have seen the process of setting up an open system as difficult. Establishing an open system requires a potentially lengthy standards-setting process, then finding vendors willing to support the standard. In locations where the tolling or transit agencies were relatively distant from other agencies, the potential market for equipment would have been small, and may not have been profitable for multiple vendors in an open system.

Another reason that tolling and transit agencies may not have pursued open systems is that they may not have understood that closed systems have the potential to lead to vendor lock-in and higher costs. Vendor lock-in is a situation in which the existing equipment or service vendors makes it difficult for the agency to change vendors. For example, the existing vendor may use proprietary technology, so selecting a new vendor would require swapping out all the tags in a region's vehicles, necessitating a costly and disruptive customer service process. When it is difficult to change vendors, the existing service vendor may charge higher prices than when that vendor faces competition in an open system.

It is generally not necessary to specify a system architecture for closed systems. To procure a closed system, the state must simply describe what the system must do—what goals it must achieve—and then procure a system that meets those goals.



[1] FasTrak is not a closed system, due to the open Title 21 specification, but only one vendor has provided most toll tags and readers in California, possibly due to the smaller size of the California electronic tolling market compared with the size of the nationwide market.

Open Systems are Rare but Increasing in the Transportation Sector

An open system is one that is based on common standards. Because the standards are open, and not proprietary, equipment from one vendor can be readily substituted for equipment from another vendor. Examples in transportation include London's public transit system, Transport for London, which was the first major transit operator in the world to accept contactless credit and debit cards as payment for accessing the network. In the U.S., the Utah Transit Authority accepts contactless credit and debit cards as payment for riding the system. Ireland has an open system for tolling, with several competing toll tag providers vying for customers

- In an open road charging system, motorists would have accounts and submit payment for transportation services to a road charge account manager of their choice. The road charge account manager would then forward payment to the state. Road charge account managers may offer additional services that appeal to motorists such as usage-based insurance (UBI).
- In order to create an open system, standards must be chosen, at a minimum, for devices used in the system and software used in system interfaces. An organization, called a certification entity, would verify whether each participating firm meets the standards and can thus participate in the system.
- To procure an open system, the state must specify an architecture, develop standards or requirements for each component of the architecture, and open a market for each component.
- Due to its size, with millions of potential vehicles, California is likely to be able to support a profitable open system for hardware vendors.

The rest of this section specifies a system architecture for a potential open road charging system in California.

Example of an Open System Architecture for Road Charging

The system architecture proposed here is analogous to the cell phone industry. In-vehicle road charge devices that measure distance traveled are analogous to cellular phones such as Samsung, Apple, and Nokia, while road charge account managers are analogous to wireless carriers such as AT&T, Sprint, and Verizon.

The system architecture proposed would have the three main subsystems described below. All subsystems could support both GPS and non-GPS options. However, for manual operational concepts, motorists would interface directly with the account management subsystem, while for automated concepts, the mileage reporting interfaces with account management.

1. Mileage reporting: the subsystem that reports data from the vehicle to the account manger. This subsystem would include in-vehicle devices and any off-vehicle IT systems needed to translate data to the open standard for communications. The mileage reporting subsystem will not be used for manual methods such as the time permit or the odometer charge, as these do not require the use of vehicular data or in-vehicle electronics.

2. Account management: the subsystem that takes in mileage data, updates user accounts based on mileage data, sends invoices to customers, receives payment from customers, sends payments to the state, and reports road charge data to the state accounting system. Account managers would accept input from motorists opting for manual methods directly.

3. Account management oversight : the subsystem that takes road charge data from the account management subsystem and verifies that all vehicles are registered in the program, all account managers are paying appropriate sums of money to the state each month, and all account managers are abiding by the rules of the program.

Open System Subsystem 1: Mileage Reporting

Mileage reporting includes in-vehicle devices to measure mileage traveled and an IT system that translates raw data from the device into a standard format, which can be sent to the account management system.

In-vehicle devices may be a UBI device, other location-based device, smartphone, or vehicle telematics system. The devices send raw mileage traveled data to a data collection system. Distinct data records would typically be stored for each day.

Next, the raw data must be translated from the device to a standardized format and transmitted to the account management subsystem. This could theoretically occur within the device itself, but is more likely to occur at an external IT subsystem provided by the company who provides the device, or by a separate firm that may take in data from multiple different types of devices using various communications protocols.

Possible reasons for translating the data into standardized format at an external IT subsystem include the following:

- It may not be easy or desirable to give typical in-vehicle devices (UBI devices and vehicle telematics applications) direct, unfettered internet access.
- It may be desirable to have devices transmit data in the most compact way possible, in order to minimize communications costs.

Open System Subsystem 2: Account Management

Account management is the subsystem that takes in mileage data, updates user accounts based on mileage data, sends invoices to customers, receives payment from customers, provides customer service, sends payments to the state, and reports road charge data to the state for accounting purposes.

Account managers may be state agencies or be private companies called Commercial Account Managers (CAMs). There are several reasons why it may be desirable to allow CAMs.

- CAMs may offer value-added services including UBI insurance, safety services such as post-crash support, or any of a range of location-based services.
- CAMs may reduce costs of program administration, as they can earn money from charging their customers monthly fees for value-added services, and thereby provide road charging services at a low or no cost to the state.
- Allowing private companies like CAMs to handle technology relieves the state of any risk associated with managing and updating the technology components.

It may also be helpful for the state to offer a State Account Manager (SAM). The SAM could manage the accounts for all vehicles registered for non-technology methods. SAMs could, potentially, also manage technology methods. However, CAMs would generally prefer not to have the state competing with the services that they are providing. One possibility would be for a SAM to support only manual concepts and devices without location technology and not provide any value-added driver services.

