Oregon
Road Usage Charge
Pilot Program
Final Report

June 2013
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Definitions and Abbreviations

In this document, the following definitions and abbreviations are employed.

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<thead>
<tr>
<th>Term / Abbreviation</th>
<th>Definition/Description</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>COTS</td>
<td>commercial-off-the-shelf</td>
<td></td>
</tr>
<tr>
<td>CSP</td>
<td>Certified Service Provider</td>
<td></td>
</tr>
<tr>
<td>EV</td>
<td>Refers to Electric Vehicles</td>
<td>While EV and PHEV have some important distinctions, these two classes of vehicles are often bundled together, particularly within the latest Road Usage Charge legislation.</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System</td>
<td></td>
</tr>
<tr>
<td>ICD</td>
<td>interface control document</td>
<td></td>
</tr>
<tr>
<td>JSON</td>
<td>JavaScript Object Notation</td>
<td>JSON is a lightweight data-interchange format. It is easy for humans to read and write. It is easy for machines to parse and generate. It is based on a subset of the JavaScript Programming Language, Standard ECMA-262 3rd Edition - December 1999.</td>
</tr>
<tr>
<td>MRD</td>
<td>Mileage reporting device</td>
<td></td>
</tr>
<tr>
<td>OBE/U</td>
<td>On Board Equipment/Unit</td>
<td></td>
</tr>
<tr>
<td>OIPP</td>
<td>Oregon Innovative Partnerships Program</td>
<td>Program administered by ODOT’s Office of Innovative Partnerships and Alternative Funding</td>
</tr>
<tr>
<td>PCI compliant</td>
<td>Payment Card Industry compliant</td>
<td></td>
</tr>
<tr>
<td>PHEV</td>
<td>Plug-in Hybrid Electric Vehicles</td>
<td></td>
</tr>
<tr>
<td>RFI</td>
<td>Request for expressions of interest</td>
<td>Alternately RFEI (RFI is used in Oregon)</td>
</tr>
<tr>
<td>RFP</td>
<td>Request for proposal</td>
<td></td>
</tr>
<tr>
<td>RP</td>
<td>Responsible Party</td>
<td>See RUC payer</td>
</tr>
<tr>
<td>RUC</td>
<td>Road Usage Charge is the name of the ODOT program to collect a tax on the miles traveled by a vehicle.</td>
<td></td>
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<tr>
<td>RUCA</td>
<td>Road Usage Charge Accounting</td>
<td></td>
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<tr>
<td>RUC payer</td>
<td>RUC payer refers to any individual subject to and responsible for paying the Road Usage Charge, including the registered owner of a motor vehicle that is registered in Oregon, and any person who leases a motor vehicle that is registered in Oregon.</td>
<td></td>
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<tr>
<td>RUCPP</td>
<td>Road Usage Charge pilot program</td>
<td></td>
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<tr>
<td>SOAP message</td>
<td>Simple Object Access Protocol message</td>
<td>SOAP is an XML-based messaging protocol.</td>
</tr>
<tr>
<td>TP</td>
<td>Transaction processor</td>
<td></td>
</tr>
<tr>
<td>VIN</td>
<td>Vehicle Identification Number</td>
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Executive Summary

The objective of the Road Usage Charge Pilot Program (RUCPP) was to demonstrate several choices for measuring and paying a road usage charge that are easy for motorists to perform while maintaining an efficient collection system administered by multiple interoperable providers, including ODOT and private sector entities. The RUCPP, which featured technology and services of three private vendors, successfully measured mileage and distributed invoices to 88 participants (people who volunteered to pay the road usage charge) from three states (Oregon, Washington, and Nevada) over a 4-month period with high levels of ease of compliance, convenience of use, and responsive customer service. By the most important measures—ease of use, motorist choice, and open, interoperable private sector administration—as well as by other measures, the RUCPP was success.

The purpose of this report is to evaluate the detailed results of the RUCPP for Oregon participants. This report provides background on road usage charging activities in Oregon, a description of the RUCPP and its evaluation, the evaluation results, and recommendations and conclusions for future pilot testing.

RUCPP Background

In 2001, in response to anticipated improvements in light vehicle fuel efficiency leading to declines in fuel tax revenues, the Oregon legislature created the Road User Fee Task Force (RUFTF) to identify a new road funding program. The RUFTF identified a road usage charge as the most promising alternative source of broad-based funding for roads. ODOT, with policy guidance from RUFTF, developed and tested a “pay-at-the-pump” approach to mileage-based road usage charges in which 285 subject vehicles were equipped with GPS receivers. The 2006-2007 pilot test of this approach was technically and administratively successful, but did not lead to legislation because of the following primary concerns:

- The public and decision makers shared concerns about privacy due to the requirement of a GPS device in every vehicle.
- The implementation of the system was potentially complex and expensive and could lead to a costly, permanent new government bureaucracy.
- The applied technology, if developed and owned by ODOT, would not be subject to market forces, leading to the fears of slow technology evolution and high costs.

By 2010, as light vehicle fuel consumption in Oregon continued to decline from the 2006 peak and electric vehicles entered the market, RUFTF was reconstituted. RUFTF formulated a new vision for road usage charges that removed the vehicle location technology (GPS) requirement, maximized participation by private firms, and emphasized “user choice”—providing drivers choices for reporting and paying for mileage. The current RUCPP demonstrates the viability of this new vision.

The new vision includes a range of mileage collection and reporting plans, five of which were tested in the RUCPP:

1. **Flat Rate plan, administered by ODOT**: Unlimited mileage purchased for a high flat annual or monthly fee, with no technology required, administered by ODOT. The flat fee was based on an assumed maximum miles driven of 35,000 per annum.
2. **Basic plan, administered by ODOT**: Wireless reporting of mileage data without vehicle location data, with accounts managed by ODOT.

3. **Basic plan, administered by a private service provider**: Wireless reporting of mileage data without vehicle location data, with accounts managed by a private sector partner.

4. **Advanced plan, administered by a private sector provider**: Wireless reporting of mileage data with vehicle location data to avoid charging for out-of-state and off-road travel, with accounts managed by a private sector partner.

5. **Smartphone plan, administered by a private sector provider**: Wireless reporting of mileage data with vehicle location data, transferred using a smartphone, to avoid charging for out-of-state travel, with accounts managed by a private sector partner.

Under the new vision, mileage collection and reporting plans can be offered to users and operated by private sector partners called Certified Service Providers (CSPs). CSPs store mileage data, maintain user accounts, send monthly invoices, collect road usage charges, and remit charges to ODOT. In addition, ODOT operates a public administrative alternative that supports only the Flat Rate and Basic plans.

ODOT undertook a multi-stage engagement with industry to procure the RUCPP. First, ODOT issued a Request For Information (RFI) regarding the operational concepts that industry foresaw for implementing the above options. The RFI received 28 responses from a variety of domestic and international companies, including tolling, insurance, telecommunications, and financial companies. Next, ODOT issued a Request For Proposal (RFP) to these 28 companies. ODOT received responses to the RFP from nine teams comprising 19 companies. Seven of the nine teams were awarded five-year agreements to provide equipment or services to ODOT. Of those seven teams, ODOT chose three as potential vendors for the initial RUCPP and invited them to detailed in-person interviews and unit testing. Finally, ODOT contracted with two of the teams, Sanef and Raytheon, to provide equipment and services for the RUCPP.

The Sanef team provided two mileage reporting devices (for the Basic Plan and the Advanced Plan) and account management services. Raytheon provided one mileage reporting device that interfaces with a user’s smartphone to report mileage. ODOT tested these devices and systems thoroughly.

After procurement of mileage reporting devices and services, ODOT set up the pilot by creating the support tools, including a web page and a help desk. ODOT recruited participants and introduced them to the various road usage charge plans. The participants signed a participation agreement, chose a plan, and set up an account. They then received mileage reporting devices by mail and installed them in their vehicles. The mileage reporting devices activated immediately upon installation: mileage reporting began and participants were assessed a road usage charge. Each participant received an invoice at the end of each month, which they pay by check for the ODOT plans or online for plans administered by the private sector.

Phase one of the pilot officially began on November 1, 2012 and ended on January 1, 2013. Phase two began on December 1 and ended on February 28, 2013.
Evaluation of the RUCPP

In November 2011, RUFTF approved four categories of metrics to be used in evaluation of the RUCPP and any follow-on demonstrations or pilots: policy and public acceptance; technology, operations, and cost. Each category includes several detailed metrics. Two data sources have been used to compute these metrics: objective, quantitative data collected during the RUCPP and surveys completed by participants and vendors. Participants have completed two surveys thus far: one prior to the start of the RUCPP and another following receipt of first invoices. All vendors were surveyed prior to the start of the pilot.

Evaluation Results

Analysis of the evaluation data has resulted in the following key findings:

- Based on surveys feedback to date, users regard the system as acceptable because it protects privacy, offers multiple reporting and payment choices, and, above all, is easy to use. In particular, pilot participants found mileage reporting equipment easy to install; plan type selections easy to make; and account management and bill payment easy to complete.

- The mileage-based road usage charge demonstrated in the RUCPP generated slightly more revenue than the fuel tax for participating vehicles. Mileage-based charges can generate more revenue from highly fuel efficient vehicles than the current gas tax generates from highly fuel efficient vehicles.

- The RUCPP demonstrates that mileage reporting hardware is safe and, based on statements of mileage reporting hardware vendors, resistant to tampering and fraud attempts.

- The RUCPP system performs well on a number of other system criteria: it is feasible, accurate, reliable, secure, and open.

- The pilot Road Usage Charging system was easy to operate, and if a similar system is used for the full implementation, it should also be easy to operate.

- The cost of mileage reporting devices is $50-$100. Costs of device operations and account management range widely, from $5 to $20 per month, depending on design and volume, as of 2013. Costs will continue to decline as time goes by and as volumes increase, and are expected to be notably lower (10-30% less) by 2015. In addition, many of these costs will be borne by private investors looking to build a platform for a variety of services such as data aggregation, as pay as you drive (PAYD) insurance, and vehicle concierge services. Road usage charging can be an inexpensive add-on to these existing services.

- The cost of operations is minor after setup of base system (just the cost of a call center, database maintenance). A base system setup can be completed for $200k if built on a pre-existing system.
Conclusions

The evaluation team drew the following conclusions from the results:

1. The RUCPP met its objectives of demonstrating an easy-to-use mileage reporting and payment system replete with palatable choices administered in an open, interoperable fashion by multiple private sector vendors.

2. Results suggest that road user charging with an open system is feasible, and a nascent market exists for the provision of a range of services related to road usage charge collection and administration by the private sector.

3. Giving participants a choice of road usage charging plans is possible and supports the success of the pilot, based on participant feedback.

4. 1.56 cents per mile was generally acceptable as a price point.

5. A road usage charge is generally perceived as being equitable by the participants in the RUCPP.

6. Mileage Reporting Devices were quick to install and easy to use.

7. Online accounts were user friendly, although PayPal payments presented problems for several participants and should not be offered as a central feature in full system operations.

8. OBDII ports can be used as a data source for aftermarket mileage reporting devices, but there are significant technology issues:
   - Inconsistency of data port location and conformity with OBDII standard among vehicles, especially hybrids and electric vehicles.
   - ODOT should consider using location information for distance measurement with advanced MRDs, and calibrating with OBDII port speed information.

9. Smartphones are feasible as part of a mileage reporting solution, but the pilot deployment was not effective and the technology requires refinement before it is deployed in a fully operational system.

10. Operations of a RUC system are feasible and can be effectively implemented for revenue collection.

11. The cost of dongles is $50-$100 and $5-20/month to operate a limited sample, limited duration one-off pilot program as of 2013; and will be less to operate a growing, permanent mileage charging program in the future where these costs can (1) be negotiated in a competitive market and (2) can be offset by private investment to build platforms for marketing various services such as data aggregation and pay as you drive (PAYD) insurance.

12. The cost of operations, after setup of base system, is primarily the cost of running a call center and database maintenance. A base system setup can be completed for $200k if built on a pre-existing system. The monthly cost of operations depends on the size of the system but should remain under $20,000.
13. Multi-state operation of RUC is technically feasible, and a system that begins in one state can be expanded to support multiple states, assuming that other states adopt a road usage charging business model that accommodates industry participation in a manner similar to Oregon. Because road usage charging is highly scalable, the additional accounts across several states could lead to further reductions in per-account costs if managed properly.

14. A Road Usage Charge accounting system is feasible.

15. User opinions of road usage charging as a policy improved, or in a minority of cases remained neutral, based on the pilot experience.

16. A few mileage reporting devices may fall out of the vehicle, or be bumped by the driver, although none are likely to interfere with driving. It is desirable for MRDs to have the smallest form factor possible and tightest fit into the OBDII port.

17. The best way to determine the amount of fuel tax credits for a motorist is to calculate fuel consumption based on data from sensors built into the vehicle engine. In vehicles that do not provide such data, it is reasonable to use EPA estimated fuel economy times the number of miles traveled as a substitute. In either case, fuel tax credits are computed by multiplying the number of gallons consumed by the amount of tax per gallon.

18. While RUC policy is broadly viewed by RUCPP participants as either the same as or more fair than the gas tax, all participants viewed it as a fair policy for them personally.

19. While participants generally trusted that RUCPP provided privacy protection and account security and provided similar protections as mobile phones and credit cards, they had no means of verifying this.

20. Despite the simplicity of the RUCPP from a user perspective, two participants worried about high administration and account management costs for government.

21. Account Management Vendors may wish to create a list of major private roads (including, for example, large parking facilities) in order to provide refunds for travel on these facilities, thereby creating more value for their customers. Although the maps used in the pilot accounted for off-road travel perfectly, private roads were not generally identified as being private in the database.
Introduction

Purpose and Organization of this Report

This report provides a summary of evaluation results of the Oregon Road Usage Charge Pilot Program (RUCPP).

The RUCPP demonstrated the new direction of the Oregon Road User Fee Task Force (RUFTF) that was formulated after an earlier trial in 2006-2007. RUFTF’s new policy directives include the following: user choice; open system for access to the existing technology market with no mandate for particular technologies such as GPS; and utilization of private sector for mileage reporting, tax processing and account management functions as an alternative to the government directly providing these functions.

The portion of the RUCPP involving Oregon residents was a pilot test whereby participants paid a mileage-based charge over a four-month period beginning November 1, 2012 and ending February 28, 2013. The individuals participating in the trial (pilot participants1) installed mileage reporting devices in their vehicles to record mileage, compute gas tax credits, and serve as the basis of billings and actual payments for road usage based on mileage as well as offsetting refunds for any gas taxes paid.

There were two phases of the RUCPP. Phase one began on November 1 with 34 participants, including 31 Oregon residents and 3 Washington residents using several mileage reporting devices that completed acceptance testing prior to November 1, 2012.

Phase two included 54 additional participants from Washington, Oregon and Nevada, and included additional mileage reporting devices (MRDs) that were accepted during November and December 2012. The 54 participants in phase two registered for the RUCPP throughout December 2012 and January 2013.

The following table summarizes participation in the pilot:

<table>
<thead>
<tr>
<th>Table 1: Summary of RUCPP participation by phase and state</th>
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<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>Total participants</td>
</tr>
<tr>
<td>Total Phase 1 participants</td>
</tr>
<tr>
<td>Total Phase 2 participants</td>
</tr>
</tbody>
</table>

1 For the purpose of the Oregon portion of the pilot, participants are defined as those individuals who signed up for the pilot, chose a mileage reporting plan, installed the mileage reporting device if applicable, and drove chargeable miles on the Oregon public roadway network.
During the pilot, all participants paid for their mileage traveled through one of five of mileage reporting plans.

- **Basic, provided by ODOT:** Wireless transfer of mileage data from the vehicle to the road usage charge processor. Account management by ODOT, with participant making payments directly to ODOT.

- **Basic, provided by Sanef:** Wireless transfer of mileage data from the vehicle to the road usage charge processor. Account management by private service provider Sanef, with participant making payments directly to Sanef.

- **Advanced, provided by Sanef:** Same as Basic, except that mileage data include location information to allow out-of-state and off road mileage not to be charged.

- **Smartphone, provided by Sanef:** Wireless transfer of mileage data with vehicle location information provided by user’s smartphone to allow for exclusion of out-of-state mileage from charging.

- **Flat Rate, provided by ODOT:** Pay a flat fee of $135 based on an assumed maximum mileage driven of 8,750 for the three-month term of phase one of the pilots.

Any fuel tax paid by participants was automatically calculated and offset against the mileage charges for all but the flat rate plan.

The following table summarizes participation by plan:

<table>
<thead>
<tr>
<th>Plan/MRD</th>
<th>Oregon</th>
<th>Washington</th>
<th>Nevada</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanef Advanced</td>
<td>24</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>Sanef Basic</td>
<td>8</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td>ODOT Basic</td>
<td>7</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Smartphone</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Prepaid Flat Rate</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td>44</td>
<td>21</td>
<td>23</td>
</tr>
</tbody>
</table>

This document presents the evaluation of the RUCPP on a range of metrics, which fall into four main categories chosen by the RUFTF: policy and public acceptance, technology, operations, and costs. Each of these categories includes several distinct metrics. Inputs used to measure the metrics are a combination of quantitative data collected from the mileage reporting devices and users as well as qualitative surveys of key stakeholders involved, such as participants and vendors.
The remainder of this report is organized as follows:

- Chapter 2 presents background to the Road Usage Charging program including the policy basis for a Road Usage Charging program.

- Chapter 3 describes how the pilot was created.

- Chapter 4 describes the implementation and execution of the Road Usage Charging Pilot program.

- Chapter 5 describes the evaluation of the RUCPP, including the evaluation strategy and results.

- Chapter 6 summarizes the responses of pilot participants to the RUC system as presented in the survey, especially the responses that were not included in the evaluation metrics presented in chapter 5.

- Chapter 7 presents the technical recommendations of the evaluation team.

- Chapter 8 presents overall conclusions from the pilot evaluation for the RUC program.

- The appendices include the detailed system architecture, the detailed evaluation strategy, the detailed evaluation results, and the raw data.
Oregon Road Usage Charging Program Background

2001-2007: Origins and first pilot tests

In 2001, it was brought to the attention of the Oregon Legislative Assembly that highly fuel efficient light vehicles were about to enter the marketplace, that this trend was accelerating due to new technologies such as hybrid vehicles, and that in the long term this trend would negatively impact transportation revenues from fuels taxes. In response, the Assembly established the Road User Fee Task Force (RUFTF), specifically to answer the questions: What would happen to state road revenues if Oregonians started buying and driving these new vehicles in large numbers? And how should Oregon's road revenues system be adjusted to respond?