Open System Subsystem 3: Account Management Oversight

Account management oversight is a state function comprising compliance and enforcement of the road charging system. The main functions of account management oversight are the following:

- Verify that all potential subject vehicles are registered for the road charge
- Verify that all account managers pay the correct amount on a monthly basis
- Perform or oversee certification, recertification, and auditing of account managers

To verify that all potential subject vehicles are registered for the road charge, the account management oversight unit would examine the DMV's vehicle registry and note vehicles subject to the road charge. As vehicles are added to or eliminated from the vehicle registry, account management oversight updates its list of subject vehicles. The account management oversight unit collects current membership lists from all account managers, and verifies that all vehicles on the subject vehicle list are registered with an account manager.

To verify that all account managers pay the correct amount on a monthly basis, the account management oversight unit examines a series of data reports provided by the account managers each month, determines whether the account manager is making all computations correctly, and verifies that the account manager's deposit into state accounts is equal to the amount specified.

To perform or oversee certification, recertification, and audit of account managers, the account management oversight unit develops the framework for a method by which compliance to all road charging specifications can be checked. It then carries out the check itself, or has a third party certification body do so.

APPENDIX: DETAILED TECHNOLOGY CONSIDERATIONS

Detailed Technology Considerations

The purpose of this section is to provide a framework for evaluating potential technologies to use in California's road charge pilot program. First, we provide an overview of the evaluation criteria that SB 1077 asks the TAC to consider in examining alternatives for the pilot. Next, we present a range of technology considerations that apply to the seven operational concepts. We group the technologies into the following categories, based on the operational concept categories:

Technologies supporting user-reported operational concepts:

- Time permit
- Odometer charge
- Mileage permit

Technologies supporting automated operational concepts:

- Engine Run-time measuring devices
- Usage-based insurance (UBI) devices and similar devices
- Smartphone
- Telematics
- Other location-based devices

Note that the last four technologies can support both Concept 6 (automated reporting with no location data) and Concept 7 (automated reporting with general location). Most of these devices include GPS chips, but some UBI devices do not.

The section concludes with observations on two other areas of technology interest:

- Technology considerations related to fuel tax credits or refunds
- Why the pay-at-the-pump model is not included

SB 1077 evaluation criteria

Each technology presented in this section is evaluated according to the criteria listed in SB 1077, Section 3090 (f)(1-7). For the first two criteria, *availability* and *adaptability*, the legislature's intention is not clear. Therefore, we offer two ways of evaluating each:

- **3090(f)(1) *Availability*** is assessed with respect to *acquisition*, and *IT availability*:
  - *Acquisition* refers to how easy is it for a motorist to obtain the product.
  - *IT availability* refers to the potential uptime of the IT system, in other words the time that the system is operating normally and able to be accessed by the user.
- **3090(f)(1) *Adaptability*** is assessed both in terms of *suitability* and *changeability:*
  - *Suitability* means the degree to which the technology is suitable for all vehicles in the California fleet.
  - *Changeability* means the degree to which the technology can be updated in any way.

We suggest the following definitions for other criteria:

- **3090(f)(1) *Reliability*** means the ability of a given technology to function correctly (not to fail) for a normal product lifecycle.
- **3090(f)(1) *Data security*** means the degree to which the technology protects all data from unauthorized use.
- **3090(f)(2) *Ability to protect personally identifiable information*** means the ability of the technology to specifically protect all information that could cause a motorist's identity to become known.

SB 1077 evaluation criteria (continued)

- **3090(f)(3)** ***Ease of recording and reporting*** means the motorist's ease of using the system with that technology.
- **3090(f)(4)** ***Ease of administering*** means the ease the state agency/agencies have in running the road charging program using that technology.
- **3090(f)(5)** ***Enforceability*** means the ease with which fraud attempts can be prevented and compliance with the law attained using that technology.
- **3090(f)(6)** ***Ease of re-identifying location data*** means the ease with which location data that has been stored in a somehow encoded form can be decoded to determine the original location or the ease with which location patterns can be used to identify individual persons even though their personally identifiable information has been removed.
- **3090(f)(7)** ***Increased privacy concerns when data used for other technology*** refers to any potential privacy concerns about the use of data generated by the road charge system if that data is used by a different system.

SB1077 includes several criteria that are not considered as part of this briefing book.

- ***Cost*** criteria within Sections 3090(f)(3) and 3090(f)(4) are not discussed here. They will be studied in the business case workstream, which will begin at the May TAC meeting.
- Section 3090(f)(8) offers an eighth criterion, "Public and private agency access, including law enforcement, to data collected and stored for purposes of the road charge to ensure individual privacy rights are protected pursuant to Section 1 of Article I of the California Constitution." This criterion does not articulate a quality that differs by technology, so we omit it from consideration in this section. It will be analyzed during a future meeting on the topic of Organizational Design.

SB 1077 evaluation criteria (continued)

These evaluation criteria are not all-inclusive.

- They do not reflect many of the important considerations that the TAC must make about the technologies. For example, the time permit does not reflect actual highway usage, and it may need to be priced much higher than other options to discourage noncompliance, but these considerations are not provided in the legislation.
- Similarly, the evaluations of location-based reporting methods against these criteria do not reflect the fact that these are likely the only methods that would enable out-of-state and off-public-road travel not to be charged.
- It is important as the TAC evaluates technology options to consider not only these criteria, but the totality of advantages and disadvantages of the technologies and their corresponding operational concepts.

TAC ASSIGNMENT

At the April TAC meeting, TAC members will be asked to select which operational concepts and technologies they feel should be included in a pilot. To prepare for this meeting, TAC members may decide to rate the technologies against each of the criteria. A system will be needed for any rating attempt. One possible rating system would be a simple scale of 1 to 5, where 1 is poor, 2 is fair, 3 is good, 4 is very good, and 5 is excellent.

A score sheet is provided on the next page for the convenience of the TAC members. In addition to the rows for the criteria defined above, a row is provided for rating other issues, and a row is provided for the overall rating.