The RUFTF determined that the fuel tax cannot be directly and accurately connected to the burden the vehicle places on a state highway system—a burden that is proportionate to vehicle miles driven and the time of day in which they are drive—and therefore unable to support any form of road usage charging. Even more significantly, the RUFTF noted all vehicle fuel efficiency improvements reduce fuel tax payments per vehicle mile traveled, and many vehicle fuel efficiency improvements can be expected due to rapidly advancing technology. The RUFTF suggested a new road revenue program with four policy remedies for these trends:

1. A tax on studded tires, which cause a disproportionate amount of roadway wear and tear (which RUFTF proposed as legislation in 2003 but did not pass in the legislature).
2. Tolling of new highway capacity.\(^2\)
3. Congestion pricing (which was determined to be primarily an issue for the Portland Metropolitan Area, which is still considering it).
4. A Mileage Fee or Road Usage Charge (which has since this time been studied by the Oregon DOT Office of Innovative Partnerships and Alternative Funding).

Based on the available studies, the RUFTF in 2003 determined that a Road Usage Charge should have two purposes:

- To replace the gas tax—not just supplement it, and
- To manage congestion.

\(^2\) Three tolling projects stalled in 2007 owing to financing difficulties and lack of public support, with the exception of a fourth, the ongoing mutual effort with Washington State to build the new Columbia River Crossing.
Based on these purposes, ODOT developed a ‘pay-at-the-pump’ system for deployment in its first pilot, in which all vehicles would have a device installed in their vehicles to measure mileage, and that when vehicles refueled, the motorist would pay their road usage charge when the device in their vehicle communicated with a receiver mounted near the gas pump. To fulfill the first purpose, drivers would pay the road usage charge instead of the fuel tax—the fuel tax would not be charged at all, demonstrating that this tax replaced the fuel tax, instead of supplementing it. To fulfill the second purpose, the system included higher pricing for travel during rush hours in the Portland area.

The in-vehicle device included a GPS receiving unit to measure mileage and to determine when the vehicle was in Oregon and in the Portland area. ODOT was well aware of privacy concerns surrounding the use of GPS, and so chose to use a ‘thick client’ device—one in which the distances driven, both inside and outside the Portland region, were computed in the device, and only sums of these distances were transmitted to the gas-pump mounted receiver. Specifically, the GPS coordinates of the vehicle were never transmitted outside of the in-vehicle device.

ODOT developed the device used specifically for the pilot, as no commercial-off-the-shelf (COTS) equipment to fulfill these requirements was available at the time.

The pilot ran for 12 months from March 2006-March 2007, with 299 vehicles, all of whom were members of the public. The pilot was technically and administratively very successful. Vehicles were successfully charged the mileage fee instead of the fuel tax, and participants were pleased with the convenience.

However, four challenges emerged from the public discussion of the 2006-2007 pilot:

- State-wide implementation of the tested system was potentially complex and expensive due to the need for a device in each vehicle and new hardware at all gas stations.

- Because the system employed specially-designed, specified, and built hardware, it would permit only a slow technological evolution. Hence it was “stuck in time,” a closed system not allowing marketplace innovations to drive prices down and services up.

- Some members of the public expressed great concerns about privacy because the system mandated the use of vehicle location technology despite that the in-vehicle device reported only summary mileage data and was not capable of transmitting vehicle location data outside of the vehicle.3

- Because the State would own and operate the entire system, the public expressed concerns about a costly bureaucracy.

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3 This type of approach is also called a ‘thick client’ solution because the in-vehicle device, or client, requires significant computational resources to translate the vehicle location data into a distance measurement.
For these reasons, no legislative action took place following the 2006-07 trial, and RUFTF temporarily ceased work.

2010-2012: Reconstitution of RUFTF

The RUFTF was reconstituted in 2010 for three reasons: continued financial trends, the fact that new electric vehicles were not paying the fuels tax at all, and the emergence of a new vision for Road Usage Charging within ODOT. ODOT’s new vision is to involve the private sector in the provision of commercial-of-the-shelf (COTS) hardware and in the management of road usage charge measurement, reporting, and payment.

First, by 2010, it had become clear that the financial issues that motivated the RUFTF’s earlier work and the first pilot were real and starting to impact Oregon’s transportation budget. Specifically:

- Oregon’s and the US federal government’s fuel tax receipts were now in permanent decline owing to dropping fuel consumption,\(^4\) and
- U.S. new vehicle fuel economy (CAFE) standards for 2016 and 2025 will impact the entire future passenger vehicle fleet composition and fuel efficiency.

Second, vehicles were entering the marketplace and not paying for road usage:

- Standard passenger vehicles with 100 percent electric motive power entered marketplace in 2010, and
- Plug-in hybrid vehicles entered the marketplace in 2012.

Third, COTS technology had become available that would support the payment of a road usage charge. Such technology currently includes equipment used to report pay-as-you-drive insurance (such as the Progressive Snapshot), various toll payment devices and factory installed telematics (such as On-Star, Ford Sync and Nissan Car Wings).

Since 2010, the reconstituted task force has met eight times to assess the viability of a new approach for the per-mile charge collection system, to develop policy recommendations, and to develop draft legislation in support of a mileage-based road usage charge system in Oregon. One piece of recent legislation – H.B. 2138, which was passed and signed by the Governor in 2011 – reinforced the RUFTF’s mission to further develop a system to support the enactment of a Road Usage Charge, and directed the RUFTF to consider new criteria for the design of pilot programs to test alternative approaches for a Road Usage Charge.

\(^4\) Oregon’s fuel tax rate increased 6 cents on January 2011, leading to a one-time revenue increase in 2011. However, consumption of fuel (gasoline and diesel) has declined 7% since peaking in 2006. 2012 fuel consumption is at its lowest level since 1997 despite an 8% increase in registered vehicles and 4% increase in VMT over that time frame. RUFTF did not perceive that the legislature would be willing to increases fuel taxes regularly enough to keep up with this continuing trend.
The reconstituted RUFTF developed several policy directives for a Road Usage Charge system in Oregon based in part on the lessons learned from the 2006 Road User Fee Pilot Program. They are included in the table below.

Figure 1: RUFTF’s Oregon Road Usage Charge System Goals

- **Implement a cost-effective and transparent system for collecting the vehicle Road Usage Charge**, one that is highly automated and is easy to use and simple to understand.
- **Provide RUC payer(s)**\(^5\) **with choices** regarding road usage reporting and methods for invoicing and payment.
  - At least one method for collecting and reporting the number of miles shall **not** use vehicle location technology (for example, GPS).
  - Provide a high flat annual charge option that RUC payers may adopt in lieu of paying based on miles traveled in order to purchase the ability to drive an unlimited number of miles.
  - Provide multiple options for payment, including cash, check, credit/debit card, electronic transfer of funds from bank, and so forth.
- **Establish public-private partnerships** to develop a system that allows RUC payers to interface directly with a certified service provider (CSP) of their choice to record mileage and/or provide invoicing and payment.
- **Implement a government system** as an alternative to the CSPs and as “provider of last resort” for basic measuring and invoicing activities for those individuals who cannot qualify or choose not to use a CSP.
- **Protect privacy of motorists.**
  - No government mandate for any particular technology including GPS/vehicle location.
  - Legal requirements for protection of any personally identifiable information used in reporting highway use and invoicing.
- **Only charge Oregon residents for in-state travel**, unless travelers report mileage undifferentiated by geographic location (in which case, all recorded mileage will be assumed to have been driven within the state).
- **Provide credits or refunds for travel on private property** within Oregon by residents.
- **Provide credits or refunds for fuel taxes paid for vehicles** that are subject to the vehicle Road Usage Charge.
  - The measurement of fuel consumed to calculate the fuel tax credit should be automated.
- **Base the system design on an open architecture using common standards** for the system components and processes that need to be interoperable for an efficient and cost-effective system.

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\(^5\) The term **RUC payer** refers to individuals who are subject to and responsible for paying the Road Usage Charge, including the registered owner of a motor vehicle that is registered in Oregon, and any person who leases a motor vehicle that is registered in Oregon.
Restated at a high level, RUFTF’s goals for the Road Usage Charge system are:

- **No Technology Push.** The government should not mandate or push motorists to particular technologies, especially GPS.

- **An Open System.** Allow for system technologies to evolve with marketplace capabilities and motorist preferences. “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.”

- **Private Sector Administration.** Tap into market forces to allow the public to choose either government or private sector provision of data collection and payment services.

- **Motorist Choice.** Motorists should choose from several collection methods and technologies to meet individual preferences.

- **Standards.** ODOT sets standards for mileage data messaging and tax processing systems.

- **Certification.** ODOT engages an independent certifications entity to certify on board technologies, transaction processing and account management.

ODOT took RUFTF’s policy directives, coupled them with directives contained in the original legislation and information obtained during a series of workshops, and elaborated on them to create the following list of goals for the Road Usage Charging system. ODOT’s newly added goals are in bold print, while RUFTF’s original goals appear in regular text.

**Figure 2: ODOT elaboration on RUFTF’s Oregon Road Usage Charge System Goals**

- Implement a cost-effective and transparent system for collecting the vehicle Road Usage Charge, one that is highly automated and is easy to use and simple to understand.
  - Automation via on-board equipment and wireless communications.
  - Data collection and payment systems that access existing processes familiar and acceptable to the public.

- Provide RUC payer(s)\(^6\) with choices regarding road usage reporting and methods for invoicing and payment.
  - At least one method for collecting and reporting the number of miles shall not use vehicle location technology (for example, GPS).
  - Provide a high flat annual charge option that RUC payers may adopt in lieu of paying based on miles traveled in order to purchase the ability to drive an unlimited number of miles.
  - Provide multiple options for payment, including cash, check, credit/debit card, electronic transfer of funds from bank, and so forth.

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\(^6\) The term RUC payer refers to individuals who are subject to and responsible for paying the Road Usage Charge, including the registered owner of a motor vehicle that is registered in Oregon, and any person who leases a motor vehicle that is registered in Oregon.
Establish public-private partnerships to develop a system that allows RUC payers to interface directly with a certified service provider (CSP) of their choice to record mileage and/or provide invoicing and payment.

- Tap into market forces to the greatest extent possible for providing mileage collection and road charge processing services. The use of such third party CSPs not only provides RUC payers with choices, but also helps dispel the perception that a new Road Usage Charge would necessitate a new, expensive governmental bureaucracy.

- It is envisioned that the Road Usage Charge services will eventually become a "value added" to other services offered by private entities, such as pay-as-you-drive insurance and factory-installed in-vehicle devices and services (such as On-Star, Sync, and other vehicle telematics).

- ODOT will be responsible for the certification program and monitoring of third parties and the services they provide.

- Implement a government system as an alternative to the CSPs and as "provider of last resort" for basic measuring and invoicing activities for those individuals who cannot qualify or choose not to use a CSP.

- Protect privacy of motorists.
  - No government mandate for any particular technology including GPS/vehicle location.
  - Legal requirements for protection of any personally identifiable information used in reporting highway use and invoicing.

- Only charge Oregon residents for in-state travel, unless travelers report mileage undifferentiated by geographic location (in which case, all recorded mileage will be assumed to have been driven within the state).

- Provide credits or refunds for travel on private property within Oregon by residents.

- Provide credits or refunds for fuel taxes paid for vehicles that are subject to the vehicle Road Usage Charge.
  - The measurement of fuel consumed to calculate the fuel tax credit should be automated.

- Ensure efficient account management operations that provide a convenient way for taxpayers to access, administer, and make inquiries regarding their accounts and the processes by which the Road Usage Charges are calculated.

- Provide viable audit trail to ensure proper recording of mileage and associated payments.

- Promote compliance and minimize evasion through a combination of education, regular audits (and associated audit trail), and enforcement activities to minimize avoidance and payment violations.

- Base the system design on an open architecture using common standards for the system components and processes that need to be interoperable for an efficient and cost-effective system.
  - Use of standard functional requirements and interfaces that are fully accessible to the market place, allowing various private entities to participate in the parts of the program that they are best suited to support.
  - Through an independent certification entity selected by ODOT, certify commercial-off-the-shelf (COTS) technologies according to applied standards for data message format, data accuracy and security and anti-tampering protocols.
- Prevents the system from being locked into a single provider for any system components.
- Allows technology to evolve and future scalability.

- Develop a system design that does not preclude future expansion and/or collection of a variety of transportation charges.
- Future connections to other states with Road Usage Charge systems for sharing information and revenue transfers, including taxing out of state vehicles for miles driven within Oregon.

Restated at a high level, ODOT’s elaboration on RUFTF’s goals for the Road Usage Charge system includes the following additional goals:

- **Respect Markets.** Minimize disruption to existing markets.

- **Allow Unrelated Services.** Certified service providers allowed to offer services not directly related to the road usage charge.
Creating the Road Usage Charging Pilot Program

This chapter provides a summary on the background of the RUCPP and operational concepts tested in the RUCPP. It includes a summary of the implementation and execution of the RUCPP.

RUCPP background

In the early 2012, ODOT initiated efforts to run a Road Usage Charge pilot program (RUCPP) based on the new policies adopted by RUFTF. ODOT’s goal was to start the pilot and have preliminary results ready for the 2013 legislative session. The purpose of the RUCPP was to demonstrate the rudimentary features of a fully implemented RUC. The RUCPP was intended to address many of the overall RUC goals, including choices for mileage reporting (types of mileage reporting technologies) and for account management, an automated process for determining the amount of gas taxes paid and providing a credit for this amount, protecting the motorist’s privacy, and an actual “open” system that includes more than one vendor. In addition, the RUCPP was intended to demonstrate problem-free account processing and technologies and system that are simple and easy to use, and work with minimal errors and mistakes.

The RUCPP was planned for a select group of volunteer motorists from Oregon. The RUCPP was planned not to just be a paper exercise—it was planned to include real payment of funds and credits for fuel taxes paid under the authority of Oregon statutes.

During the preparations for the RUCPP described below, Washington State DOT and Nevada DOT both approached ODOT, and asked to participate in the RUCPP. Both had modest funding to contribute to the costs of the pilot—sufficient to cover the marginal cost of their participation in the trial. Unlike the Oregon RUCPP participants, Washington State and Nevada participants would not actually pay real money (or be given real gas tax credits for participating in the trial) but instead, their miles traveled would be recorded, and their hypothetical road use charges calculated, and they would receive an illustrative billing.

Operational concept developed for the RUCPP

After the state decided to move forward with a pilot project, ODOT first developed an operational concept to fulfill the RUFTF’s general goals for the RUC system outlined in the last section. Based on these goals, ODOT developed four mileage collection and reporting options, called road usage charge plans for the RUCPP:

- **Basic**: Wireless transfer of mileage data from the vehicle (e.g., OBD-II port or odometer).
- **Advanced**: Wireless transfer of mileage data with vehicle location capability to allow for exclusion of out-of-state travel and off-road travel.
- **Smartphone**: Wireless transfer of mileage data with vehicle location capability...
provided by user’s smartphone to allow for exclusion of out-of-state travel.

- **Flat Rate:** Pay a flat fee of $135 based on an assumed maximum mileage driven of 8,750 for the three-month term of phase one of the pilots.

**Figure 3: Mileage Reporting Device for Basic Road Usage Charge Plan**

The Basic Road Usage Charge Plan employed a mileage reporting device that does not measure vehicle location, but uses only information from the vehicle electronics to measure and wirelessly report distance traveled and fuel consumed. Fuel tax rebates or credits are computed based on all fuel consumed. Basic Road Usage Charge reporting does not support refunds for out-of-state or off-road travel. A mileage Reporting Device for this plan is pictured in Figure 3.

**Figure 4: Mileage Reporting Device for Advanced Road Usage Charge Plan**

The Advanced Road Usage Charge Plan employed a mileage reporting device that measures vehicle location so it can report miles traveled by zone or region. In the pilot, the state of Oregon is one zone, and the other states, including Washington and Nevada, are other zones. The advanced plan supports RUC refunds or credits for miles driven outside of Oregon and miles driven off-road. Fuel tax rebates or credits are computed based on fuel consumed while driving on public roads in the state where the vehicle is registered. ODOT envisioned two types of devices for reporting mileage under the Advanced Plan: aftermarket devices and factory-installed in-vehicle telematics devices. Personal navigation devices may also be able to support this plan. A mileage reporting device for this plan is pictured in Figure 4.
The Smartphone Road Usage Charge Plan employed a mileage reporting device that wirelessly communicates with a smartphone provided by the RUC payer, and the RUC payer-provided smartphone measures vehicle location so it can report miles traveled by zone or region. The mileage reporting device should wirelessly report mileage traveled to the road usage charging system.

ODOT sought a Smartphone mileage reporting device that would continue to function normally if a user did not bring his or her smartphone into the vehicle (i.e., an MRD that contains long-range wireless communications technology itself). However, no such MRDs were proposed in response to the RFI. The Raytheon device chosen by ODOT for use in the trials utilized the user’s smartphone for communications. However, it had a large data buffer that allowed it to store all data for travel while the user’s smartphone was not in the vehicle. It would then transmit that data to the road charge processing system when the smartphone was again brought into the vehicle.

Similar to the advanced plan, the smartphone plan supports refunds or credits for miles driven outside of Oregon from the state’s road usage charge. Fuel tax rebates or credits are computed based on fuel consumed in the state of Oregon. In addition, the smartphone plan offers the user the ability to disable vehicle location reporting at any time through a setting on the smartphone application. A mileage reporting device for this plan is pictured in figure 4. A screenshot of the Smartphone App for this plan is pictured in Figure 5.