Proposed Technology Score Sheet

SB 1077 CRITERION	TIME PERMIT	ODOMETER CHARGE	MILEAGE PERMIT	ENGINE RUN TIME	UBI	SMART-PHONE	TELE-MATICS	OTHER LOCATION-BASED
Availability (acquisition)								
Availability (IT)								
Adaptability (suitability)								
Adaptability (changeability)								
Reliability								
Data security								
Ability to protect PII								
Ease of recording and reporting								
Ease of administering								
Enforceability								
Ease of re-identifying location data								
Increased privacy concerns when data used for other technology								
Other issues								
Overall rating								

Foundation for all Operational Concepts: Road Charging Database

The main technology required to support all road charging operational concepts is a database that includes all vehicles in the road charging program.

California-registered vehicles could be required to be registered for exactly one valid operational concept at all times. The database would store information on all California vehicles subject to the road charge and their chosen concept. For example, if the vehicle is registered for a time permit, it could record the start and end dates of the permit; if the vehicle is registered for an odometer charge, it could include the most recent odometer reading of the vehicle; etc.

Such a database would be easy to implement with modern database technology, such as Oracle, SAP, or a variety of cloud-based solutions. Simply adding this information to the existing state vehicle registry may or may not be the easiest or cheapest solution, depending on the status and flexibility of existing systems. Further research is planned to assess this in future work streams.

In cases where the vehicle registry is inflexible, the state could create a separate new database for road charging. The new system should be flexible and based on latest available technology. Updates from the existing vehicle registry could be sent on a regular (daily) basis to the new database, so that all vehicles subject to road charges could be added to the new database rapidly and regularly.

Time Permit

The only technologies needed to implement the time permit are the database described above, possibly coupled with windshield stickers. It should be recalled from the discussion of the operational concept that the time permit does not measure roadway use in distance; rather, it grants unlimited usage for a specified time period.

For each vehicle registered for a time permit, the road charge database would store some amount of history of the time permits purchased for a given vehicle, including start and end dates of time permits. Enforcement officers could be given access to data from the road charge database. Officers might need to enter in a vehicle license plate number to check the status of road charge registration and payment. Appropriate data security measures (including strong passwords, user authentication and authorization, etc.) would need to be in place and records of all accesses to the database would be stored.

Technology performance according to measures specified in SB 1077 Section 3090(f)(1-7):

- Availability. In the sense of availability that means it is easily acquired by the public, if no windshield sticker is required for using a time permit, then a time permit would be highly available—it could be purchased on the web, via smartphone, or even by touch-tone telephone. If a windshield sticker is required, the time permit would be somewhat less available. Such stickers could be sold at gas stations and grocery stores, and also sent by mail. In the IT sense of the word availability, the technology needed for the time permit, a database, can also be highly available. Modern cloud-based databases often have availability over 99.9%.
- Adaptability. In the sense of suitability for all vehicles, the time permit is adaptable to all vehicles. In the sense of being able to be changed, the time permit is not very adaptable. The only time permit value that can be changed is the duration of the permit. The time permit cannot be changed to also record or report roadway usage.

Time Permit (continued)

- Reliability. The time permit is very reliable, as the only technology needed is a database and modern databases are very reliable.
- Security. The security of the time permit rests on the security measures of the road charging database. Thus, the security of the time permit depends on the ability of the agency overseeing it to put in place modern IT security measures on the database.
- Ability to protect Personally Identifying Information (PII). With a time permit, the only instance where PII is recorded is in the road charge database. Therefore, PII protection is a function of the security measures in place on the database.
- Ease of recording and reporting. The time permit does not record or report mileage or hours driving on the roadway. The only value recorded is the time of validity of the time permit from purchase. Since mileage reporting is not required, the time permit is relatively easier to use than other distance-based methods.
- Ease of Administering. The time permit only requires maintenance of a database, making it relatively easy to administer. If windshield stickers are required, then the time permit becomes more difficult to administer, because stickers must be purchased, inventoried, and distributed.
- Enforceability. All vehicles that are registered for the time permit operational concept must always have a valid time permit. If a motorist's time permit expires, they are in violation (although a grace period of a few days or weeks may be allowed). Enforcement then becomes a function of enforcement agencies' capacities to enforce time permit rules.
- Ease of re-identifying location data. No location data is recorded with the time permit, so it cannot be re-identified.
- Increased privacy concerns when data is used for other technologies. Data from a time permit cannot be used with other technologies in a way that compromises privacy.

Odometer Charge

The technology used to record odometer charges would use the road charge database described above. For vehicles registered for the odometer charge, the following items would be recorded:

- An odometer reading associated with a given date
- An indication of who provided each odometer reading (the motorist, a state official, or other authorized agent)
- In the case of a pre-pay option, entries for estimated mileage paid at the beginning of a year
- The system could automatically compute charges owed based on traveled miles (post-pay) or estimated miles (prepay)

One technology challenge with odometer charges is that odometer values can be fraudulently adjusted.

- Mechanical odometers can be rolled back by unethical sellers of used vehicles wishing to make the vehicles appear to have fewer miles than they actually do. Digital odometers, standard on most vehicles built in the last 20 years, can also be fraudulently altered.
- To combat potential vehicle odometer fraud, some countries such as New Zealand require heavy vehicles to employ hub-odometers—mechanical odometers installed on any non-driven vehicle axle—to be the odometer of record. Such hub-odometers are virtually impossible to manipulate without breaking a seal and thus leaving physical evidence of manipulation. Although suitable for heavy vehicles, hub-odometers are likely not a viable option for light vehicles due to their expense and the challenges of installation.
- Another way to minimize digital odometer fraud is to audit individuals who are suspected of odometer fraud. Auditing would involve asking such individuals about their places of residence, work, and other activities, and verifying information. While the number of such audits that the state would carry out would likely be low, the threat of such audits can work as a deterrent.
- In addition, odometer fraud is a federal crime punishable by fines and prison time.

Odometer Charge (continued)

Technology performance according to measures specified in SB 1077 Section 3090(f)(1-7):

- Availability. From the perspective of acquisition, if drivers are allowed to report their own odometer usage, then odometer charges are highly available. Reporting could be by purchase on the web, via smartphone, or by touch-tone telephone, for example. If official odometer readings taken by a representative of the state or authorized third party are required, then the odometer charge is less available. In the IT sense of the word *availability*, the technology needed for the odometer charge, a database, can also be highly available. Modern cloud-based databases often have availability over 99.9%.
- Adaptability. In the sense of suitability for all vehicles, the odometer charge is adaptable to all vehicles with an odometer. In the sense of being able to be changed, the odometer charge is not very adaptable. The frequency of odometer readings may be changed, but no other changes may be made.
- Reliability. The odometer charge is reasonably reliable, with reported odometer error rates of up to 4%. The potential for odometer fraud can decrease reliability.
- Security. The security of the odometer charge rests on the security measures of the road charge database. Thus, the security of the time permit depends on the ability of the agency overseeing it to put in place modern IT security measures on the database.
- Ability to protect PII. With an odometer charge, the only instance where PII is recorded is in the road charge database. Therefore, PII protection is a function of the security measures in place on the database.

Odometer Charge (continued)

- Ease of recording and reporting. If self-reported odometer readings are used, the odometer charge allows recording and reporting of mileage by a variety of methods: web, smartphone, touch-tone phone, or paper reporting. This variety of reporting methods makes it easy to use, depending on each individual's preferences. If official odometer readings are required, then motorists will need to go to a qualified agent to take the official odometer reading at given intervals, perhaps once a year. This approach would make odometer charges one of the less convenient technologies.
- Ease of administering. If official odometer readings were required, then the burden of administering the staff or overseeing a network of authorized agents to read odometers would decrease the ease of administering the odometer charge. If self-reported odometer readings are acceptable, the odometer charge would only require maintenance of a database, making it easy to administer.
- Enforceability. Due to the potential for odometer fraud described above, odometer charges may be somewhat challenging to enforce. As described above, it would require auditing some individuals. However, it should be noted that the motivation to behave in a fraudulent manner is greatly reduced in the case that a gas tax remains in place.
- Ease of re-identifying location data. No location data is recorded with the odometer charge, so it cannot be re-identified.
- Increased privacy concerns when data is used for other technologies. The only data available from odometer charges is the number of miles traveled in a given period of time (e.g., one year). These data would only be shared with the state, and only over secure channels. It is not clear that there are any privacy concerns with the sharing of odometer data in such a manner.

Mileage Permit

The technology used to record mileage permits would use the road charge database described above.

- An official record of the odometer may be required for enforcement purposes when the vehicle enters the mileage permit program.
- After that, odometer readings could be taken randomly.
- Or they could be required at specific intervals (in time or mileage).

Similar to the time permit, the mileage permit could require paper stickers, or it could be purely electronic. Paper stickers could indicate the starting and ending odometer readings for the validity of the permit.

The same concerns about fraudulent odometer readings that apply to the odometer charge also apply to the mileage permit.

Technology performance according to measures specified in SB 1077 Section 3090(f)(1-7):

- Availability. In the sense of acquisition, mileage permits could be made highly available by sales over a variety of channels (web, smartphone, touch-tone phone, etc.), but if physical stickers are required, they will be less available. In the IT sense of the word *availability*, the technology needed for the odometer charge, the road charge database, can also be highly available. Modern cloud-based databases are often have availability over 99.9%.
- Adaptability. In the sense of suitability for all vehicles, the mileage permit is adaptable to all with an odometer. In the sense of being able to be changed, the mileage permit is not very adaptable. The number of miles in mileage blocks available for purchase may be changed.
- Reliability. The mileage permit is reasonably reliable, but the potential for odometer fraud decreases its reliability.

Mileage Permit (continued)

- Security. The security of the mileage permit charge rests on the security measures of the road charge database. Assuming modern IT security measures are put into place, the odometer charge is highly secure.
- Ability to protect PII. With a mileage permit, the only instance where PII is recorded is in the road charge database. If that database is secure, then the odometer charge has a great ability to protect PII.
- Ease of Recording and Reporting. To start a mileage permit, an official odometer reading may be required. Motorists will need to go to an individual qualified to take the official odometer reading. After that, motorists could purchase mileage permits over a variety of channels (web, smartphone, retail store, etc.), making continued use easy.
- Ease of Administering. The mileage permit is fairly easy to administer, likely requiring one initial odometer reading. If stickers are required, then there would be an additional burden of administering the sticker program.
- Enforceability. Due to the potential for odometer fraud described above in the section on odometer charges, mileage permits may be somewhat challenging to enforce. As described above for odometer charges, it would require auditing some individuals. However, it should be noted that the motivation to behave in a fraudulent manner is greatly reduced in the case that a gas tax remains in place.
- Ease of re-identifying location data. No location data is recorded with the mileage permit, so it cannot be re-identified.
- Increased privacy concerns when data is used for other technologies. No data from a mileage permit can be used with other technologies in a way that compromises privacy.

Introduction to Automated Mileage Reporting Technologies: Mileage Reporting Devices and OBDII

Mileage Reporting Devices (MRDs) are any electronic device or software that measure the mileage driven by a vehicle for the purpose of reporting distance to a road use charging system. These devices support all of the automated operational concepts presented here. Such devices may be the devices used for Usage Based Insurance; they may be smartphones with special software to connect it to a vehicle; they may be GPS tolling hardware, or they may be vehicle telematics. All mileage reporting devices need to somehow be anchored to the vehicle so that dishonest drivers would not be tempted to remove them from a vehicle in order to avoid paying the road charge.

The simplest way for a MRD to be anchored to a vehicle is to have it plug into a vehicle's OBDII (or testing) port.