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7 Basic road usage charge devices included pay-as-you-drive insurance devices provided by IMS (Intellimec).
8 Note that, just like for Oregon participants, Washington participants using a differentiated mileage concept were charged only for miles driven inside Washington, but not for miles driven outside of Washington. Unlike Oregon, however, Washington participants did not actually pay the road usage charge as part of the pilot. Nevada participants also were only charged for miles driven in Nevada, but received an illustrative billing and did not actually pay the road usage charge.
9 Fuel tax credits were only provided for chargeable miles—miles driven on public roads in Oregon. Non-chargeable miles include out-of-state miles and off public road. To ensure that fuel tax credits were only provided for travel on public roads, the fuel tax credit was computed by multiplying the ratio of chargeable miles (chargeable miles divided by total miles) times the estimated amount of fuel consumed times the fuel tax.
10 Factory-installed telematics devices are available from most major automobile manufacturers. Examples include GM’s OnStar, Ford’s Sync, Toyota’s Entune, Nissan’s Carwings, and Mercedes’ mbrace. Aftermarket devices include some pay-as-you-drive insurance devices such as those provided by IMS (Intellimec), Scope Technologies, Xirgo. Aftermarket devices also include GPS toll tags such as those provided by Siemens, GMV, EROAD, and many others for truck tolls, and many others.
11 Personal navigation devices with integrated wireless communication such as the Garmin Nuvi 1600 series and 3700 series or the TomTom Go series could serve as mileage reporting devices. However, these devices would require a software update and additional security measures to serve as a mileage reporting device.
12 As with the Advanced Plan, fuel tax credits were only provided for chargeable miles. However, the smartphone mileage reporting device was not configured to measure whether travel was on public or private land, so non-chargeable miles on the smartphone plan included only miles traveled outside Oregon.
The Flat Rate Road Usage Charge Plan did not employ a mileage reporting device. Participants who opt for this plan paid a three month fee for unlimited road usage based on an assumed maximum number of miles driven for that period of 8,750 and were ineligible to receive a fuel tax credit.

In the Basic, Advanced, and Smartphone plans, users had Road Usage Charge accounts that store their miles driven and charges owed. For the advanced and smartphone mileage reporting plans, the account management system was supported only by a private company, called a Certified Service Provider (CSP), and not ODOT. For the basic mileage reporting plan, the account management system may be provided by either a CSP or ODOT itself. In this way, privacy is even more securely protected because the CSP and only the CSP (and not ODOT) is in possession of any location data.

In general, data flows from the mileage reporting device to an account management system (provided either by a CSP or by ODOT), and excerpts of that data are forwarded to ODOT’s mileage tax accounting division for audit and reconciliation purposes. High-level details of
the data flows and architecture are provided in Appendix A. The full details of these architectures are explained in the *ODOT Operational Oregon Vehicle Road Usage Charge System and Road Usage Charge Pilot Program Updated Concept of Operations Version 1.1 March 15, 2012.*
Implementation of RUCPP

After ODOT developed the operational concept, ODOT acted to implement the pilot with substantial participation of private industry. To do so, ODOT and its contractors employed an iterative procurement process that began with a widely publicized Request for Information (RFI), followed by a Request for Proposal (RFP) open to those who had responded to the Request for Information. ODOT awarded all vendors whose proposals met minimum qualifying criteria with five-year contracts to provide products and services. From among the awardees, ODOT would choose a select number of firms to actually support the RUCPP.

ODOT released the RFI, which presented the RUCPP objectives and operational concepts outlined above, in early February 2012. ODOT received a total of 28 responses from domestic and international companies that represented a mixture of tolling hardware, tolling software / management system / integrators, pay-as-you-drive insurance providers, and major IT integrators and consultants.

In March 2012, ODOT released the RFP, which specified that responders could bid to fill one or more of three necessary roles and one optional role: mileage reporting device vendor (necessary), account management system vendor (necessary), Mileage Tax Accounting (necessary), and data aggregator (optional). Mileage reporting device vendors could bid on any or all of three categories of mileage reporting device: basic, advanced (either aftermarket telematics or factory-installed telematics), and smartphone. All of the RFI respondents could bid on the RFP, and all were invited to bid on any or all of the roles. ODOT received a total of nine responses to the RFP. Nine teams comprising 19 companies responded to the RFP. The nine responses included several mileage reporting device providers. Since none of the bidders provided a suitable advanced factory-installed telematics mileage reporting device, the advanced factory-installed telematics device was not included in the pilot. ODOT received suitable bids for all other categories. ODOT chose not to award either the role of data aggregator (the optional role) or the role of mileage tax accounting (which for the pilot was provided by ODOT’s consultants). The awardees were Battelle, Brisa, GMV, Accenture, Raytheon, Sanef (teamed with IMS), and IBI.
Of the seven awardees, ODOT chose three for potential inclusion in the RUCPP based on evaluation results of the RFP and the complimentary nature of their systems: IBI, Raytheon, and Sanef (teamed with IMS). The other four may still be used in future pilots or related testing.

Each of the three firms chosen for potential inclusion attended a daylong interview and technical demonstrations of their products. Of the three, ODOT did not select IBI for inclusion in the RUCPP based on the interviews and demonstrations. ODOT chose French integrator Sanef, teamed with Canadian pay-as-you-drive insurance hardware provider IMS, and US contractor Raytheon for the RUCPP.

Sanef provided three components of the system: the basic mileage reporting device, advanced aftermarket telematics mileage reporting device, and the account management system. Raytheon provided the mileage reporting device that connects with a smartphone application. The device provided by Raytheon does not include hardware to report mileage to the road usage charging system as envisioned in ODOT’s operational concept; instead, it employs the user’s smartphone to transmit that information. In a fully operational system, ODOT would require a mileage reporting device that includes wireless transmission hardware, so transmissions can occur even if the user fails to bring his/her smartphone into the vehicle, or the smartphone’s battery dies.

Raytheon and Sanef spent several months implementing the ODOT Interface Control
Documents (ICD), including the “mileage message” which specifies how mileage data was to be transmitted to the account management system. After this development, ODOT subjected Raytheon and Sanef’s products and services to intense testing. First, the products went through bench testing to verify that the products worked correctly on their own. Next, the products went through integration testing to verify that the product interfaces including the mileage message were implemented correctly. Finally, the products went through system testing to verify that they worked correctly as a system.

While product testing was underway, ODOT’s contractors prepared for the RUCPP by setting up a help desk to support participants during their involvement in the pilot. ODOT set up two websites and the contractor, Sanef, set up one website:

- [http://www.oregon.gov/ODOT/HWY/RUFPP/Pages/rucppvolunteers.aspx](http://www.oregon.gov/ODOT/HWY/RUFPP/Pages/rucppvolunteers.aspx): This is the road usage charge pilot program website for the participants.
- [http://roadchargeoregon.org](http://roadchargeoregon.org): This is the dedicated pilot website and for members of the public interested in the trial.
- [https://www.sanef-oregon.com](https://www.sanef-oregon.com): Once a participant signed an agreement with ODOT, this is where participants went to choose their plan and set-up and manage their accounts.

**Execution of the RUCPP**

ODOT recruited a select group of volunteer participants to participate in the RUCPP. The participants were solicited from the Transportation and Revenue Committees of the Oregon Legislature, the Oregon Transportation Commission, and Road User Fee Task Force and ODOT executive management. A few others were accepted after requesting participation upon hearing about the pilot. All participants were generally required to have a vehicle from model year 2004 or newer, and were willing to participate in the pilot and pay the road usage charge in lieu of the fuel tax.\(^\text{13}\)

RUCPP Participants were introduced to the pilot activities through an onboarding process. In that regard the Participants were:

- Sent regular communications to update them on the pilot timelines,
- Sent a participant overview sheet explaining how the pilot would operate, and

\(^\text{13}\)Certain earlier models of vehicles were able to be accepted for participation provided they were equipped with an adequate on-board diagnostic port (a.k.a., OBDII port with a recent protocol).
• Provided help desk support throughout the onboarding process and the pilot itself. To start the pilot, all participants signed a participant agreement confirming their willingness to participate.

*Mileage Reporting Plan Selection.* Once signed on, the RUCPP Participants chose their preferred road usage charge plan and set up their accounts. The following table explains the essential elements of the five plans available for the pilot.

**Table 3: Road usage charge plans available in the RUCPP**

<table>
<thead>
<tr>
<th>RUCPP Plan</th>
<th>Miles Reported</th>
<th>Invoice</th>
<th>Payment Method</th>
<th>Online account management</th>
<th>Uses GPS?</th>
</tr>
</thead>
<tbody>
<tr>
<td>ODOT Basic Plan</td>
<td>All</td>
<td>Mailed Monthly</td>
<td>Check</td>
<td>No</td>
<td>No, does not report where miles are driven</td>
</tr>
<tr>
<td>ODOT Flat Rate Plan</td>
<td>N/A</td>
<td>Once, at start</td>
<td>Check</td>
<td>No</td>
<td>No device</td>
</tr>
<tr>
<td>Sanef Basic Plan</td>
<td>All</td>
<td>Emailed Monthly</td>
<td>Credit/debit card</td>
<td>Yes</td>
<td>No, does not report where miles are driven</td>
</tr>
<tr>
<td>Sanef Advanced Plan</td>
<td>Public roads in Oregon only</td>
<td>Emailed Monthly</td>
<td>Credit/debit card</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Sanef Smartphone Plan</td>
<td>With application running, only roads in Oregon; without application running, all roads</td>
<td>Emailed Monthly</td>
<td>Credit/debit card</td>
<td>Yes</td>
<td>Yes, when the application is running</td>
</tr>
</tbody>
</table>

*Installations.* Everyone who was on any plan other than the flat rate plan was sent a mileage reporting device in the mail. They were also sent instructions on how to install the mileage reporting devices in their vehicles. These instructions appear in Figure 6 below. A photo of a mileage reporting device being installed appears in Figure 7 below.
**Before You Begin:**

- The Device needs to be installed in the same vehicle that was registered during account set up.
- For a better connection, perform installation outdoors or in a well–lit place.
- For your safety, ensure that your vehicle ignition is OFF during installation.

If you have any queries, contact the RUCPP Help Desk at 855-797-1266

**HOW TO INSTALL THE MILEAGE REPORTING DEVICE**

1. Locate Your Port
   - Your vehicle’s OBD-II port is an outlet typically located near the pedals.

2. Plug-In Device
   - Ensure it is installed securely and is not loose.

Once installed, it is important you wait 1-2 minutes before starting your vehicle to allow the Device to configure.

Your mileage data will be automatically recorded and sent for processing.

It is important to ensure that the Mileage Reporting Device does not interfere with your ability to safely enter, exit, or operate the vehicle. If so, contact the Help Desk.

If your OBU becomes disconnected for any reason, simply repeat these steps.
Invoicing and Payment. After the pilot participants installed their mileage reporting devices, they drove, and received a monthly invoice that informed them of the number of miles they drove, the road usage charges that they owed and their fuel tax credit earned. Participants with an ODOT Plan paid invoices by check mailed directly to ODOT. Participants with a Sanef Plan paid invoices online with a credit or debit card. A typical invoice is presented in figure 8 below.
The pilot was conducted in two phases:

- Phase one, which began on November 1, 2012 and ended on January 31, 2013.
  
  o Phase one included 34 participants: 31 Oregon residents and 3 Washington State residents.
  
  o It included all plans except the Smartphone Plan.

- Phase two, began December 1, 2012 and ended February 28, 2013.
  
  o Phase two includes 54 total participants: 13 additional Oregon residents, 18 additional Washington State residents, and 23 Nevada residents.
  
  o It included all plans, including 4 Oregon residents using the Smartphone Plan.

This report covers both phases, but focuses on the results of the Oregon participants. Results for Washington participants are included in Appendix C.
Evaluating the Pilot Program

This chapter presents a summary of the formal RUCPP evaluation. It summarizes the RUCPP evaluation strategy based on the metrics determined by the RUFTF and the results of the evaluation. The detailed method of evaluation is included in Appendix B. The detailed evaluation results are included in the next chapter.

Evaluation strategy

Evaluation means determining the potential future impacts of the RUCPP and RUC programs. Evaluation was completed by determining how well the programs fulfill their intended goals.

The goals have two sources:

1. The evaluation strategy accepted by RUFTF for the overall measurement of the Road Usage Charge program (encapsulated below in Table 4: Overview of RUCPP Evaluation Strategy).

2. The goals and objectives of the RUCPP as stated in the RUCPP Concept of Operations, and listed below in Table 4.

Based on these goals, ODOT and the evaluation team agreed on the following evaluation strategy.

<table>
<thead>
<tr>
<th>Goal</th>
<th>Impacts</th>
<th>Evaluation Criteria Category</th>
<th>Metrics(^{14})</th>
</tr>
</thead>
</table>
| Determine the level of public acceptance of the RUC program | Customer program acceptance and response AND Public attitudes | 1. Policy and public acceptance | a. Similar revenue contribution by RUC payers under RUC as under the motor fuel tax

b. Acceptance by RUC payers and other system users concerning:
   - Costs to RUC payers
   - Ease and convenience to RUC payers
   - Privacy protection
   - Fairness
   - Transparency
   - Aversion/attraction
   - Choice |
<table>
<thead>
<tr>
<th><strong>Goal</strong></th>
<th><strong>Impacts</strong></th>
<th><strong>Evaluation Criteria Category</strong></th>
<th><strong>Metrics</strong>[^14]</th>
</tr>
</thead>
</table>
| Demonstrate and measure the technical and operational viability of the proposed RUC concept through demonstrations | Infrastructure and usage impacts AND System operational factors | 2. Technology | a. Adaptability of the RUC system  
b. Ease of installation of mileage reporting devices  
c. Safety of mileage reporting devices, mileage reporting device installation, and system operations for motorists.  
d. Anti-tampering  
e. System performance  
f. Hardware, software and other system elements including  
   • Feasibility  
   • Accuracy  
   • Reliability  
   • Security/encryption  
   • Open system  
   • Energy consumption  
   • Account management system experience |
| Gain a preliminary understanding of the operational aspects of the RUC program | System operational factors | 3. Operations | a. Ease and cost efficiency of administering the RUC  
b. Ease of use and cost of compliance with the RUC system by RUC payers and other system users, including evasion potential  
c. Accuracy and perception of accuracy of data transmitted to the central database and used for assessing mileage taxes  
d. Privacy options for RUC payers in protecting personal, private data  
e. Ability to audit  
f. Usefulness for phasing and partial implementation |
| Gain a preliminary understanding of the costs associated with implementing the RUC program | Financial impacts  
Economic impacts | 4. Costs | a. Start-up costs (capital and retrofitting)  
b. Operations and maintenance  
c. Costs of collection relative to fuel tax |

[^14]: In this evaluation, a **metric** is defined as the value to be measured to determine how well each program goal is fulfilled. For example, “Ease of Mileage Reporting Device Installation” is a metric that measures how easy it is to install the mileage reporting device, a key part of the first system goal—that the system is easy to use. The specific numerical value held by a metric is called an **indicator**. The indicator for the “Ease of Mileage Reporting Device installation” is the average (mean) of the responses to the following survey question: What was the level of difficulty to install the mileage reporting device? Response options: 1. Very high, 2. High, 3. About right, 4. Low, and 5. Very low.
The team identified the following six key RUCPP stakeholder groups. Evaluation activities comprised surveys of and data collection from each of these groups:

1. **Participants or RUC payers.** Individuals who were responsible for paying the road usage charge, typically vehicle owners or lessors. For the purpose of the pilot, participants are defined as those individuals who signed up for the pilot, chose a mileage reporting plan, installed the mileage reporting device if applicable, and drove chargeable miles on the Washington roadway network.

2. **Mileage reporting device vendors.** Representatives of the companies who supplied the mileage reporting devices.

3. **Account management system vendors.** Representatives of the company who provided the private account management systems.

4. **Pilot participant coordinators.** Representatives from Oregon DOT who coordinated activities of the pilot participants.

5. **Road Usage Charge Accounting System Operator.** The contractor who operated the Road Usage Charge accounting system.

6. **System Integrators.** The contractors who integrated, tested, and provided ongoing support for all elements of the RUCPP.

One of the first steps in the evaluation was distribution of initial surveys to vendors and participants in order to determine their perspectives and opinions prior to initiation of RUCPP, as a baseline. Vendors were surveyed during the stakeholder information sessions before the start of the RUCPP, as described above, and were surveyed again at the end of the RUCPP. No midpoint survey was held for vendors. Participants were surveyed three times:

1. A pre-screening survey to determine RUC payers’ opinions, thoughts, and behaviors at the outset of the program.

2. A mid-point survey to determine RUC payers’ opinions, thoughts, and behaviors during the program following receipt of the first invoice.

3. A third and final survey was distributed at the conclusion of the pilot to determine RUC payers’ opinions, thoughts, and behaviors after the program finished.

During and after the data and survey collection, the evaluation team compiled responses, analyzed indicators, and prepared this report.

In addition to the largely qualitative feedback from surveys, the evaluation team collected raw data from a range of pilot stakeholders at various points throughout the pilot. The evaluation team asked each of the stakeholder groups to provide the data in the original formatting in which it was recorded (whatever spreadsheet or other formatting had been used to record the data). For illustrative purposes, below is a partial list of data collected:
• Number of mileage reporting devices that are reported broken, missing, etc.

• Whether any mileage reporting device, data collection, transactions processing, account management system options available to participants before RUCPP failed, and why.

• Compilation of Road Usage Charge Accounting reports.

• The capital and retrofitting costs that ODOT incurred starting up the Road Usage Charge pilot system.

• The operations and maintenance costs that ODOT incurred starting up the Road Usage Charge pilot system.

• The marginal costs of operating Road Usage Charge system in multiple states.

• Miles travelled (by zone) and taxes owed and paid for each RUCPP participant (may be provided as part of road usage charge accounting records)

• Customer service logs and issue logs (may be included in Help Desk Logs).

• Logs of road usage charging transactions.

• Error logs from mileage reporting devices.

A full list of data collected and a complete description of the method of evaluation can be found in Appendix B.
**Summary of results**

The following table provides a summary of the evaluation results for the metrics for each evaluation category.