- The OBDII port is an electronic port located in the cockpit, near the steering wheel, of all US-sold vehicles manufactured since 1996 (and some models from 1994 and 1995).
- The California Air Resources Board (ARB) originally mandated OBDII ports—an electronic interface to provide emissions-relevant vehicle data to external testing equipment so that emissions-related issues could be quickly diagnosed by mechanics.
- Following ARB's mandate of the OBDII port, the US Environmental Protection Agency (EPA) quickly made the OBDII port a nationwide mandate. Internationally, slightly modified versions of the OBDII port have been adopted in Europe, Japan, and elsewhere.

OBDII ports provide emissions relevant information as specified in ARB's regulation.

- The exact information provided varies greatly from one vehicle make/model to another.
- Certain basic information is consistently provided on all OBDII ports.
- A vehicle's speed is always provided, and can be used to calculate distance traveled.

Introduction to Automated Mileage Reporting Technologies: Mileage Reporting Devices and OBDII (continued)

Electric vehicles may not have fully supported OBDII ports.

- Because OBDII ports are required by regulations that cover vehicle emissions, and because electric vehicle have no emissions, automakers are not necessarily required to support OBDII ports on electric vehicles.

MRDs that plug into the OBDII port can easily be installed by the vehicle owner.

- UBI device manufacturers can provide guidance to insurance customers on how to find their ports.

MRDs that plug into the OBDII port can also easily be removed by a driver, which creates an opportunity for fraud.

- MRDs can measure when they are disconnected from, and reconnected to, the vehicle.
- Storing a record of the disconnections and reconnections provides a strong indication of whether fraudulent activity has occurred.

OBDII ports do not provide the current odometer mileage.

- It would be useful to have the odometer mileage for a road charging program.
- As California originally mandated OBDII port, it could mandate that odometer values be added to the OBDII port.

Engine Run Time Measurement Devices

Engine Run Time Measurement devices would be devices that would be anchored to a vehicle and contain a vibration sensor. Such devices do not currently exist— vibration sensors exist, and vehicle anchors exist, but the two would have to be combined. Consumer-ready engine run time measurement devices would have to be designed and tested. Because they are new, they would likely be expensive (several hundred dollars). Because they have not been developed, there is little that can be said about them.

Technology performance according to measures specified in SB 1077 Section 3090(f)(1-7):

- Availability. Engine run time measurement devices are currently not available for acquisition. For that reason, nothing yet can be said about their IT availability either.
- Adaptability. In the sense of suitability, such devices are not suitable for electric vehicles— telematics systems would need to be used to measure engine run time for electric vehicles. In the sense of changeability, it depends on how the devices are designed when they are developed.
- Reliability. Because they haven't been developed, nothing can be said about their reliability.
- Security. It depends on how the devices are designed when they are developed, but using modern IT security methods such devices can be made to be very secure.
- Ability to protect PII. With other devices, PII will be recorded in the account manager's database, as well as in the road charging database. All account managers, as well as the road charging database, should include modern security measures.

Engine Run Time Measurement Devices (continued)

- Ease of Recording and Reporting. It depends on how the devices are designed when they are developed. After installation, they should be easy to use. However, the likely challenges with installation on a vehicle's axle may render the device difficult to use.
- Ease of Administering. Using such devices will require hardware management, account management and monthly invoicing, which may be more complicated to administer than the manual methods. It is not clear that commercial account managers could be found for such devices.
- Enforceability. Because such devices have not yet been developed, it is impossible to speak to their enforceability. Specifically, it would be vital that vibration sensors could not be removed from the vehicle without that removal being detected.
- Ease of re-identifying location data. No location data is recorded with the engine run time charge, so it cannot be re-identified.
- Increased privacy concerns when data is used for other technologies. The only data available from engine run time charges is the number of minutes traveled in a given period of time (e.g., a year). This data would only be shared over secure channels. It is not clear that there are any privacy concerns with the sharing of odometer data in such a manner.

Usage-based Insurance Devices and Similar Devices

Usage Based Insurance (UBI) is a relatively new concept in auto insurance. In discussion for roughly 10 years and available on the market for roughly the last 5 years, UBI means any form of auto insurance in which driving habits or patterns are measured so that the insurance company could get a more accurate estimate of the driver's habits and thus provide a more competitive premium to the driver.[2] UBI generally involves the driver installing a MRD in the vehicle's OBDII port to measure his/her driving habits. Recently, some vehicle telematics services also incorporate UBI applications directly into factory-installed equipment (see vehicle telematics section below).

The most well-advertised and well-known example of UBI in the United States is the Progressive Snapshot, whose device is pictured at right. However, many other insurance companies in the US also offer UBI. These companies purchase their devices from companies specialized in making and programming such devices. Usage Based Insurance devices often include GPS chips, but some models do not include such chips, and rely entirely on vehicle-provided data. UBI devices also include cellular modem chips to communicate mileage data to a central system.

[2] UBI was formerly often called Pay-as-you-Drive (PAYD) insurance. However, because no commercial programs actually involved payment while driving, the term came to be seen as inaccurate, and has been dropped from common usage, in favor of UBI. The term PAYD can still occasionally be seen in literature relating to the industry.

Usage-based Insurance Devices and Similar Devices (continued)

Although not yet common in the industry, some UBI devices also support an interface to the user's smartphone. Such devices are provided by Raytheon and the Bay Area startup TrueMileage. The smartphone interface allows users to view their driving data, and to disable/enable the use of GPS location data.

UBI devices can be made very secure, using standard Internet-grade authentication, authorization, and encryption. Early devices used by one major provided of UBI devices did not include sufficient security measures, leading to headlines about the security of such devices.

Technology performance according to measures specified in SB 1077 Section 3090(f)(1-7):

- Availability. In the sense of acquisition, UBI devices are readily available from Usage-based insurance companies today, and could quickly become very available from commercial account managers. In the IT sense, account managers can be required to have systems that are highly available. Modern cloud-based systems can have availability over 99.9%.
- Adaptability. In the sense of suitability for all vehicles, the UBI devices are adaptable to most vehicles with a standard OBDII port (which includes all non-electric vehicles manufactured since 1996, and some from 1994 and 1995; many electric vehicles have non-standard OBDII ports). In the sense of being able to be changed, UBI devices are very adaptable. UBI device software can be changed to account for new vehicle models and to provide new value added services.[3]

[3] In general existing devices would not be reprogrammed, but devices with new software could easily be developed.

Usage-based Insurance Devices and Similar Devices (continued)

- Reliability. UBI devices are fairly reliable, with failure rates typical of consumer electronics. Because they can be removed from OBDII ports, and replaced, UBI devices may miss some miles traveled. However, repeated removals will lead to fraud investigation.
- Security. UBI devices provided by many companies are generally secure. Devices, such as those provided by firms Danlaw and IMS, utilize standard internet-grade authentication and encryption. However, it is important to include such electronic security requirements in any technical requirement specification for mileage reporting devices.
- Ability to protect PII. With a UBI device, PII will be recorded in the account manager's database, as well as in the road charging database. It will likely not be included on the UBI device itself—this measure can be required. All account managers, as well as the road charging database, should include modern security measures.
- Ease of Recording and Reporting. A UBI device should be easy for a motorist to use—simply install it in the vehicle's OBDII port. Finding the OBDII port is not difficult on most vehicles, but a toll-free phone number can be set up to assist motorists in finding the OBDII port. After that, recording and reporting should be automatic.
- Ease of Administering. Using UBI devices requires hardware technology administration, account management, and periodic invoicing, which is more complicated to administer than the manual methods. However, the use of commercial account managers may ease this burden.
- Enforceability. The main enforcement concern with UBI devices is that they can be removed from vehicles. The devices can detect when they are removed and replaced, and can also detect when they are inserted in a different vehicle. However, they cannot record mileage traveled when they are not connected to a vehicle. Removing devices from vehicles rarely, and only for brief periods, is not suspicious; frequent or long removals are suspicious. Data analysis programs can be developed to automatically determine when suspicious activity occurs. With such programs, enforceability with UBI devices should be strong.

Usage-based Insurance Devices and Similar Devices (continued)

- Ease of re-identifying location data. If mileage data is only transmitted to account managers as a single bucket of miles for all travel (for Concept 6 no location data), or as a bucket of miles traveled on public roads within a given state (for Concept 7 general location), then re-identifying location data is impossible. If mileage data is transmitted in another format, then re-identifying location data may be possible, depending on the format.
- Increased privacy concerns when data is used for other technologies. If mileage data is only transmitted to account managers as a single bucket of miles for all travel (for Concept 6 no location data), there would seem to be very low privacy concerns when such data is used with other technologies. If mileage data is only transmitted as a bucket of miles traveled on public roads within a given state (for Concept 7 general location), there may be some minor increased privacy concerns, but since miles are aggregated by state of travel, such concerns are likely to be minor, and whatever concerns remain should be alleviated by the fact that drivers may be able to occasionally disable the use of location data or opt out of concept 7 altogether. If mileage data is transmitted in another format, then other privacy concerns may arise, depending on the format.

Smartphone

Smartphones are an increasingly ubiquitous technology and thus may be desirable to use as a primary tool for road charge reporting. However, it is not straightforward to use an app on a smartphone to report roadway use, because it is necessary to somehow guarantee that miles will be recorded whether or not a phone is in the vehicle, and with a sufficiently charged batter, powered at any given time.

Two companies, GeoToll and Vehcon, have announced a way of using smartphones to measure road charges without the possibility of fraud. These applications require users to couple their smartphones to their vehicles by Bluetooth, and to occasionally send pictures of their vehicle odometers taken by the phone when Bluetooth is coupled to the vehicle.

Whenever the phone is in the vehicle the app on the phone couples to the vehicle via Bluetooth, and reports mileage. When the phone is not in the vehicle or not charged, mileage traveled continues to be captured by the vehicle odometer, and is transmitted whenever the next odometer image is submitted. The requirement that a vehicle have Bluetooth limits the use of this app to relatively recently manufactured vehicles (roughly, to vehicles produced since 2002 or 2003). Because this concept uses odometer readings as the basis for the charge, the concerns about odometer security apply as well.

If a motorist wishes to report location data to avoid paying fees for out-of-state miles or miles driven on private roads, the app can be enabled to use the smartphone GPS data. When the phone is not charged or not in the vehicle, it will be impossible for the motorist to use location data.

Smartphone (continued)

While both GeoToll and Vehcon have proposed such a solution, additional development by either or both companies would be needed for it to be used in a pilot.

Technology performance according to measures specified in SB 1077 Section 3090(f)(1-7):

- Availability. In the sense of acquisition, smartphones are very widespread and can be acquired virtually anywhere in California. Due to occasional network outages, lack of coverage in rural areas, and the possibility of dead batteries, the IT availability, while high, is not perfect.
- Adaptability. In the sense of suitability for all vehicles, the smartphone use described here only works on vehicles with Bluetooth, limiting it to vehicles built in the last ten years. In the sense of being able to be changed, smartphones are obviously changed often by consumers.
- Reliability. Smartphones are fairly reliable, with failure rates typical of consumer electronics. Smartphones do occasionally fail, and having a dead battery leads to the inability to use location-based services.
- Security. Smartphone applications with appropriate security software are generally secure. It is important to include electronic security requirements in any technical requirement specification for mileage reporting devices.
- Ability to protect PII. With a smartphone, PII will be recorded in the account manager's database, as well as in the road charging database. It will likely not be included on the smartphone application itself—this can be required. All account managers, as well as the road charging database, should include modern security measures.
- Ease of Recording and Reporting. Recording and reporting data both require Bluetooth coupling of the phone to the vehicle. Coupling should only need to be done once per phone per vehicle, and should be automatic after that. Then, the motorist is expected to take occasional pictures of the vehicle odometer (at least once a year, but perhaps more often). This activity may be seen as somewhat more cumbersome than activities for other technologies.