**Table 5: Summary of Evaluation Results**

<table>
<thead>
<tr>
<th>Evaluation Category</th>
<th>Metric</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Policy and public acceptance</strong></td>
<td>Metric 1: Similar revenue contribution by RUC payers under RUC as under the gas tax</td>
<td>In aggregate, RUCPP participants had an average of 24.3 MPG and contributed more RUC than they would have fuel tax.</td>
</tr>
</tbody>
</table>
|                                    | Metric 2: Acceptance by RUC payers and other system users concerning several criteria | a. Impacts to RUC payers: average of $0 cost and 44 minutes per participant.  
b. Ease and convenience to RUC payers: all participants responding to the survey lauded the ease of use of the RUCPP.  
c. Privacy protection: privacy was protected and adequately explained through user choice of GPS vs. non-GPS mileage reporting devices.  
d. Fairness: almost all participants agree that RUC is at least as fair as a gas tax.  
e. Transparency: this metric has not yet been measured.  
f. Aversion/attraction: overall, participants found the RUC methods acceptable.  
g. Choice: providing user choices alleviated many of the concerns about the RUCPP. |
| **Technology**                     | Metric 1: Adaptability of the RUC system                               | The system demonstrates a high degree of adaptability including scalability and the ability to accept payments from many sources.  
Metric 2: Ease of installation of mileage reporting devices | All but one participant installed the devices themselves in a matter of minutes.  
Metric 3: Safety of mileage reporting devices, mileage reporting device installation, and system operations for motorists | There have been no reported incidents of mileage reporting devices compromising the safety of any aspect of the system, from driving to bill paying.  
Metric 4: Anti-tampering | Vendors have expressed confidence in device anti-tampering features and algorithms in their products.  
Metric 5: System Performance | Overall system performance has been high—it has exceeded expectations in terms of accuracy, efficiency, and ease of use.  
Metric 6: Hardware, software and other system elements | a. Feasibility: Yes.  
b. Accuracy: Yes.  
c. Reliability: Yes.  
d. Security/encryption: Yes.  
e. Open system: Yes.  
f. Energy consumption: Yes.  
g. Account management system experience: Yes. |
| **Operations**                     | Metric 1: Ease and cost efficiency of administering the MT            | The system was easy to administer (required no unusual operations or training) and very cost-effective (required few person-hours once it was up and running).  
Metric 2: Ease of use and cost of compliance with the MT system by RPs and other system users, including evasion potential | Both the system vendors and the integrators believed it would be easy and free for participants to use the system, and participants confirmed this view with statements on their surveys. |
<table>
<thead>
<tr>
<th>Evaluation Category</th>
<th>Metric</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Metric 3: Accuracy and perception of accuracy of data transmitted to the</td>
<td>Distance measurement accuracy was measured to be 2-3%. Participants perceived the system to be very accurate—not to over-count or to miss miles.</td>
</tr>
<tr>
<td></td>
<td>central database and used for assessing mileage taxes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Metric 4: Privacy options for RPs in protecting personal, private data.</td>
<td>Vendors and participants felt that the system provided many privacy options and protected user privacy well.</td>
</tr>
<tr>
<td></td>
<td>Metric 5: Ability to audit</td>
<td>The accountant who executed mileage tax accounting concluded that the system was simple and straightforward to audit using a new set of auditing tools.</td>
</tr>
<tr>
<td>Costs</td>
<td>Metric 1: Start-up costs (capital and retrofitting)</td>
<td>Startup costs for a CSP are estimated to be $200,000 if they have suitable account management software or $500,000 if they do not have suitable account management software.</td>
</tr>
<tr>
<td></td>
<td>Metric 2: Operations and maintenance</td>
<td>O&amp;M costs for a CSP are estimated to be about $18,000/month.</td>
</tr>
<tr>
<td></td>
<td>Metric 3: Costs of collection relative to fuel tax</td>
<td>Based on figures available from the pilot experience, a low volume of road usage charges is considerably more costly to collect than a high volume of fuel taxes. However, the converse is also true: a high volume of road usage charges is considerably less costly to collect than a low volume of fuel taxes. At volume, the cost to ODOT of collecting either tax (RUC or fuel tax) is comparable. Full details are available in Chapter 6, Section 6.4, Metric 3.</td>
</tr>
</tbody>
</table>

**Explanation of results**

**Policy and public acceptance:** The main policy result is that the system has a strong revenue potential and is sustainable while the gas tax is not. The main public acceptance result is that the system tested in the RUCPP had a high acceptability among stakeholders including users, vendors, and DOT managers, particularly due to its “ease of use” and “simplicity.”

**Technology:** The RUCPP successfully demonstrated multiple technology options and achieved high user satisfaction in an open system framework. The system was shown to be adaptable. The mileage reporting device technologies were shown to be easy to install. Mileage reporting devices were shown to be completely safe. The system was shown to perform with a high degree of accuracy. And it was shown to have passed a wide range of hardware and software criteria.

**Operations:** The RUCPP showed that RUC system supports smooth and effective operations. The system was easy and cost-effective to operate. Interfacing with the system was easy and cost effective for participants. The system was operationally accurate, and it was perceived to be accurate by participants. It provided effective privacy options for participants. Finally, the system operations supported easy and effective auditing.
**Costs:** The RUC system required relatively limited cost impacts. Startup costs for a CSP were estimated to be $200,000 if they have suitable account management software or $500,000 if they do not have suitable account management software. O&M costs for a CSP are estimated to be about $18,000/month at low vehicle volumes.

A more detailed analysis of evaluation data and results is included in the next chapter.
Detailed Evaluation Results

Evaluation category 1: Policy

Policy and public acceptance metric #1: Similar revenue contribution by RUC payers under RUC as under the gas tax

The purpose of this metric is to assess the difference in revenue generated by road user charges and fuel taxes. Analysis of the RUCPP reveals that the road usage charge in the pilot generated more revenue than the fuel tax. This is true, in general, so long as the fleet to which RUC applies has an average fuel economy of at least 19.2 MPG.

The road usage charge used in the pilot is a per-mile fee that, unlike the fuel tax, does not vary based on the fuel efficiency of the vehicle. The amount of road usage charge revenue a group of vehicles generates stays the same, but the amount of gas tax they pay decreases as the efficiency of the group increases.

The table below summarizes the actual distances driven and road usage charges paid by vehicles participating in the RUCPP during the four months of operations. Although most participants began on November 1, 2012 and concluded on January 31, 2013 a few began on December 1, 2012 and concluded on February 28, 2013.

Table 6: Characteristics of RUCPP first billing cycle, November 2012

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Oregon-registered vehicles participating in RUCPP</td>
<td>44</td>
</tr>
<tr>
<td>Total miles driven from Nov 2012 through Feb 2013</td>
<td>128,338.3</td>
</tr>
<tr>
<td>Total chargeable miles driven from Nov 2012 through Feb 2013</td>
<td>121,371.4</td>
</tr>
<tr>
<td>Total road usage charges billed for Nov 2012 through Feb 2013</td>
<td>$1,893.39</td>
</tr>
<tr>
<td>Average measured fuel efficiency of pilot vehicles (MPG)</td>
<td>24.7</td>
</tr>
<tr>
<td>Fuel tax offset</td>
<td>$1,478.50</td>
</tr>
<tr>
<td>Net charges collected</td>
<td>$414.89</td>
</tr>
</tbody>
</table>

As shown in the table above, Oregon participating vehicles paid $1,893.39 in road usage charges. For the same mileage, the RUCPP recorded that these vehicles consumed 5,192 gallons of fuel, or about 24.7 miles per gallon. At the Oregon tax rate of $0.30 per gallon, these vehicles contributed $1,478.50 in fuel taxes (note that only gallons assumed to have been consumed in Oregon were eligible for fuel tax offset). Road usage charges generated $414.89, or about 28 percent, in additional revenue beyond the fuel tax. This scenario appears in the second row of the table below. For comparison, we show scenarios where the vehicles subject to road usage charges have an average fuel efficiency of 19.2, 40, and 55 miles per gallon, as well as a final scenario in which only electric vehicles are subject to road user charges.
Table 7: RUC vs. fuel tax for various MPG scenarios, based on RUCPP Oregon mileage of 121,371.4

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Gallons of fuel consumed</th>
<th>Nominal fuel taxes</th>
<th>RUC Paid</th>
<th>RUC paid minus nominal fuel taxes</th>
<th>RUC vs. fuel tax percent difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>19.23 MPG</td>
<td>6,311.30</td>
<td>$1,893.39</td>
<td>$1,893.39</td>
<td>$0.00</td>
<td>0%</td>
</tr>
<tr>
<td>24.7 (approx. RUCPP actual)</td>
<td>4,913.82</td>
<td>$1,478.50</td>
<td>$1,893.39</td>
<td>$414.89</td>
<td>28%</td>
</tr>
<tr>
<td>40 MPG</td>
<td>3,034.29</td>
<td>$910.29</td>
<td>$1,893.39</td>
<td>$983.11</td>
<td>108%</td>
</tr>
<tr>
<td>55 MPG</td>
<td>2,206.75</td>
<td>$662.03</td>
<td>$1,893.39</td>
<td>$1,231.37</td>
<td>186%</td>
</tr>
<tr>
<td>All electric vehicles</td>
<td>0</td>
<td></td>
<td>$1,893.39</td>
<td>$1,893.39</td>
<td>N/A</td>
</tr>
</tbody>
</table>

This chart illustrates that in the RUCPP, about $415 more revenue was generated than under a fuel tax. If the average fuel efficiency of the fleet in the RUCPP was higher (40 or 55 mpg), or if the fleet in the RUCPP was all-electric, even more revenue would be generated. For example, at 55 MPG, the RUCPP would have generated $1,231.37, which is 186% more than the amount of fuel tax revenue paid for the same amount of mileage. Only if the fleet in the RUCPP were to have an average fuel efficiency of 19.2 mpg or lower would the expected revenue of the RUC be less than that of the fuels tax.

In general, if the average of the vehicle fleet is 19.2 mpg or better, the revenues of the RUC will be equal to or greater than the revenues from the fuels tax.

Since the road usage charging system for the pilot does ask participants to specify the states in which fuel was actually purchased, it was not possible to provide precise refunds on an individual basis. Instead, ODOT relied on the following reasonable assumptions:

- Motorists in general are likely to purchase fuel where they are incurring mileage. Oregon-based motorists are more likely to purchase fuel in Oregon than elsewhere because they live in Oregon. Consequently, for participants with an Advanced Plan, ODOT refunded fuel taxes in proportion to miles driven in Oregon. For example, if a participant consumed 100 gallons of fuel but drove only 50% of miles in Oregon, then ODOT offset the tax corresponding with 50 gallons of fuel tax ($15) from the road usage charge bill.

- For participants with a Basic Plan, ODOT refunded all fuel taxes. Since the Basic Plan requires participants to pay for all miles, regardless of location, a refund for all fuel taxes paid, also regardless of location, is appropriate.

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15 Some figures off due to rounding

16 All scenarios are based on the 30,746.6 chargeable miles driven during the November 2012 billing cycle of the RUCPP.
The table provides a range of scenarios that fulfill this metric regarding the ability of road user charges to generate revenues relative to the fuel tax in Oregon. These figures are derived from actual distances driven in the RUCPP by participating vehicles as well as, in the case of the second scenario, the actual gallons of fuel consumed in the RUCPP.

**Policy and public acceptance metric #2: Acceptance by RUC payers and other system users concerning several criteria**

The RUCPP shows that the RUC system is very acceptable to participants. Evaluation of the RUCPP entailed two types of road usage charge acceptability measurements: data (objective) and survey (subjective). In this section we present results of both.

First, the table below summarizes objective data collected from users and vendors during first phase of the RUCPP.

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average participant cost in dollars</td>
<td>$0</td>
</tr>
<tr>
<td>Average time devoted to the RUCPP per participant, in minutes&lt;sup&gt;17&lt;/sup&gt;</td>
<td>67&lt;sup&gt;18&lt;/sup&gt;</td>
</tr>
<tr>
<td>How many participants started the pilot?</td>
<td>44</td>
</tr>
<tr>
<td>How many participants completed the pilot?</td>
<td>44</td>
</tr>
<tr>
<td>How many participants dropped out of the pilot?</td>
<td>0</td>
</tr>
<tr>
<td>How many participants fully paid the RUC they owe?</td>
<td>44/44</td>
</tr>
<tr>
<td>How many participants did not fully paid the RUC they owe?</td>
<td>0</td>
</tr>
</tbody>
</table>

Based on the first two months of operations, all Oregon participants in the RUCPP who started the pilot are still enrolled. They have devoted an average of 45 minutes per person to the pilot test so far with zero costs beyond the cost of the road user charge itself.

Next, the evaluation process considered responses to survey questions. All participants were asked to complete a survey before the start and at the midpoint of the RUCPP. Approximately 60 percent of those surveyed responded, and the responses form the basis of the metrics presented below.

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<sup>17</sup> Includes time devoted to the following activities: reading and signing the participant agreement; selecting a plan; setting up an account, installing the mileage reporting device; troubleshooting issues with the device; reading, understanding, and paying a bill; troubleshooting account problems; and completing evaluation surveys.

<sup>18</sup> Based on participant responses to surveys. The minimum time devoted was 30 minutes. The maximum time devoted was 180 minutes.
Ease and Convenience. RUCPP participants found the system to be very easy and convenient. The table below summarizes survey responses regarding ease and convenience of a variety of aspects of the RUCPP. In addition to the five categories, the far right column represents ease and convenience of the overall system. For each category, the majority of respondents viewed the RUCPP as “easy/convenient” or “very easy/convenient,” as illustrated by the blue shaded portion of each column. The number of “neutral” responses ranged from zero to two depending on the category (shown in green), and there was only 1 “difficult/inconvenient” response for the “registering and setting up an account” aspect. Out of 24 respondents, 23 rated the overall system as easy/convenient or very easy/convenient, while one rated the overall system neutral. Of the 14 survey respondents who answered the question “what aspects of the mileage tax system do you like best so far,” 11 cited “ease” or “simplicity” of the system.

![Figure 11: Respondents' opinions about the ease of various aspects of the RUCPP](image)

Privacy Protection. RUCPP participants found that the system protects their privacy well. A variety of privacy issues were explored through the survey instrument before, during, and after the RUCPP.

- Interestingly, prior to the RUCPP, a minority of survey respondents indicated that personal location privacy is important: 42 percent rated personal location privacy as important or very important, while 21 percent were neutral and 37 percent rated it not important. On the other hand, 100 percent of respondents felt that account security is important.

- At the midpoint of the RUCPP, 61 percent of respondents believed their personal location privacy was being protected well or very well, while 28 percent were neutral, and 11 percent did not believe their location privacy was being protected well. At the conclusion of the pilot, the number believing their personal location privacy was being protected well or very well rose to 75%, with 21% neutral and 1 respondent
(4%) “not very well.” Based on open-ended comments, it is likely that most “neutral” respondents were unable to make a determination about privacy protection. Those who responded “not very well” were among the participants who had opted for location-based road usage charging.

- By the conclusion of the pilot, fully 88 percent of respondents felt their account security was being maintained well or very well, with 12 percent neutral. No participant had a negative response for account security.

**Fairness.** RUCPP participants found the system to be fair. At the outset, prior to the RUCPP, 58 percent of respondents out of 24 felt that the Oregon excise tax on fuel of 30 cents per gallon is “too little” while 38 percent found it “about right” and one respondent (representing 4 percent) found it “too much.” By comparison, 83 percent of the same respondents find road user charging to be “a lot more fair” or “somewhat more fair” than gas taxes, while 13 percent are neutral, and one respondent finds road user charging “somewhat less fair” than the gas tax. When considering fairness by vehicle class, the responses vary. In general, road user charges are viewed as more fair for fuel-efficient vehicles than for other vehicles. Overall, though, a majority of respondents feel that road user charges are fair or very fair for all vehicles. The chart below summarizes detailed survey responses.

**Figure 12: RUCPP Survey Respondents' Views on Fairness of RUC for Various Types of Vehicles**

At the midpoint, RUCPP participants were again surveyed about fairness. Only 11 participants responded to the question, “Do you believe the amount you paid (for your first RUC bill) was a fair price?” However, all 11 participants responded affirmatively.

**Choice.** One of the principal objectives of the RUCPP is to demonstrate the concept of user choice. RUCPP participants were offered five different choices of mileage collecting
and reporting plans. The level of satisfaction with the RUCPP shows that this has been well received by participants. However, there are many dimensions of choice. The following table summarizes the choices by level of importance to survey respondents.

**Overall Aversion/Attraction.** Prior to the RUCPP, 21 percent of survey respondents had a neutral attitude toward road usage charges, while 79 percent held a positive or very positive attitude. None had a negative attitude (see chart below).

**Figure 13: Importance of Various Types of RUC Service Plan Choices**
To RUCPP Participants

Based on responses at the conclusion of the pilot, the RUCPP experience improved the already positive view of road usage charging. Fully 58% of respondents had a “more positive” or “much more positive” view of road usage charging, compared with 42% who reported no change. All but one of those individuals reporting “no change” already had a “very positive” view of road usage charging.

Reflecting the positive impact that the RUCPP had on participant view of road usage charging, the chart below reflects responses at the conclusion of the pilot to the question, “Based on your pilot experience, do you see road usage charges as a viable way to pay for road usage?” Nearly 80% responded “definitely,” with 17% “probably” and only 4% “neutral.”

Overall, the survey responses and objective data indicated a high degree of acceptance of the system as demonstrated in the RUCPP. Measures of ease and convenience, privacy protection, fairness, choice, and overall attraction are very strong. The vast majority sees the system as easy to use, and fair, while sufficiently protecting location privacy and account security. These subjective responses are corroborated by objective data, which showed a zero
dropout rate and 100 percent on-time payments.

Evaluation category 2: Technology

Technology metric #1: Adaptability of the RUC system

This metric was intended to measure the use of the RUC system for other services, the openness of the RUC system for changes in the RUC structure, and the scalability of the RUC system. It was measured by interviews with the system vendor Sanef and the system integrator CH2M Hill.

Sanef stated that their system was highly adaptable: it is capable of accepting both charges and payments from a variety of sources, and it is highly scalable. It can be easily configured to accept multiple types of charges, such as tolling, parking, and value added services. In order to accept other charges, all that would be needed is an interface to the service from which the charge is to be accepted, and a modification of the invoice to customers to reflect charges from this new service. In fact, the RUC system was just such an adaptation of their tolling system—only the interface to devices was added, and the invoice specifications adjusted from that system. Their system is also capable of accepting payments from a wide variety of sources.

CH2M Hill, IMS, and Raytheon confirmed Sanef’s estimation of the system’s strong degree of adaptability, but stated that there is one area in which system adaptation may require significant effort: the ability to receive data from vehicles that are completely or partially noncompliant with OBDII standards. The MRD’s interface/interfaces to such vehicles may need to be developed on a case-by case basis for such vehicles. This applies especially to electric vehicles, to which OBDII regulations do not apply.