Smartphone (continued)

- Ease of Administering. Using smartphones requires account management and periodic invoicing, which may be more complicated to administer than the manual methods. However, the use of commercial account managers may ease this burden for the state.
- Enforceability. The use of Bluetooth coupling ensures that images of the odometer actually are from the vehicle it is coupled with. However, the same concerns about odometer fraud that are present with the odometer charge and mileage permit apply to the smartphone option as well.
- Ease of re-identifying location data. If mileage data is only transmitted to account managers as a single bucket of miles for all travel (for Concept 6 no location data), or as a bucket of miles traveled on public roads within a given state (for Concept 7 general location), then re-identifying location data is impossible. If mileage data is transmitted in another format, then re-identifying location data may be possible, depending on the format.
- Increased privacy concerns when data is used for other technologies. If mileage data is only transmitted to account managers as a single bucket of miles for all travel (for Concept 6 no location data), there would seem to be very low privacy concerns when such data is used with other technologies. If mileage data is only transmitted as a bucket of miles traveled on public roads within a given state (for Concept 7 general location), there may be some minor increased privacy concerns, but since miles are aggregated by state of travel, such concerns are likely to be minor, and whatever concerns remain should be alleviated by the fact that drivers may be able to occasionally disable the use of location data or opt out of concept 7 altogether. If mileage data is transmitted in another format, then other privacy concerns may arise, depending on the format.

Telematics

Telematics are computer systems embedded in vehicles that can communicate with external computer systems and use this connection to provide a range of services to vehicle drivers. Telematics systems may have a very simple user interface (a single button), but commonly have a touch screen interface in many new vehicles. Road charging could be an application running on a vehicle telematics platform. A telematics application would likely be the most user-friendly interface for road charging possible, because it would not require an additional in-vehicle device, it would allow the user to switch location data on and off very easily and safely, and it could provide a very convenient interface for account management. However, telematics systems are not present in all vehicles, and while their penetration of the vehicle population is increasing, they may never be in all vehicles, so it is a technology that might best be used in conjunction with other technologies.

Each automaker has its own unique telematics system, most of which have distinct brands: GM has Onstar, Ford has Sync, Toyota has Entune, etc. For vehicles made by Tesla, the telematics is so integral to the vehicle function that Tesla has chosen not to create an additional brand to their telematics system. There have been efforts to standardize telematics platforms across vehicle brands, but such efforts have not yet born much fruit. Thus, a separate app for road charging would need to be developed for each automaker's telematics platform.

Creating an application to run on a given vehicle brand's telematics platform would be a relatively straightforward programming task, because vehicle data such as speed and odometer reading would generally be available, as well as location data (vehicles with telematics systems have GPS).

Telematics (continued)

To support telematics use in a California road charging pilot, a road charging application would need to be developed. Developing such an application will require permission from the automaker on whose platform the app would run. Thus far, automaker support for road charging has been measured, but automakers have said they will not object to road charges as long as those charges are technology neutral (apply to all vehicle engine/motor types equally). If the TAC could obtain permission of an automaker to allow such an app to run on one of their platforms, the application could be developed by an academic institution.[4] Such an application would likely not require a large amount of programming effort, but would need to be thoroughly tested before it could be used in a road charge program.

Technology performance according to measures specified in SB 1077 Section 3090(f)(1-7):

- Availability. In the sense of acquisition, telematics are available on many vehicles, but it is likely still a minority of vehicles in the California fleet. Telematics systems on some vehicles may not support addition of new applications. IT availability will be very high, but as for the smartphone, there are occasional network outages or gaps in coverage when the telematics platform will not be able to send data.
- Adaptability. For suitability, as for acquisition availability, telematics are available on many vehicles, but it is likely still a minority of vehicles in the California fleet. Telematics systems on some vehicles may not support addition of new applications. In the sense of changeability, some new telematics systems are extremely adaptable, allowing the download of third-party applications that are updated in the way mobile phones apps are. However, many legacy telematics systems are not very adaptable.

[4] UC Davis is currently developing a fuel efficiency application, and would make them well-suited for such a task. For more information see: http://phev.ucdavis.edu/project/325/

Telematics (continued)

- Reliability. Telematics systems are highly reliable. Automakers often strive to make their electronics more robust than standard consumer-grade electronics.
- Security. Automakers are going to ever-greater lengths to make their telematics systems secure. However, some security concerns have been raised about some telematics systems, but no major consumer problems are known to have occurred because of such issues.
- Ability to protect PII. With telematics, like a UBI device, PII will be recorded in the account manager's database, as well as in the road charging database. It will likely not be included on the road charging application. All account managers, as well as the road charging database, should include modern security measures.
- Ease of Recording and Reporting. The telematics application should be very easy for the motorist to use. Application requirements can be developed to ensure that this is the case.
- Ease of Administering. Using telematics requires account management and monthly invoicing, which may be more complicated to administer than the manual methods. However, the use of commercial account managers may ease this burden for the state.
- Enforceability. The only potential enforcement concern with telematics is whether the road charging software running on the telematics platform could somehow be externally hacked. Because automakers control software running on their telematics platform very tightly and aim to have high security, this concern seems very unlikely to be realized. Thus, telematics are expected to be highly enforceable.
- Ease of re-identifying location data. If mileage data is only transmitted to account managers as a single bucket of miles for all travel (for Concept 6 no location data), or as a bucket of miles traveled on public roads within a given state (for Concept 7 general location), then re-identifying location data is impossible. If mileage data is transmitted in another format, then re-identifying location data may be possible, depending on the format.

Telematics (continued)

- Increased privacy concerns when data is used for other technologies. If mileage data is only transmitted to account managers as a single bucket of miles for all travel (for Concept 6 no location data), there would seem to be very low privacy concerns when such data is used with other technologies. If mileage data is only transmitted as a bucket of miles traveled on public roads within a given state (for Concept 7 general location), there may be some minor increased privacy concerns, but since miles are aggregated by state of travel, such concerns are likely to be minor, and whatever concerns remain should be alleviated by the fact that drivers may be able to occasionally disable the use of location data or opt out of concept 7 altogether. If mileage data is transmitted in another format, then other privacy concerns may arise, depending on the format.