Technology metric #2: Ease of installation of mileage reporting devices

RUCPP Participants found the mileage reporting devices very easy to install. The ease of installation of the mileage reporting devices is demonstrated by an analysis of combined vendor responses, surveys, and pilot participant coordinator records.

Vendor Surveys. Both vendors indicated that the mileage reporting devices (hardware) are designed to plug into the OBDII port and should be self-installed by the users without additional assistance for most car models (if the car model has an OBDII port). The vendors stated that hardware installation process, including becoming familiar with the installation guidelines, should take an average of about five minutes. The only activity that may prolong the process is locating the OBDII port. To facilitate the installation and help desk support, IMS provided documentation to the help desk on where OBDII ports are on various car types.

Participant Surveys. The main results from the respondents are derived from the midpoint RUCPP survey that included responses to most questions from 19 Participants. A summary of the key reaction to each installation related question is as follows:
• Did you install it yourself or did you need help? If you needed help, who helped you?
  • All but one respondent indicated that they were able to install the device without assistance (the participant using the flat rate plan did not have an MRD to install). This means that self-installation for such mileage reporting devices is possible and has been proven to be something that a vast majority of respondents are able to accomplish with little or no difficulty.

• Was there any cost to you for installation?
  • Of the 19 respondents, they all indicated that they incurred no costs for installation. This item was recorded on both the Mid-point survey and the Final Survey. This clearly demonstrates that installation of RUCPP mileage reporting devices leads to no additional installation charges for RUC payers.

• How long did it take to install the OBU start to finish?
  • The time to install for all 19 respondents with mileage reporting devices ranged from a low of only 1-2 minutes for five respondents to a high of 15 minutes for two respondents. The average time to install was 5.9 minutes. One of the key determining factors of installation time is the ability to locate the OBDII port, which depends on the make and model of the vehicle.

• What was the level of difficulty to install the mileage reporting device?
  • For this category, two respondents viewed installation of the mileage reporting device as “neutral” with the remaining 16 respondents indicating “easy/convenient” or “very easy/convenient.” (The participant in the flat rate plan did not respond). There were very few issues related to installation of the mileage reporting device.

19 It should be noted that there are 17 respondents for these questions and not 18 because one person chose the unlimited mileage collection and reporting plan (unlimited mileage purchased for a flat annual or monthly fee, with no technology required, administered by ODOT).
• How useful were any provided installation instructions?

  - Of 19 responses, only one person indicated that instructions were not useful, two persons indicated a neutral viewpoint, 14 indicated they were useful, one indicated very useful, and the participant on the flat rate plan did not respond. These results demonstrate that the installation instructions were reliable and self-explanatory.

Figure 15: RUCPP Survey Respondents' Views on Usefulness of MRD Installation Instructions
Technology metric #3: Safety of mileage reporting devices, mileage reporting device installation, and system operations for motorists

RUCPP participants have found the mileage reporting devices to be very safe without any significant issues related to installation of the mileage reporting device and systems operations. The safety, installation and system operations aspects of the mileage reporting devices are demonstrated by an analysis of the responses by participants to a set of questions.

**Participant Surveys.** The results from the respondents are derived from the following six questions:

- Did the OBU ever physically impede your driving? If so, how? And how often?
- Did the OBU ever distract you during driving? If so, how? And how often?
- Did the OBU ever cause a safety-critical event or impair the vehicle? If so, how often?
- Did the OBU ever fall out of the OBDII port? If so, how often?
- Did the MT system operations ever interfere with your driving in any other way? If so, how and how often?
- Have the Road Usage Charge system operations ever interfered with your vehicle or driving in any other way?

For each of these six questions, the response was “never” for all 19 respondents, except for the second question “Did the OBU ever distract you during driving?” In effect, two respondents indicated that on one single occasion for each of them, the mileage reporting device was a distraction while driving. No further information on the type of distraction was provided by these two respondents. However, there are two possible sources for the distraction:

- The lights were visible in a way that interfered with the driver’s attention. While the drivers must have grown used to the lights, the device manufacturers should take care to not make them blink or otherwise disturb the driver.
- The placement of the device in the OBDII port made the driver concerned if he or she was going to hit it. Because OBDII port placement can’t be controlled, the devices should be as small as possible.

The results of the survey for this metric related to safety, installation and system operations issues demonstrate that the Road Usage Charging system implemented for the RUCPP is safe and easy to use for the mileage reporting devices. This safety issue means that none of the mileage reporting devices actually fell out of the OBDII port, and no incidents transpired leading to interference with driving. Furthermore, the results demonstrate that installation and on-going system operations have been without any major issues.
Technology metric #4: Anti-tampering

The anti-tampering metric is demonstrated by an analysis of combined vendor responses. The following table provides the indicators representing the combined vendor responses to two questions.

<table>
<thead>
<tr>
<th>Question</th>
<th>Vendor Response</th>
<th>How effective are your anti tampering means?</th>
<th>Could an unskilled individual learn to effectively tamper with the mileage reporting device, for example, by reading how to do so on the Internet?</th>
</tr>
</thead>
</table>
| Sanef/IMS| • Enclosure has tamper-evident tape (see if device is opened).  
• Sanity checks in firmware.  
• Compare distance OBU in GPS to distance from engine. | • Sanef did not answer this question directly but implied that if signals used to detect device removal from vehicle were monitored by the account management system it would be very hard to commit fraud. | |
| Raytheon | • Device detects and logs if it is removed from vehicle. | • Raytheon believe anti-tamper prevents user from removing device from vehicle without being noticed, the main means of tampering. | |

Technology metric #5: System performance

The system performance record indicates that the system is performing very well: there have been no identified lost transactions, no inaccurate billing, and no missed or misrecorded mileage.
The system performance metric shows these results using the following five indicators:

**Acceptance Testing.** Acceptance testing demonstrated that the mileage reporting devices, and by extension the system, could accurately measure distance traveled, and in the case of advanced mileage reporting devices, could accurately measure distances traveled off-road and out-of-state. During acceptance testing, a few bugs were discovered in the smartphone MRD. The decision was made to proceed with the RUCPP, knowing that the mileages measured by the smartphone MRD could contain errors.

Full details of acceptance testing are recorded in the Acceptance testing reports; however, it is sufficient to state that mileage reporting devices correctly measured distances traveled. Thus, the acceptance testing indicator shows that the system performs very accurately.

**System and Mileage Reporting Device Errors from System Logs.** The help desk monitors and logs all errors recorded by the system. During the RUCPP, no mileage reporting device errors have been logged, indicating the system has performed very well.

**Mileage Tax Accounting Auditing of Transactions.** The RUCPP includes a detailed accounting analysis of all mileage tax transactions that is designed and implemented by an accountant experienced in large government-run transaction systems. This analysis was performed on the first three months of data (November and December 2012, and January 2013), and resulted in finding few errors in billing or mileage charging, and complete consistency in results.

The few errors discovered related to a small number of transactions in the late November timeframe that were counted twice. This was due to a manual system transition, and only applied to transactions that were recorded during the time of transition. The errors were corrected and never repeated during the rest of the RUCPP.

The few errors discovered in mileage charging were due to the Raytheon MRD generating abnormally large mileage recordings. The Mileage Tax Accounting noted these unusual transactions. The cause of these unusual and incorrect mileage records is still under investigation.

**Participant Survey Questions.** To the survey question: “Do you believe any driving events or miles have been missed by the system?” All participants with MRDs responded negatively, and the participant with a flat rate plan did not respond.

To the question “Do you believe the system has over-counted your mileage?” All but two participants responded negatively. One participant provided no response, and the other participant indicated that about 100 miles out of state had been charged. However, this participant had selected the basic plan with a mileage reporting device that does not have the capability of reporting out of state miles driven. Thus, this participant’s basic mileage reporting device correctly counted all mileage, including the 100 miles out of state. Therefore, the survey questions indicate that participants believe that the system performed perfectly.
Odometer Measurements Reported by Some Participants. Participants were asked, optionally, to provide their odometer readings before the start, and after the conclusion of the RUCPP. In total, 13 Oregon participants provided odometer readings from before and after the RUCPP. Of those, 3 participants had used the smartphone MRD, 7 used the advanced MRD, and 3 the basic MRD.

Users of the basic and advanced MRDs typically had total odometer distances that were 100-400 miles greater than the total distance that had been invoiced. This is a logical result, since the odometer readings were taken several days before the RUCPP started and several days after the RUCPP concluded. The average additional distance was 261 miles.

Users of the smartphone MRD had a negative distances. This indicated that the smartphone MRD contained a bug that led to over-counting of miles. The smartphone MRD will be re-tested once this bug has been corrected.

Conclusion for System Performance. Taken together, these indicators demonstrate that for the basic and advanced MRDs, the system is measuring all miles driven, and neither over-counting nor undercounting, and sending participants accurate bills on a monthly basis. This shows a very high level of system performance.

The smartphone MRDs contain a bug that must be fixed, but this does not indicate a systemic problem—it is limited to the smartphone MRD.

Technology metric #6: Hardware, software and other system elements

The RUCPP system is feasible, accurate, reliable, secure, open and has neutral or beneficial energy consumption impacts. The following sections address the evaluation results for all of these elements.

a) Feasibility

The system is feasible, as demonstrated by two indicators:

1. Acceptance Testing of Devices Used to Support Service Plans in Phase One. The rigorous acceptance testing process of devices used in phase one was successful and thus demonstrated that the system is feasible. All Advanced mileage reporting devices performed well. The Basic mileage reporting devices also performed well.

2. Vendor Surveys. In vendor interviews, Sanef/IMS indicated that their products were already in production (IMS mileage reporting devices support eight insurance companies' pay-as-you-drive insurance products; Sanef’s account management systems support tens of thousands of tolling customers). Sanef stated that scaling up production and operation would be straightforward.
b) Reliability

The system is reliable, as measured by four indicators:

1. **Mileage Reporting Device Failures Observed During RUCPP.** A few mileage reporting devices failed during the RUCPP, but neither was caused by faulty hardware, except perhaps a couple of the Smartphone devices. One device was kicked out of the OBDII port by a driver who was unaware of the mileage reporting device. This driver then stepped on the mileage reporting device and damaged it. Another mileage reporting device was plugged in a car that experienced an electrical system issue. This electrical system issue damaged the mileage reporting device. A further mileage reporting device was inoperable due to a blown fuse in the vehicle. Several mileage reporting devices were deemed incompatible with the vehicles they were installed in (either because they were Electric Vehicles or Plug-in Hybrids with nonstandard OBDII ports, or because they were vehicles built before the 2004 standardization of the OBDII protocol).

Two Smartphone mileage reporting devices recorded unusually, incorrectly high values for mileage traveled, and had to be replaced. The cause of these high mileage readings is still under investigation.

2. **Mileage Reporting Device Vendor Survey.** IMS stated that their devices have a minimum design lifetime of 5 years.

3. **Availability of Account Management System.** IMS did not specify a precise availability but stated that their system was very highly available.

4. **Participant Survey Questions.** The same survey questions as indicated accuracy (no missed miles, no over-counted miles) indicate that the system is reliable from the Participant perspective.

c) Security

The system is secure. The indicator for system security is vendor survey responses.

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20 The electrical system issue was not caused by the mileage reporting device; it was an unrelated automotive issue.
The mileage message had no encryption by specification. This choice was made to ease the implementation of the RUCPP system; in full operation, encryption would be used on the mileage message.

However, the choice was made during the RUCPP to use the WS-OASIS security standard for the mileage message. Online operations use AES 256-bit CVC encryption, an encryption standard equal to or better than most e-commerce websites.

Sanef’s system also uses firewalls and other standard cybersecurity measures.

Using the cybersecurity measures included in the pilot (WS-OASIS and various firewalls) combined with additional measures such as message encryption to be implemented during revenue operations; the system is and will continue to be secure to cyber-attacks.

d) Open System

The RUCPP system is open, as demonstrated by three indicators:

1. **Use of Standard Mileage Message.** All mileage reporting devices and the account Management system used a standard information format known as the **Mileage Message** to transmit mileage information. The Mileage Message is a completely open, public, standardized means of communication. Using such an open public standard means that any new vendor of either mileage reporting devices or Account Management System services can simply build a product that is compliant with the specification and be certain that it will work with the system.

2. **Use of Mileage Reporting Devices by different manufacturers.** During the RUCPP, Sanef’s Account Management system read messages from mileage reporting devices manufactured by IMS and from mileage reporting devices manufactured by Raytheon. Using multiple mileage reporting devices from different vendors demonstrates that the system is open to as many vendors as wish to participate in the system.

3. **Availability of Choices to Participants.** All Participants had the choice of five different mileage plans, as explained in table 1 above: the ODOT Basic Plan, the ODOT Flat Rate Plan, the Sanef Basic Plan, the Sanef Advanced Plan, and the Sanef Smartphone Plan. These plans worked seamlessly during RUCPP, and Participants had the option of switching plans if they so desired. The availability and coexistence of multiple supported by different CSPs demonstrates that the system is open to participation by as many vendors as wish to support it.

e) Energy Consumption

This metric shows that mileage reporting devices do not impact energy consumption of vehicles in which they are used:

**Indicator: Stated Energy Consumption of the Mileage Reporting Devices.** Both the IMS and Raytheon mileage reporting devices use minimal electricity when the vehicle is operating and almost no electricity when the vehicle is off. The IMS device does include a “heartbeat
message” for vehicles that are not driven on a given day: when a vehicle is not driven for a day, the system briefly wakes up the MRD to confirm its functionality. This does cause a small discharge of the battery, but the time from wake up to shutdown is only a few seconds, so it will not impact vehicle operations or cause the battery to discharge significantly. In total these small electricity consumptions are very minor and will not impact the fuel consumption of vehicles, demonstrating that use of the mileage reporting devices does not increase energy consumption.

f) Account Management System Experience

RUCPP Participants found that the system has an easy or convenient account management system as demonstrated by Participant Survey questions.

In response to the question “How easy or convenient have you found each of the following aspects of the road usage charge system so far? - Registering and setting up an account,” there were 8 responses of Easy, 6 responses of Very easy, 1 Response of Neutral, and 1 response of difficult or inconvenient. These responses generally show that users feel that setting up an account is easy.

In response to the question “How easy or convenient have you found each of the following aspects of the road usage charge system so far? - Viewing account and reviewing charges on account,” there were 12 responses of Easy and 6 responses of Very easy at the midpoint survey. The participant with the flat rate plan did not respond. At the final survey, of 24 responses there were 14 responses of Very Easy, 6 responses of Easy, 2 responses of Neutral, and 2 responses of Not Applicable. These responses generally show that users feel that viewing an account is easy.

Finally, in response to the question “How easy has it been to use the account management system website and/or access your account by other means?” there were 12 responses of Easy, 2 responses of Very easy, and 4 responses of Neutral. The participant with the flat rate plan did not respond. These responses show that users feel that viewing an account is easy.

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21 The IMS device uses about 100mA when operating (when the vehicle is on) and about 2 mA when the vehicle is off and the mileage reporting device is in sleep mode). The Raytheon device uses less than 1 mA when it is operating in sleep mode. Raytheon did not specify the operational electric consumption of their mileage reporting device, but it is likely to be 100 mA like the IMS device.
Conclusion

Metric 6 demonstrates that the Road Usage Charging system implemented for the RUCPP is feasible, reliable, secure, open, reduces energy consumption, and provides RUC payers an easy, convenient account management system experience.

Evaluation Category 3: Operations

Metric 1: Ease and cost efficiency of administering the MT

The purpose of this metric was to illustrate the relative ease and cost-efficiency of administering the mileage tax system.

The RUCPP system was relatively straightforward to administer. Ease of administration was measured through discussions with the private sector operator (Sanef) and the ODOT system integrator (CH2M Hill team). Sanef stated operating this system was “Business as Usual,” because it was very similar to administering tolling systems that they usually operate. The only change that they made during system operation was a cosmetic update to the appearance of invoices.

The only unexpected problem was the difficulty of getting MRDs to communicate with electric vehicles. This difficulty arose because fully electric vehicles (EVs) do not produce emissions and thus are not required by law to comply with the OBDII standard, which was created to help reduce emissions. Most EVs sold on the US market today do contain a data connection in the same physical form as an OBDII port (including the Chevy Volt, Nissan Leaf, and Tesla S), but the data messages they support differ from the standard OBDII data messages - messaging is proprietary and unique to each manufacturer.

ODOT is now pursuing three solutions for electric vehicles: custom designed data interfaces, location-information-only MRDs, and telematics system apps for RUC reporting. Custom-designed data interfaces are MRDs that are designed to use the proprietary, manufacturer-specific data set available on the electric vehicles that have OBDII ports. ODOT is now developing a custom-designed data interface for one model of electric vehicle. The second solution is advanced MRDs that use only location data to determine distance traveled. Such an MRD would require a system by which it is anchored to a vehicle through the vehicle’s electrical system to ensure it is not removed from the vehicle. The third solution is developing apps for EV telematics systems. EVs contain telematics systems (although a few low-volume, low end models do not) so that it would be straightforward to create an app to run on the telematics to support the RUC system. Vehicle manufacturer support would be required to create such an app.

Sanef stated that they had required a few person-months of development to achieve the correct system interface (with the mileage message), but that once the system was operating, maintaining the system required “much less” than one FTE per month. CH2M Hill said that operating the system was “Easy,” because the technical defects in the system had all been worked out during testing. CH2M confirmed this by stating that they received many fewer calls on the Help Desk than expected. In fact, operating the Help Desk was the only ongoing aspect of system operation, and because call volume was so light, it required much less...
than one FTE per month to operate. Both Sanef and CH2M stated that manual efforts were used to send out and process invoices each month, but that much of this could be eliminated through automation in full system operation.

Administering the pilot system was very cost-effective because it used hardware and software that were designed and operational for other purposes. IMS was able to provide a low-cost MRD, because these were the devices used for PAYD insurance. Sanef was able to provide a total system cost of $140,000 because the core system was developed as a tolling transactions processing and account management system. The average monthly cost of operation for Sanef was $18,000, and that this value would increase only slightly with a greater number of accounts. Sanef also stated that the marginal cost of operation in multiple states would be very small. Further cost metrics, including a comparison with the cost of collecting fuels taxes, are included below.

**Metric 2: Ease of use and cost of compliance with the MT system by RPs and other system users, including evasion potential**

This metric was intended to gauge the ease of use of the system by drivers. It was measured both by interviews with vendors and by survey questions to RUCPP participants.

Vendor interviews indicated that the system would be easy to comply with, free or very inexpensive, and hard to evade for participants:

- Sanef, Raytheon, and IMS all felt that the system would be very easy to use for participants. Perhaps the only challenging portion could be installing the MRD, and then only for owners of a small percentage of vehicles. Installation of the MRD is straightforward on most vehicles, but on a small portion of vehicles, the OBDII port can be hard to locate. Owners of such vehicles can simply call the help desk, where a directory of the locations of OBDII ports on all vehicles that have OBDII ports is stored.

- Sanef, Raytheon, and IMS all stated that the only potential costs to users are the costs of the MRD and the costs of Data communications. They pointed out that the MRD cost could be subsidized by the CSP, in return for a fixed-period contract (18-months or 2 years), in a similar manner to the way in which cell phone service providers subsidize the cost of a cell phone for subscribers to their network. For basic and advanced MRD holders, the costs of data communications would likely be incurred by the account management vendors. Account management vendors would recoup these costs through income from value-added services and, when necessary, account management fees. The cost of dongles was $50-$100 and for a limited sample, limited duration one-off pilot program as of 2013; and will be less for a permanent mileage charging program in the future where these costs can (1) be negotiated in a competitive market and (2) can be offset by private investment to build platforms for marketing various services such as data aggregation and pay as you drive (PAYD) insurance.

- Sanef, Raytheon, and IMS felt that evasion potential was low. The most likely opportunity for evasion was simply removing the MRD and leaving it unplugged. However, OBU removal is detected both by the Raytheon MRD and the IMS MRD.
Other sources of evasion, such as using a GPS jamming signal, are very difficult to accomplish and easy to detect unless perfectly executed. For example, a GPS jamming signal would need to produce a speed profile nearly identical to the speed profile given by the vehicle over the OBDII port, or the MRD would detect the inconsistency immediately and flag it for review/audit.\footnote{A GPS jamming signal would involve installing a GPS signal transmitter in the vehicle that would transmit fraudulent GPS data with sufficient power to drown out the relatively weak signals from the GPS satellites. Such a device would be difficult to create, and even more difficult to design in a way that would provide GPS signals that were not obviously fraudulent to the MRD, especially when distance travelled based on the GPS data is compared with distance travelled from the vehicle data. No equivalent to GPS jamming exists for the Basic MRD.}

On surveys most participants said that they found all aspects of the system either to be easy or to be very easy to use. The only aspect of the system that more than one participant found difficult was the installation of the MRD, which was difficult to locate on a few vehicles.

The only suggestions for making the system easier to use was to have more clear feedback from the MRD that it was in fact operating correctly, and to have more clear feedback about how many miles had already been driven in a given billing period (information that was available on online accounts).

All 19 midpoint and 24 final survey respondents agreed that the system has no cost to comply with.

**Metric 3: Accuracy and perception of accuracy of data transmitted to the central database and used for assessing mileage taxes**

This metric was intended to measure the accuracy of the system, both as perceived by the participants, and as measured from the data generated by the pilot.

Participants believed the mileage measurement and billing to be very accurate, although a few concluded that they didn’t/couldn’t know the accuracy of the system. Only one participant (from the Washington test group) believed that there was an inaccuracy in the billing. This participant had the MRD removed during an oil change, and the MRD was not tightly plugged in after the oil change. Thus, the MRD was not working and not counting miles. This issue was not related to mileage measurement accuracy, but with being certain that the device was properly installed.
No participants with advanced MRDs believed that there were inaccuracies with the refunds for out of state or off-road travel, although several responded “Don't Know” to the question.

Objective measurement of measurement accuracy of MRDs was conducted during acceptance testing, and shown to be 2-3% in all cases. Please refer to ODOT acceptance testing documents for details.

**Metric 4: Privacy options for RPs in protecting personal, private data**

This metric was intended to measure the availability of privacy options provided by the system and the efficacy of those options at protecting individuals data, both as evaluated by the vendors and as perceived by the individuals.

The vendors (Sanef, Raytheon, and IMS) all felt that the way the system is structured, privacy is well-protected. Users had options not to use electronics at all; or to use electronics that contained no GPS. For the smartphone plan, use of GPS data could be turned on and off. Also, users were asked to provide minimal data to support accounts. Sanef did point out that there were currently no requirements on maximum data retention, and that purging individual transaction data (though retaining aggregate data) could be another way to improve privacy protection. Data purging requirements have subsequently been added to the authorizing legislation under consideration in Oregon.

Most participants believed that the system protected their privacy. Three quarters of participants felt that the system protected their privacy Well or Very Well. The remaining participants were neutral in their response to the question, except for one participant who felt that the system did not protect privacy very well.
Figure 16: RUCPP Survey Respondents' Views on RUCPP System’s Protection of Location Privacy

About 1/3 of participants felt that the system protected their privacy better than mobile phone operators. The remaining two-thirds felt that the RUC system protects privacy about the same as mobile phone companies do.

Figure 17: RUCPP survey respondents' comparison of RUC system privacy to mobile phone privacy

Similarly, 3 participants felt that the RUC system protected privacy about the same as credit card companies do. Seventeen felt that the RUC system protected privacy better than credit cards do, while just 1 felt that the RUC system did not provide as good privacy protection as credit card companies do.
In conclusion, both vendors and participants felt that the system protected privacy well - as good as or better than common systems such as credit cards and mobile phones. The only improvement suggested was to purge transaction data after a fixed cutoff time.

**Metric 5: Ability to audit**

This metric was designed to measure the auditability of the system. It was vital for the auditing of the CSP's account management system, so the state can be certain that they are compliant with the requirements, interfaces, and business rules of the program. The state must ensure CSP compliance so that the public trusts the system. This metric was measured by interviews with the vendors, and an interview with the MTA representative who was a CPA who examined the data provided by the CSPs each month very closely and performed monthly accounting for all accounts using this data.

Sanef felt that their system was highly auditable, based on their experience having used a similar system for other operational tolling projects and having been audited on those projects, but deferred the final analysis of auditability to the MTA system representative.

The MTA system representative stated that the system was very auditable, although improvements could be made. Most of these improvements will be included in the updated requirements, ICD, and Business Rules documents. The improvements include formalizing/standardizing the monthly reporting from the CSPs, defining the precise nature of a transaction, requiring comprehensive numbering of transactions, and allowing no missing, purged, or deleted transactions. Full details of the MTA system are included in the MTA final report. The MTA system representative did point out that while during the pilot, all individual transactions were made available to the MTA, the MTA is designed so that this will not be the case during a full implementation of revenue operations. Rather, CSPs will provide only summary information, and will provide individual transaction data only in cases where fraud is suspected or spot audits are needed to verify the proper function of the MTA.
Between the experience of Sanef and the statements of the MTA system representatives, the evaluation team concluded that the system is very auditable.

**Evaluation Category 4: Costs**

**Metric 1: Start-up costs (capital and retrofitting)**

This metric was intended to measure the up-front costs of running the pilot program, and by extension, instituting a RUC. It was measured by interviews with the system vendor, Sanef, the OBU vendors IMS and Raytheon, and the system integrators, CH2M Hill.

This metric does not suggest how the costs should be covered. For CSPs in full system operation, much or all of their costs may be covered by selling additional services to customers, or selling customer access to other service providing companies such as Pay-As-You-Drive insurance companies (which may even act as CSPs).

For the RUCPP, Sanef charged $212,431 for all their services, including integration and operations. Sanef stated that roughly 2/3 of the costs were incurred prior to system operation, so it is reasonable to conclude that up-front costs for a CSP would be about $2/3 \times 212 = $140k, which includes development and customization of the account management system, but no MRDs, and no payment system. Sanef stated that they built the account management system on a piece of software that they already owned, which cost about $300,000. It also did not include Help Desk operations, which were provided by CH2M Hill.

IMS stated that MRDs are currently available near the $100 price point, and that this number would continue to drop. Independent research by the evaluation team found market research that forecast the cost of MRDs will be in the $50-$75 price range by 2015, and continue to drop.

Raytheon declined to state what the price point of the Smartphone MRDs is or would be, but indicated that it would be higher than the price point of the MRDs that IMS is providing due to the fact that they are not in production for other uses (IMS’s MRD’s are widely used by insurance companies for Pay-As-You-Drive insurance products).

In summary, the evaluation team concludes that capital and retrofitting costs for an account management/transactions processing system from a vendor with a pre-existing account management system would be about $200,000 ($140k + ~$60k for the payment system, the help desk setup, and buffer funds), or if the firm didn’t have a pre-existing system, would be about $500,000. Additional capital/retrofitting costs, such as acquiring MRDs and maintaining a storefront office, will cost extra.

Both Sanef and CH2M Hill stated that startup costs for an account management system such as servers, software, and development will increase, but in a very gradual way, as the number of customers (individuals subject to RUC) increases, and that they would not increase dramatically in the case that the service is provided to a number of different states, so long as no state adds additional requirements that increase costs.
Metric 2: Operations and maintenance

This metric was intended to measure the ongoing, monthly costs of running the pilot program, and by extension, running a RUC. It was measured by interviews with the system vendor, Sanef, the OBU vendors IMS and Raytheon, and the system integrators, CH2M Hill.

As with the capital costs metric, this metric does not suggest how the costs should be covered. For CSPs in full system operation, much or all of their costs may be covered by selling additional services to customers, or selling customer access to other service providing companies such as Pay-As-You-Drive insurance companies (which may even act as CSPs).

As stated above, for the RUCPP, Sanef charged $212,431 for all their services, including integration and operations. Sanef stated that roughly 1/3 of the costs were ongoing operations and maintenance (O&M) costs, so it is reasonable to conclude that O&M costs for a CSP would be about 1/3*212 = $71,000. Divided over a 4-month period, this comes to about $18,000/month. It is likely that this value could drop further as the system becomes fully automated.

Based on input from Sanef, IMS, and Raytheon, the cost of operations for MRD is a $5-20/month for this limited sample, limited duration one-off pilot program as of 2013. It will be less, likely significantly less, to operate a growing, permanent mileage charging program in the future where these costs can (1) be negotiated in a competitive market and (2) can be offset by private investment to build platforms for marketing various services such as data aggregation and pay as you drive (PAYD) insurance.

CH2M Hill indicated that the only ongoing costs they incurred were the time of the employee who answered calls for the Help Desk, sent out invoices and checked payments. Call volume was quite low, so this did not result in significant additional costs.

These values will increase with increasing numbers of participants, but invoicing and payment can be fully automated. It will be necessary to provide customer service online and via phone, but this can be outsourced or combined with other existing customer service provision, and after an initial outlay to set up the customer service, should be very affordable.

Metric 3: Costs of collection relative to gas tax and use fuel tax

The purpose of this metric is to compare the relative costs of collecting road usage charges and fuel taxes. However, information gathered from the RUCPP alone is insufficient to make a complete and accurate assessment of relative costs. As a result, the figures presented in this section draw on information obtained from additional research conducted as part of related tasks. In order to provide an “apples-to-apples” comparison of RUC and fuel taxes, we present the following computations:

- Forecast cost to collect RUC for 10,000 vehicles based on information provided from RUCPP vendors
- Cost to collect fuels tax for 3+ million vehicles in Oregon today based on information gathered from ODOT
- Forecast cost to collect RUC for 1 million and 3+ million vehicles based on
financial modeling conducted as part of the RUC research complementary to the RUCPP
- Forecast cost to collect fuels tax for 10,000 and 1 million vehicles based on assumptions made about hypothetical program requirements

First, the cost of collection for the pilot program of 44 vehicles can be broken down as follows:

- Hardware (MRDs)
- Fixed costs associated with setting up a transaction processor and billing system. However, for many firms, these systems already exist and require only modest modifications for use for RUC.
- Monthly costs of operations, including MRD telecommunications, data analytics, mapping, data hosting, and account management and billing. Again, many of these costs are already incurred by vendors providing related services such as pay-as-you-drive insurance, so the marginal cost associated with RUC is very small.

Building these figures into a full operational cost estimate for a RUC system with 10,000 vehicles, we arrive at capital costs under $1 million and annualized operational costs of about $1 million. However, a substantial proportion of these costs would be shared with industry, which has built and will continue to build these systems as a platform for marketing other driver and vehicle services. Based on the pilot, participants drove an average annualized mileage of 12,400, which would generate $193.44 per vehicle, or about $1.9 million in a small, 10,000-vehicle system. Exclusive of setup costs, the cost to operate RUC based on these sketch figures would be at most about 50% of revenues and possibly as little as under 20%.

Second, the cost of collection for fuels tax in Oregon today varies depending on the type of fuel. Based on budget records from the Fuels Tax Group, the cost of collecting gasoline tax is about $1.9 million per year, or just above 0.4% of revenues (based on FY2011 revenues of $451 million). For use fuel taxes (including diesel), the cost is a further 4% of revenues since use fuel sellers keep a 4% fee in exchange for collecting the tax on behalf of ODOT.

Third, the cost to collect RUC should decline as a proportion of revenue as the program grows larger due to economies of scale. For example, because transactions are automated, the cost to process transactions does not increase at the same rate as revenues as the program grows. Moreover, as the program grows, CSPs will continue to provide RUC collection as a low-cost, marginal additional service as part of a larger platform from which to sell value-added services to motorists. As this business model expands, the cost of collecting RUC will decline substantially, because the private sector will offer it as a service to customers, but the vast majority of the costs will be built in to other service offerings covered by service provider revenues from other services (e.g., insurance, telecommunications, and vehicle concierge services). Once the total population of vehicles collecting RUC will decline substantially, because the private sector will offer it as a service to customers, but the vast majority of the costs will be built in to other service offerings

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23 1 million vehicles and 3 million vehicles are population sizes that would indicate a multi-state RUC market leveraging the infrastructure put in place by ODOT. Current legislation will not achieve this size of subject vehicle population, and ODOT does not foresee the population of subject vehicles in the state reaching this size in the next decade.
covered by service provider revenues from other services (e.g., insurance, telecommunications, and vehicle concierge services). Once the total population of vehicles subject to a RUC in all states and regions where a RUC has been implemented exceeds 3 million vehicles, ODOT’s collection costs are expected to decline to below 5% of revenues based on cost estimates built using a financial model and projections of growth in PAYD, telematics, and similar services.

Finally, the cost to collect fuels tax from 10,000 vehicles would not decline in proportion to today’s costs of collection. Assuming average statewide fuel economy of 22 MPG and 12,400 miles per year (as evidenced in the pilot), a 10,000-vehicle fuels tax program would generate about $1.7 million in revenues (and declining, as fuel economy improves). To manage collections of such a small-scale program, ODOT would need several staff devoted to the program, including a program manager, compliance officer(s), auditors, and accounting technicians. Although the number of staff would not be as large as it is today, it is safe to presume annual operating costs for the total compensation of the ODOT employees of between $500,000 and $1 million, or operating costs of 30-60% of revenues while the system would operate with 10,000 vehicles. This value would drop rapidly as the population of subject vehicles would increase.

The table below summarizes the above sketch-level computations.

<table>
<thead>
<tr>
<th>Program</th>
<th>10,000 vehicles</th>
<th>1 Million vehicles</th>
<th>3 million vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RUC</strong></td>
<td>~$1.9 million revenues</td>
<td>~$190 million revenues</td>
<td>~$570 million revenues</td>
</tr>
<tr>
<td></td>
<td>~$1 million annual operating costs</td>
<td>&lt;$20 million annual operating costs</td>
<td>&lt;$30 million annual operating costs</td>
</tr>
<tr>
<td></td>
<td>costs of 20-50% of revenues</td>
<td>costs of 3-11% of revenues</td>
<td>costs of 2-5% of revenues</td>
</tr>
<tr>
<td><strong>Fuels Tax</strong></td>
<td>~$1.7 million revenues</td>
<td>~$170 million revenues</td>
<td>~$540 million revenues</td>
</tr>
<tr>
<td></td>
<td>~$0.5 -1 million annual operating costs</td>
<td>~$1-$1.5 million annual operating costs</td>
<td>~$1.9 million annual operating costs</td>
</tr>
<tr>
<td></td>
<td>costs of 30-60% of revenues</td>
<td>costs ~0.6%-1% of revenues*</td>
<td>costs of 0.4% of revenues*</td>
</tr>
</tbody>
</table>

*use fuel tax has an additional cost of 4% of revenues

It is clear that fuels taxes have a lower cost of collection than RUC as long as the volume of RUC vehicles is low and fuels tax vehicles is high. However, when comparing programs of similar size, the costs are of the same order of magnitude. It is also important to note that evasion and lost revenues are not captured in these estimates for either program. Neither is known, but fuel tax evasion was most recently by FHWA in 1992 at between 3-7% for gasoline and 15-25% for diesel. RUC evasion will be an issue as well, but there are no comparable figures available at this time. There was no evasion reported in the pilot program, but the small sample of knowledgeable participants is not representative of the larger population.
Motorist Response

This section presents the overall attitudes of the participants to the system as expressed on the surveys. For the most part, the conclusions reached in this section do not trace directly to the metrics that the RUFTF committee determined - that analysis was covered in chapter 5. However, the analysis in this section includes data from the surveys not covered in the metrics.

In creating this section, the evaluation team attempted to summarize the overall views expressed by participants in the surveys. The team grouped these views into the following six subsections:

1. Getting started with the system
2. Ease of use
3. Participant perception of MRD accuracy
4. Practical issues
5. Policies (including equity, privacy, and other policy topics)
6. Overall system

RUCPP participants were not chosen specifically to be representative of the general Oregon public, but the conclusions reached from the surveys are still highly relevant to future RUC program decisions. None of the participants had prior experience with the technology tested, as the RUCPP was a world-first technology trial. The participants were asked to provide feedback based on their experience, and their survey responses represent the first impressions of the live RUC system. For these reasons, the conclusions made based on these remain relevant to future RUC program decisions.

Getting Started With the System

In general, participants found getting started with the RUC system to be a straightforward and quick process. Each of the four setup tasks had an average completion time of less than 10 minutes, and most participants (over 89%) found these tasks easy or very easy. The average total setup time per participant was less than 30 minutes as summarized in the table below.