Other Location-based Devices

Personal devices that use location data acquired from a system such as GPS could be utilized to support road charging. However, such devices would need to somehow be anchored to the vehicle so that dishonest drivers would not be tempted to remove them from a vehicle in order to avoid paying the road charge. This is the main reason that personal navigation devices, such as a Garmin, or cell phones without a Bluetooth connection to a vehicle, cannot be used to measure and report road charges.

Heavy vehicle road charging devices used in countries like Germany and New Zealand could be used for road charging. Such devices are mechanically and electrically anchored to the vehicles in which they are installed. They must be installed by a professional mechanic. They are generally expensive (several hundred dollars), and they may be large and somewhat unsightly additions to a private vehicle cabin. Thus they may not be well-suited for a passenger vehicle charging program, but would be acceptable for a heavy vehicle charging program.

Technology performance according to measures specified in SB 1077 Section 3090(f)(1-7):

- Availability. In terms of acquisition, other location-based devices that would support road charging are not widely available. California would need to sign a contract with a provider to order such hardware in large quantities. Such an order may take time to deliver. For those systems that do exist, the IT availability is very good.
- Adaptability. In terms of suitability for all vehicles, such devices can be installed in most vehicles, but not without some effort by a mechanic. In terms of changeability, it depends on the system chosen, but most hardware of the type mentioned here is not especially changeable.
- Reliability. It depends on the device chosen, but most hardware mentioned here is reliable.
- Security. It depends on the device chosen, but most hardware mentioned here is very secure.

Other Location-based Devices (continued)

- Ability to protect PII. With other location-based devices, PII will be recorded in the account manager's database, as well as in the road charging database. It will likely not be included on the road charging application. All account managers, as well as the road charging database, should include modern security measures.
- Ease of Recording and Reporting. Many such devices are not as simple and user friendly as other devices.
- Ease of Administering. Using such devices requires account management and monthly invoicing, which may be more complicated to administer than the manual methods. However, the use of commercial account managers may ease this burden for the state.
- Enforceability. The main enforcement concern with such devices is that they can be removed from vehicles. Enforceability thus depends on the type of device chosen.
- Ease of re-identifying location data. If mileage data is only transmitted to account managers as a single bucket of miles for all travel (for Concept 6 no location data), or as a bucket of miles traveled on public roads within a given state (for Concept 7 general location), then re-identifying location data is impossible. If mileage data is transmitted in another format, then re-identifying location data may be possible, depending on the format.
- Increased privacy concerns when data is used for other technologies. If mileage data is only transmitted to account managers as a single bucket of miles for all travel (for Concept 6 no location data), there would seem to be very low privacy concerns. If mileage data is only transmitted as a bucket of miles traveled on public roads within a given state (for Concept 7 general location), there may be some minor increased privacy concerns, but since miles are aggregated by state of travel, such concerns are likely to be minor, and whatever concerns remain should be alleviated by the fact that drivers may be able to disable the use of location data. If mileage data is transmitted in another format, then other privacy concerns may arise, depending on the format

Technology Considerations Related To Fuel Tax Credits Or Refunds

It may be desirable to allow the state fuel tax to coexist with a potential future road charge for some time. In this case, vehicles that are liable for the road charge may need to receive credits or refunds for their fuel tax paid.

For vehicles that use a technology that accesses vehicle data, fuel usage may be able to be calculated:

- Vehicle telematics could compute fuel usage directly and immediately, and if desired, even compute where and when fuel is added to a vehicle.
- UBI devices could compute fuel usage for somewhat more than half of all vehicle makes and models. The vehicles makes/models for which UBI devices can calculate fuel usage are those that report engine air intake flow on the OBDII port. Fuel consumption is directly proportional to engine air intake flow. A significant minority of vehicles report engine air intake pressure on the OBDII port instead of engine air intake flow—for these vehicles fuel consumption cannot be easily calculated.

For vehicles using technologies other than telematics and UBI devices, and for vehicles with UBI devices that do not report engine air intake flow, fuel usage can be estimated based on the distance traveled and the US EPA's fuel economy rating for the vehicle. While actual fuel usage varies by driving style, the US EPA creates a "Combined City-Highway" fuel economy that is a reasonable approximation of the fuel economy experienced by many drivers.

Why the pay-at-the-pump model is not presented

One technology used in a major early road charging study is not presented here: pay-at-the-pump technology. That technology used in-vehicle devices with special radios that connected with devices attached to special gasoline pumps, allowing payment of road charges when vehicles refueled. While this technology has the major advantage of allowing drivers not to pay fuel taxes at all—instead of providing credits or refunds for fuel taxes paid—it has a range of disadvantages that have led to its dismissal in subsequent road charging studies. These disadvantages are as follows:

- Retrofit of gasoline pumps. Every gas pump that would support payment of such charges would require the addition of hardware that would interface with pump electronics. Such pump electronics could cost several thousand dollars per pump. Requiring fuel station owners to make such upgrades to their equipment could be politically challenging, and the upgrade could be expensive for the state to subsidize.
- Specialized mechanic-mounted in-vehicle devices. Equally if not more challenging is the fact that in-vehicle devices used to interface with the pumps are specialized, not used for other applications, and cost several hundred dollars per vehicle.
- Electric vehicles not captured. Pay-at-the-pump would not cover electric vehicles, and covering electric vehicles is one of the main reasons for studying a road charge. Electric vehicles are increasing in popularity, due in part to California's aggressive goals of introducing 1.5 million zero-emission vehicles by 2025 and reducing greenhouse gases to 1990 levels by 2050. Moving to a pump-based system would seem to run counter both to the trend in electric vehicles and to California's policies on greenhouse gases.