<table>
<thead>
<tr>
<th>Task</th>
<th>Average Time (min.)</th>
<th>Percent of participants who found task easy or very easy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signing Participant Agreement</td>
<td>6.4</td>
<td>95%</td>
</tr>
<tr>
<td>Selecting Account Type and Features</td>
<td>9.9</td>
<td>n/a</td>
</tr>
<tr>
<td>Setting up account</td>
<td>6.8</td>
<td>89%</td>
</tr>
<tr>
<td>Installing Mileage Reporting Device</td>
<td>5.9</td>
<td>89%</td>
</tr>
<tr>
<td>Total</td>
<td>29.0</td>
<td>n/a</td>
</tr>
</tbody>
</table>
The most difficult aspect of starting seemed to be choosing an account type, indicated by the relatively long time (9.9 minutes) needed for the choice. One free response comment by a Washington state survey respondent indicated that the various account choices were “somewhat confusing.” Although participants appreciated having a choice, it is important to present the choices clearly, succinctly, and accurately to avoid confusion.

**Ease of Use**

The RUCPP system was very easy to use. Both Policy Metric 2, sub-metric 2 (*Ease and Convenience*) and Technology Metric 2 (*Ease of Installation*) provide strong endorsements of the view that the RUCPP system was easy to use—nearly all participants agreed with this statement. Beyond this, many respondents used the available free response comments to further emphasize that the system was simple and easy to use: 11 of the 19 respondents to the midpoint survey from Oregon made such statements without prompting.

**The Hardest Part Was Locating the OBDII Port**

While nearly all participants found the system simple and easy to use, a few comments both by Oregon and Washington participants indicate that the hardest part of the system for a few individuals may have been locating the OBDII port on or under the vehicle dashboard. For these few individuals, the port was difficult to find, due in part to obscure placement on a few vehicle models. The Help Desk had access to a directory of the OBDII port locations for all vehicles manufactured in the last 20 years. When participants could not locate their OBDII ports, they could call the Help Desk to receive guidance. Since the location of OBDII ports is proprietary to the automakers, it cannot be published. Making information available through the Help Desk is probably the best interim solution. While locating the OBDII port may be difficult for owners of a small percentage of vehicle models, the solution used in the RUCPP makes it relatively simple for these individuals to install the MRD.

**User Account Web Portal**

The user account web portal was a key feature for many participants—all but two of 24 pre-RUCPP survey respondents said it was “important” or “very important.” All mid-RUCPP participants found the user account web portal system easy or very easy to use.

**Online Payment**

Offering online payment is a critical feature that the full system should offer—of 24 respondents on the final survey, 22 said that bill payment was easy or very easy. However, a number of free response comments expressed concern with the PayPal system, including 2 from Oregon participants. For a fully operational system, a standard banking transaction interface involving choices beyond PayPal is desirable.
Desire for Feedback on MRD operation

Several respondents expressed a desire to know whether their MRDs were working correctly. This information was displayed via status lights on the MRDs, and participants were provided a sheet describing how the status lights worked. Still, two indicated that the lights were confusing, and they couldn’t be certain that their MRDs were properly installed. Users should be provided a straightforward way of knowing whether their MRD is properly installed. A simple status light is one solution. Another solution is to provide users feedback (e.g., email or text message) when the OBU is connected to a vehicle.

Participant Perception of MRD Accuracy

Inability to Determine MRD Accuracy and Lack of RUC System Feedback

Two respondents stated in free response comments they could not determine accuracy of the MRDs. This corresponds to the high response rate of “Don’t know” to the questions about whether the MRD was correctly computing off-road or out-of-state miles (of Advanced MRD holders, about half said that they didn’t know).

One respondent stated a desire for feedback on device charges. Feedback can be provided by reading the measurement on the user account website, and it may be desirable to make this available by Smartphone App as well. It should also be explained to users that a direct comparison with the odometer is impossible (i.e., MRD readings may deviate), at least in cases where GPS may be used for distance measurement or to provide a correction to the odometer speed signal used to determine distance traveled.

Fuel Tax Credit Accuracy

During the RUCPP, fuel tax credits were provided based on the fuel used by each participant’s vehicle. The fuel used was computed by two different methods, depending on the vehicle: either calculated based on vehicle engine data, or estimated based on vehicle miles driven. If a vehicle OBDII data port provided sufficient engine data to calculate fuel consumption, then the MRD calculated and transmitted fuel consumption using this data to the user’s account. Roughly 75% of vehicles in the RUCPP provided sufficient information to calculate fuel consumption. For the remaining 25% of vehicles which did not provide sufficient data, fuel consumption was estimated by multiplying the total miles driven by the EPA estimate of miles per gallon for that vehicles make, model, and engine type.

Survey respondents were asked to state how they preferred fuel consumption to be computed. 19 of 24 respondents (roughly 75%) favored calculation of fuel consumed over estimation of fuel consumed based on EPA fuel economy figures (one favored submitting receipts, three favored estimates based on EPA fuel economy, and one did not respond). A few users expressed concern with use of EPA fuel economy for fuel tax credits in free response questions. The evaluation team believes that ODOT should use automatic fuel consumption calculation for all vehicles for which it is possible, and for all other vehicles use estimates based on EPA miles per gallon, as was done in the pilot. ODOT should inform all RUC payers that
automatic measurement is being used whenever possible. ODOT should also explain that the EPA combined city-highway fuel economy is used for the remaining vehicles. This value represents realistic driving behavior of the average motorist, not an unrealistically high value of fuel consumption. Moreover, accuracy of EPA fuel economy estimates has increased greatly on vehicles built since model year 2008, so RUC payers should be reassured that these numbers are not exaggerated.

There were no concerns expressed about accuracy of measured fuel consumption in the RUCPP. In full system operation, users interested in system accuracy will compare their reported fuel consumption to real fuel consumption, so ODOT should measure the accuracy of the measurements in a future project to be prepared for participant’s questions about fuel measurement accuracy.

**Practical Issues**

The Help Desk solved most practical issues that arose for participants during the RUCPP, and many respondents commented on the good support provided by the Help Desk.

There were only two issues that could not be solved by the Help Desk:

1. The diesel fuel decals, used to indicate that service stations are not to charge tax on use fuel, were problematic. As a matter of practice, many service stations, including large chains, do not recognize and/or do not honor decals. This problem exists beyond the RUCPP, and is due to the fact that there is no penalty in the law for service stations that do not honor them. The problem was exposed for one participant seeking to use decals as a means of obtaining the fuel tax offset to which they were entitled. The participant was offered a refund based on receipts submitted.

2. MRDs occasionally fell out of vehicles by themselves or were bumped by drivers in a way that made them fall out. This happened twice in Washington and twice in Oregon. In one Oregon case, the MRD was stepped on and destroyed. In one Oregon case, the device reported 110 disconnects and reconnects with the vehicle, indicating an on-going faulty physical connection.

Changes to the diesel decal issue are currently being considered by the Oregon legislature. ODOT should monitor this issue, and if the legislature does not resolve it, should look for another way to provide refunds or credits to diesel vehicles.

For the second issue, ODOT should consider strengthening requirements that make OBUs more firmly connected to vehicles and/or more resistant to kicking, and strengthening the corresponding certification testing of MRDs. In addition, ODOT should add a technical requirement to the SRS and a requirement in the business agreement with the CSP that extraordinary disconnect situations (too many disconnects / too long of a disconnect) must be reported to the RUC payer promptly and flagged for a potential review by auditors.
Policies (Including Equity, Privacy, and Other Policy Topics)

Equity

Survey respondents generally perceived the road usage charge as fair and in fact being more equitable than gas tax. In the pre-RUCPP survey, in response to the question, “What aspects of the mileage tax do you expect to like most?” there were 10 responses of “A lot more fair”, 11 responses of “Somewhat more fair,” 2 responses “About the same” and 1 non-response. In response to the question, “What is your favorite part of the RUCPP system?” 10 of the 22 respondents identified equity or fairness of the system. In response to the questions about the fairness of charging the RUC to a variety of classes of vehicles (electric, hybrid, gasoline, all), almost all responses were Fair or Very Fair.

The rate of 1.56 cents was largely acceptable. 6 respondents felt it was “Somewhat low”, while 14 thought it “About right,” and 4 “Somewhat high”.

These opinions from the pre-RUCPP survey were confirmed in the post-RUCPP survey:

- In response to the question: “How fair does the Road Usage Charge seem to you, in principle?” There was one “Neutral” response and the remaining responses were “Fair” or “Very Fair”.

- In response to the question: “Do you think the Road Usage Charge was fair for you personally?” there were 21 “Yes” responses and 3 “No” responses, but each of the “No” responses also stated that the RUC was fairer than the fuel tax in the following question.

- In response to the question: “How does the Road Usage Charge compare to the fuel tax?” there were 9 “Much more fair than the Fuel Tax” responses, 8 “More fair than the Fuel tax” responses, 6 “Neutral” responses and 1 “Less Fair than the Fuel Tax” response.

- Also, all but 2 respondents thought the fuel tax credits were fair.

One person did express a concern about fairness in a free response question. This respondent stated: “It is not clear to me how "fair" the mileage tax is compared with larger, heavier vehicles that create more wear and tear on the roads. Also, how does the state deal with folks traveling through Oregon? Will the gas tax remain in effect statewide to capture that revenue?”

The fact that heavy vehicles (i.e., greater than 26,000 lbs.) in Oregon already pay a RUC should be explained to RUC payers. The fact that road usage between a small electric vehicle such as a Leaf and a large SUV is nearly the same from a cost perspective should also be explained, although this is a subtle point and will be challenging to communicate in a way that the general public can accept.
Based on participant feedback, ODOT will need to consider making the RUC applicable to out-of-state residents in the long-term. In the short term, ODOT will need to consider how to respond to equity concerns raised by Oregonians who think that the RUC should apply to out-of-state vehicles.

**Flat Fee**

One individual chose the flat fee plan, even though it meant spending significantly more money than the individual would have spent with a MRD-based plan. However, one participant pointed out that “the flat rate option represented a ‘double taxation’ option, since it offered no rebate for gas tax actually paid.” The audience for this sort of plan will be a minority of RUC payers, but could be an important part of the public to serve.

**Driver Feedback**

One respondent asked for more feedback (total miles traveled and charges for a given month) from the system in a free response question. In future communications, ODOT should emphasize to drivers that feedback is provided over Internet user accounts. In a revenue-generating system, CSPs should provide feedback via Smartphone and telematics apps.

ODOT should also spend more time communicating the relationship of the miles charged to the odometer:

- One respondent specifically asked that all invoices contain beginning and ending mileage, instead of just ending mileage.

- Another comment was that the participant “didn't see an [odometer] reading on the invoices, so [it is] inconvenient to verify mileage driven during prior period.”

ODOT should consider allowing CSPs to providing hypothetical odometer readings with customers as an option. The customer would have to opt into the system by sharing their odometer reading.

**Refunds**

Participants commented that they learned during the RUCPP that they deserved refunds for traveling on private roads. Based on this observation, it seems that there is little public knowledge not only of which roads are private but also the fact that motorists are entitled to a refund for travel on such roads.

Vendors may wish to create a list of major private roads (including, for example, large parking facilities) in order to provide refunds for travel on these facilities, thereby creating more value for their customers. Although the maps used in the pilot accounted for off-road travel perfectly, private roads were not generally identified as being private in the database.
Understanding of Road Finance Policies

Knowledge of fuel tax and road finance was improved during the RUCPP, and ODOT should pay attention to this lesson on the importance of outreach on policy when the full system is implemented. In response to the question, “How did the Road Usage Charge impact your understanding of the cost of road use?” 18 participants said it improved their understanding, while 6 said it had no impact. In response to the question, “How valuable is it to you to know how much my highway taxes are,” 9 participants responded with, “It is highly valuable to me to know how much my highway taxes are” and 13 said, “It is somewhat valuable to me to know how much my highway taxes are”. Only 2 said, “It is not important to me to know how much my highway taxes are.” When the full system is implemented, a clear explanation of the amounts and uses of fuel/highway tax should form a significant part of the outreach.

Privacy

Even at the end of the RUCPP, participants felt that the system protected their privacy well, as documented in the Privacy metric described in Chapter 5. In addition to the facts presented there, it is worth noting that 12 of the 24 participants felt that the RUCPP reduced their concerns about user account privacy, 12 stated that the RUCPP had no impact on their concerns, but none said that the RUCPP raised their concerns.

In the free response questions, one participant stated “The program, if scaled up, should have specific privacy policies and implementing technologies (e.g., capturing miles traveled, not routes except for calibrating checks) and the privacy policies and implementation should be overseen by a third party independent of ODOT.”

Two additional individuals did mention that they still had privacy concerns in their free response questions.

Overall

The overall attitude of the participants towards RUC improved, or in a few cases, was simply neutral. In response to the question “How has your overall attitude toward road user charges—specifically the mileage tax you are using as part of this pilot program—changed since before the pilot started?”

- 4 “Much More Positive”
- 10 “More Positive”
- 10 “No Change”

In response to the question “Based on your pilot program experience, do you see road user charges as a viable way to pay for road usage?”

- 19 “Definitely”
- 4 “Probably”
- 1 “Neutral”
Technical Analysis and Recommendations

This section presents technical analysis for the RUC system that goes beyond the analysis included in the RUFTF metrics. For the most part, the conclusions reached in this section do not trace directly to the metrics that the RUFTF committee determined—that analysis was covered in chapter 6. However, the analysis in this section includes data from the surveys not covered in the metrics.

It also includes Technical Recommendations that are based on both the analysis of the RUFTF Metrics and on the Technical Analysis included in this section.

Technical Analysis

The Evaluation Team found three main technical issues not included in the RUFTF metrics that require discussion and analysis. These issues are:

1. Vehicle Data Port Issues
2. Primary Data Source for Distance Traveled
3. Mileage Message

Vehicle Data Port Issues

The vehicle data port, or OBDII port, is the electronic connection to the vehicle’s onboard computer. Aftermarket MRDs (MRDs other than those which run on a vehicle’s telematics system) are plugged into the vehicle port. Three issues with the vehicle data port arose during the RUCPP:

a) **Data Port Location**

The location of the vehicle data (OBDII) port is not standardized, although it is required to be within a short distance of the driver in the vehicle cockpit. Because the location is nonstandard, a few participants had a hard time locating it on their vehicles. Also, in a few vehicles, the data port was located in a position that made it easy for the driver to bump the MRD when using the parking brake or getting out of the vehicle. However, the MRD never interfered with driving or otherwise compromised safe vehicle operation.

The Evaluation team recommends employing a Help Desk as was done in the pilot to help RUC payers find the data ports in their vehicles.
b) **Data Inconsistency**

The data available on the vehicle data (OBDII) port varied across models.\(^{24}\)

The evaluation team recommends using all data relevant to RUC computations that are available on each vehicle, even if it means that some MRD functionality will be supported on some vehicles but not others.

c) **Support on HEVs, PHEVs, EVs, and Older Vehicles**

Electric, hybrid, and plug-in hybrid vehicles (EVs, HEVs and PHEVs), had vehicle data ports that performed differently than the data ports of other vehicles. Older vehicles (pre-1996) may not have OBDII ports at all.

During the RUCPP, MRD manufacturers made adjustments to MRDs to capture HEVs, PHEVs, and EVs. To support HEVs and PHEVs, MRD manufacturers employed a combination of GPS and vehicle speed data to compute miles traveled accurately under all circumstances. To support the EVs used in the RUCPP, MRD manufacturers added software to their MRDs that could access vehicle data available in the specific models of EVs used in the tests.

ODOT should require MRD manufacturers to provide solutions that allow the MRD to measure all miles traveled for HEVs and PHEVs. MRD manufacturers must ensure that their MRDs compute distance traveled when the electric motor starts driving the vehicle, even if the gasoline engine is not running.

EVs are more challenging because fully electric vehicles (EVs) are not required by law to comply with the OBDII standard. MRD manufacturers may need to come up with custom solutions for EVs, such as the one used in the pilot— adding software to access data available on specific models of EVs. There are multiple solutions for the issue of EV interfaces, and this report does not explore the solutions in detail.\(^{25}\)

**Primary data source of computing distance traveled**

During the RUCPP, advanced MRD manufacturers successfully used a combination of location information and odometer data to compute distance traveled, and ODOT should continue to support advanced MRD manufacturers employing this approach. By employing a combination of these two data sources, advanced MRDs have a reliable way of computing miles traveled when vehicle data is not available. Using GPS data for the computation of miles traveled.

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\(^{24}\) Several data values that can be used to determine if a vehicle has been driven when the MRD was unplugged are supported on some models, but not others. Data values that support computation of fuel consumption are also supported on some models, but not others.

\(^{25}\) Most EVs contain telematics systems, so it would be straightforward to create an app to run on the telematics to support the RUC system.
traveled also allows MRDs that are based exclusively on location data. Such MRDs may be desirable for vehicles without a standard data port, such as EVs, and older vehicles.

**Mileage Message**

During the RUCPP, the mileage message (the data transmission that contains data on distance traveled) was written in an older data messaging protocol. MRD vendors said in surveys that it would be desirable to use a newer protocol since it will reduce bandwidth/airtime needed to support it, and likely be more forwards compatible.

**Technical Recommendations**

After the research and analysis that went into this report, the evaluation team offers the following technical recommendations. These recommendations leverage, but do not correspond to, the issues presented in the technical analysis section above.

The recommendations are grouped into two categories: recommendations based on RUCPP operations and recommendations based on stakeholder feedback.

**Recommendations for the Future Based on Operation of RUCPP**

The evaluation team recommends the following:

- The Help Desk was very successful in making the pilot program run smoothly; such a Help Desk should always be included in any future pilot programs and the ultimate system.

- The websites set up by ODOT and the contractor, Sanef, were an important element in communicating with the general public and key stakeholders, and providing online account set up and management for participants. Both public and private sector websites should be included in any future pilot programs and the ultimate system.

- ODOT should study the accuracy of fuel consumption measurements before the system is in revenue operation.

**Recommendations for System Improvements Based on Stakeholder Feedback**

Key recommendations for system improvements include the following:

- In future system implementations, the mileage message should be composed in protocols that are compatible with current trends in web and cloud-based service programming, and use the least resources, while provided all the functionality needed for a vehicle to report mileage message.

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26 SOAP.
27 JSON, using RESTful web services.
• Future system requirements should include consistent and simple behavior of indicator lights, or the possibility to receive an email or text message indicating that the MRD is plugged in and operating correctly.

• ODOT should consider allowing GPS to be used for distance measurement, in addition to other methods, instead of using GPS only for location determination.

• ODOT should consider encouraging CSPs to provide users feedback about their road usage, and specifically allowing users to provide their odometer reading in their account so that their statements contain odometer readings and users can receive more direct feedback about their roadway usage. However, there will be divergence in the stored odometer and actual odometer values, so ODOT should consider how to respond to customer inquiries about the divergence.

• Diesel tax refunds should be handled the same way as gas tax refunds. The decal system employed in the trial was not honored by most fuelling stations.

• ODOT and/or CSPs should communicate the following to RUC payers:
  – RUC payers should be encouraged to regularly access their user accounts on the web or on a mobile phone so that they can better appreciate their road usage in real time.
  – The behavior of the mileage reporting device indicator light should be highlighted and explained in several places including with the mileage reporting device packaging and on the system website.
  – The system documentation should explain that commercial vehicles already pay RUC in the state of Oregon, but also explain that the roadway wear-and-tear caused by passenger vehicles below 6,000 pounds (including almost all SUVs, pickup trucks, sedans, and compact cars) is identical regardless of weight.
  – The general public and especially RUC payers should be provided documentation about fuel tax costs (amounts) and uses (amount of roadway spending needed and what is actually provided).
  – RUC payers should be provided documentation about when automatic fuel consumption measurement can be used, and when it cannot, about the accuracy of EPA fuel economy standards.

28 From a technical perspective, this would entail that, in lieu of using the SOAP protocol, the mileage message should use the JSON protocol and use RESTful web services both of which are more recent protocols and compatible with current trends in cloud computing.
Conclusions

Based on the analysis of evaluation data, the evaluation team offers the following conclusions:

- **The RUCPP successfully met its objectives to demonstrate an easy-to-use mileage reporting and payment system replete with palatable choices administered in an interoperable fashion.**

  Based on review of the system implemented by the RUCPP suppliers and operators, participants had a clear choice between two technologies. Albeit similar in many ways, the technology choices included one device with no location detecting capabilities and another with GPS to allow motorists to “opt in” to location-based road usage charging with differentiation of in-state, out-of-state, and off-road miles. Based on participant feedback, the technology and billing system were widely regarded as easy-to-use and user friendly.

- **Results suggest that a road usage charging with an open system is feasible, and a healthy private market exists for the provision of a range of services related to road usage charge collection and administration.**

  Users were offered a total of five road usage charging payment plans, coming from two separate service providers. All payment plans and service providers are using the interfaces as specified by open specifications. Together, these facts show that the RUCPP represents a truly open road usage charging system, and the RUCPP’s success so far shows that this system is feasible.

- **Participant feedback indicates that giving participants a choice of road usage charging plans is possible and supported success of the pilot.**

  The RUCPP successfully demonstrated the importance of allowing participant choice, as most participants indicated that choices were an important feature of the system. Oregon RUCPP participants had the following distribution of plan choices:

<table>
<thead>
<tr>
<th>Plan/MRD</th>
<th>Number of Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sanef Advanced</td>
<td>24</td>
</tr>
<tr>
<td>Sanef Basic</td>
<td>8</td>
</tr>
<tr>
<td>ODOT Basic</td>
<td>7</td>
</tr>
<tr>
<td>Smartphone</td>
<td>4</td>
</tr>
<tr>
<td>Prepaid Flat Rate</td>
<td>1</td>
</tr>
<tr>
<td>Totals</td>
<td>44</td>
</tr>
</tbody>
</table>
1.56 cents per mile was generally acceptable as a price point.

The indicative RUC rate for the RUCPP was 1.56 cents per mile, or approximately what a 20 MPG vehicle currently pays in gas taxes. Most of the pilot participants regarded this as an acceptable rate for a road usage charge, although it is important to recognize the caveat that pilot participants were from a carefully selected pool of policy makers and others familiar with transportation funding issues.

A Road Usage Charge is generally perceived as being equitable by the participants of the RUCPP.

Most participants agreed that a road usage charging program is at least as equitable as a fuel tax, and several believed that it is more equitable than the current gas tax. This perception of equity applied to vehicles with all types of drivetrains: electric, hybrid, gas, and diesel.

Mileage Reporting Devices were quick to install and easy to use.

Based on participant feedback, the OBDII dongle technology used in the pilot was generally easy to install and easy to use. Minor issues included difficulty for a few users finding the OBDII port and a few instances of users accidentally dislodging the mileage reporting device. These issues were generally regarded as minor and did not affect the overall view by pilot participants that the technology was “quick to install” and “easy to use.”

Online accounts were user friendly, although PayPal payments presented problems for several participants.

Online account management was ranked the single most needed feature a RUC program by survey respondents, and survey respondents overwhelmingly found the online web interface quick and easy to use. However, a few participants did have issues with PayPal as a payment mechanism. While the evaluation team recognizes that PayPal was never intended as the only option for full system operation, its sole use is not recommended for full revenue operation.

OBDII ports can be used as a data source for dongles, but not all vehicles follow standard OBDII port data specifications.

As mentioned previously, older vehicles do not conform to the OBDII port data standard and, therefore, do not provide data in a format that is conducive to road usage charging. On the other end of the spectrum, plug-in hybrids and hybrids behave slightly differently on OBDII communications, and electric vehicles do not conform to OBDII port data standards. In fact a few electric vehicles do not contain an OBDII port. Work-around solutions for these vehicles were created for the pilot program but would need to be addressed on a wider scale for any operational system. Also, ODOT should consider allowing location information for distance measurement with advanced MRDs, and calibrating with OBDII port speed information.
Smartphones are feasible RUC measuring instruments, but the technology requires refinement before it is deployed.

The smartphone MRDs used in the pilot were sometimes difficult to couple with user smartphones and seemed to measure more miles than users were actually travelling. However, their use in the pilot proved the concept, and the interface and measurement issues can be corrected before they are used in revenue collecting operation.

Operations of a RUC system are feasible and can be effectively implemented for revenue collection.

The problem-free execution of the RUCPP, coupled with statements by the vendors and the system integrators on the operational ease of the system, indicate that running a RUC program as ODOT has designed is operationally feasible.

The cost of dongles is $50-$100 and $5-20/month to operate a limited sample, limited duration one-off pilot program as of 2013; and will be less to operate a growing, permanent mileage charging program in the future where these costs can (1) be negotiated in a competitive market and (2) can be offset by private investment to build platforms for marketing various services such as data aggregation and pay as you drive (PAYD) insurance.

The cost of MRDs has declined precipitously in the past several years due to increasing demand in insurance telematics. Operating costs have declined as well. As penetration of in-vehicle services grows, costs will continue to decline, making use of aftermarket dongles more cost effective for road usage charging. It is doubtful that such technology is appropriate to support road usage charging as a standalone application today due to the relatively high costs associated with usage and relatively low revenues from road usage charging. However, this could change in the future as both costs decline and revenues for private providers increase through the provision of other driver services beyond road usage charging.

The cost of operations, after setup of base system, is primarily the cost of running a call center and database maintenance. A base system setup can be completed for $200k if built on a pre-existing system. The monthly cost of operations depends on the size of the system but should remain under $20,000.

The back-office system is a modest cost, and it scales favorably as the number of vehicles in a road usage charge system increases.

Multi-state operation of RUC is technically feasible.

The RUCPP demonstrated that multiple states can operate technology and road usage charging collections with distinct policies across a common platform and across state lines. This includes providing distinct choices among road usage charging plans (e.g., Oregon offered 5 plans, while Washington and Nevada offered 2) and different per-
mile rates (e.g., Oregon charged 1.56 cents per mile, Washington charged 1.87 cents per mile, and Nevada charged 1.19 cents per mile). Also, the Oregon platform can be expanded to support multiple states, assuming that other states adopt a road usage charging business model that accommodates industry participation in a manner similar to Oregon. Because Oregon’s road usage charging platform is highly scalable, the additional accounts across several states will lead to further reductions in per-account costs. Going forward, the RUC system should be designed in a completely scalable way. It can handle vehicles registered in different RUC systems in different states. In fact, supporting multiple states will improve the business case for such a system, because the costs for such a system will be spread across a larger number of vehicles.

- **A Road Usage Charge Accounting system is feasible.**

The data and summary reports generated by the vendors in the RUCPP were submitted to a road usage charge accounting entity operated by ODOT contractors. The accounting entity provided functions consistent with accounting functions of other government transportation revenue systems such as fuel taxes and tolling. There were no issues performing this function with the data available from the road usage charging system tested in the RUCPP.

- **User opinions of a RUC policy either improved or remained neutral as a result of their participation in RUCPP.**

An important caveat is that the participants in the RUCPP were selected based in part on their interest and familiarity with transportation revenue and funding policies in Oregon. That said, even for these informed participants, the RUCPP was a “world first” test of OBDII dongles for a road usage charging application. The fact that favorability of road usage charging remained unchanged or improved among participants reflects the successful demonstration of this approach to road usage charging.

- **MRDs may fall out of the vehicle data port, and a small percentage of these may even be accidentally damaged or destroyed.**

No tax system is perfect. The RUCPP relied on users to install and maintain in-vehicle dongles. A real system, as in the pilot, will involve many instances of dongles becoming disconnected from the vehicle for a variety of reasons. Also, as occurred in the pilot, a small percentage of MRDs deployed will even be damaged or destroyed. Future technologies for road usage charging, whether dongles, smartphones, telematics or something else entirely, will face similar issues. The design of any system must include contingencies for managing these scenarios. In the RUCPP, the Help Desk resolved issues of dislodged, damaged, and destroyed dongles. CSPs should be required to report to the RUC Payer when a significant disconnect situation has occurred. CSPs should record disconnects and report them to ODOT for investigation during an audit.
The best way to determine the amount of fuel tax credits for a motorist is to calculate fuel consumption based on data from sensors built into the vehicle engine. In vehicles that do not provide such data, it is reasonable to use EPA estimated fuel economy times the number of miles traveled as a substitute.

In either case, fuel tax credits are computed by multiplying the number of gallons consumed by the amount of tax per gallon. Pilot participants received statements showing miles traveled, road usage charges associated with those miles, and the amount of gas tax they had already paid for those miles, based on an estimate of fuel consumption for those miles. There are two methods to estimate fuel consumption: calculation from vehicle data using one of several data feeds from the OBDII port or estimates based on EPA ratings or adjusted EPA ratings. While the accuracy of computed fuel usage using vehicle data merits further study, it appeared to work well in the pilot, and is likely to be preferred over the use of EPA estimated fuel efficiency.

While RUC policy is broadly viewed by RUCPP participants as either the same as or more fair than the gas tax, all participants viewed it as a fair policy for them personally.

All participants who responded to RUCPP surveys indicated that, for them personally, a road usage charge was fair. Interestingly, however, not all respondents felt that road usage charging was as fair for the public at large as it was for them personally. This could reflect beliefs about the amount of road usage charges that should be paid by individuals in certain stakeholder groups, including rural motorists, owners of high fuel efficiency vehicles, and owners of low fuel efficiency vehicles.

While participants generally trusted that RUCPP provided privacy protection and account security and provided similar protections as mobile phones and credit cards, they had no means of verifying this.

Likewise, it is difficult for participants to truly measure the security and privacy protection of their mobile phones and credit cards. All of these systems require an implicit level of trust between the user and the service provider. In the case of road usage charging, initial results from participant surveys indicate a strong level of trust, but at the same time, an inability to verify that trust in a meaningful way.

Despite the simplicity of the RUCPP from a user perspective, a small number of participants worried about high administration and account management costs for government.

The concern over high costs of administration spanned the pre-pilot, mid-pilot, and post-pilot surveys. Although expressed by only a handful of survey respondents, the theme was repeated and not explicitly addressed through the RUCPP in a way that was communicated to the participants.

CSPs may wish to create a database of private roads.

Sanef’s system accounted for off-road travel perfectly, but it was not clear that all private roads were listed in Sanef’s databases. The public or private nature of a road is
generally not indicated in the databases of digital map providers such as Navteq. To provide RUC payers the greatest possible refund, CSPs will need to determine the private nature of major private roads (such as large parking facilities). ODOT may wish to make potential CSPs aware of this situation.
Appendix A

System Architecture and Data Flows for Operational Concepts

The following diagrams illustrate the flow of information from the mileage reporting device to the account management system and the ODOT Road Usage Charge accounting entity. In the diagram, RUC payers are represented as Responsible Parties and mileage reporting devices are represented as OBUs.

Figure 19: Information Flow in Undifferentiated Road Usage Charge Reporting Concept

Figure 20: Information Flow in Differentiated Road Usage Charge Reporting Concept
The two concepts of account management – one provided by private CSPs and one provided by ODOT – lead to two different overall logical architectures. The following diagrams illustrate the architectures for these two cases.

**Figure 21: RUCPP Architecture with Account Management by Certified Service Provider**

**Figure 22: RUCPP Architecture with Account Management by ODOT**
The architectures are presented only to give a general indication of the entities involved in the operational concepts. Details of these architectures are explained in the *ODOT Operational Oregon Vehicle Road Usage Charge System and Road Usage Charge Pilot Program Updated Concept of Operations, Version 1.1, March 15, 2012.*
Appendix B

Method of Evaluation

The term “stakeholders” refers to all parties involved in the Road Usage Charge Pilot Program. The evaluation team identified the following six key RUCPP stakeholders. Evaluation activities included surveys of and data collection from these groups:

1. **Participants or Road Usage Charge payers** - Individuals responsible for paying the Road Usage Charge, typically vehicle owners or lessors.

   For the purpose of the pilot, participants are defined as individuals signing up for the pilot, choosing a mileage reporting plan, installing the mileage reporting device, if applicable, and driving chargeable miles on the Oregon roadway network.

2. **Mileage Reporting Device Vendors** - Representatives of the companies supplying the mileage reporting devices.

3. **Account Management System Vendors** - Representatives of the company providing the private account management systems.

4. **ODOT Pilot Participant Coordinators** - The ODOT representatives coordinating the activities of the pilot participants.

5. **ODOT Road Usage Charge Accounting System Operator** - The ODOT contractor operating the ODOT Road Usage Charge accounting system.

6. **ODOT System Integrators** - ODOT contractors responsible for integrating, testing, and providing ongoing support for all elements of the Road Usage Charge Pilot Program.

One of the first steps in the evaluation was distribution of initial surveys to vendors and participants in order to determine their positions going into the pilot. Note that surveys of other RUCPP support stakeholders, including ODOT and its consultants were also conducted, but these results and opinions are not as useful given the longstanding involvement of ODOT staff in the Road Usage Charge Program.
Participants were surveyed three times:

1. A pre-screening survey to determine road usage charge payers’ opinions, thoughts and behaviors at the outset of the program.

2. A mid-point survey to determine road usage charge payers’ opinions, thoughts and behaviors during the program following receipt of the first invoice.

3. A third and final survey was distributed at the conclusion of the pilot to determine road usage charge payers’ opinions, thoughts and behaviors after the program finished.

Vendors were surveyed during the stakeholder information sessions before the start of the pilot, as described above, and were surveyed again at the end of the RUCPP. No midpoint survey was held for vendors.

During and after the data and survey collection, the evaluation team compiled responses, analyzed indicators and prepared this report.

Surveys

One of the most important sources of information for evaluating the performance of the pilot was feedback received from surveys of participants and vendors. Below we describe the process of obtaining survey data from these two important groups.

Participant Surveys

In order to track feedback and opinions from pilot participants in a dynamic fashion, three surveys were employed. Surveys included a combination of multiple-choice questions, rankings, and open-ended questions posted online. Participants were given approximately two weeks to respond to each survey at their convenience.

- Pre-pilot survey. The first survey was distributed to participants within a week of signing the participant agreement, in late October 2012. The survey had 26 questions, and 24 participants out of 42 responded, a rate of about 57 percent.

- Midpoint survey. The second survey, consisting of 41 questions, was distributed in early December 2012, approximately at the halfway point of the pilot, after the first round of invoices was distributed to 31 participants29. Out of a total of 31 surveyed, 18 participants responded, for a participation rate of 58 percent.

- The third and final survey was distributed at the conclusion of the two phases of the pilot (February 2013 for phase 1 participants, and March 2013 for phase 2 participants).

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29 It should be noted that 11 of the original 42 participants signed up for RUCPP service plans that began in Phase 2 and as such they did not receive the first invoice in early December.
Vendor surveys

In order to gather feedback from vendors providing technology and account management services during the pilot, a pre-pilot survey was conducted with each vendor. The surveys were conducted as interview-style teleconferences led by members of the evaluation team. The first pre-pilot survey was conducted in late October 2012 with two representatives of Sanef. A second pre-pilot survey was conducted in November 2012 with two representatives of Raytheon. Post-pilot surveys were conducted in early March 2013 with both vendors as well as OBU vendor IMS.

Questions asked during the interview included multiple-choice question, open-ended questions and free format comment opportunities.

Data collection

In addition to the largely qualitative feedback from surveys, the evaluation team collected raw data from a range of pilot stakeholders at various points throughout the pilot as summarized below. The evaluation team asked each of the stakeholder groups to provide the data in the original formatting in which it was recorded (whatever spreadsheet or other formatting had been used to record the data).

Pilot Coordinators

The following data were collected at the start of the pilot:

- Number of Participants in the pilot.
- Participant vehicle make, model, and year.
- Participant vehicle odometer reading immediately before mileage reporting device activation (if provided by Participant).

Much of this data was actually provided by the system integrators (support team).

Immediately following the pilot, the following data were collected:

- Number of Participants who successfully completed the pilot.
- Number of Participants who did not complete the pilot, when they dropped out, and why.
- Number of Participants who fully paid the Road Usage Charges owed.
- Number of Participants who did not fully pay the Road Usage Charges owed and how much was owed by any Participants that did not fully pay.
- Odometer reading of each vehicle immediately after mileage reporting device deactivation (if provided by Participant).
- Number of mileage reporting devices that were reported broken.
System Integrators (support team)

Prior to the pilot, the following data were recorded:

- Number of mileage reporting device options available to Participants.
- Number of data collection, transaction processing and account management system options available to Participants.
- Whether the mileage message was used by all mileage reporting devices.

Immediately following the pilot, the following data were recorded:

- Whether any mileage reporting device, data collection, transaction processing or account management system options available to Participants before the pilot failed, and why.
- Compilation of Road Usage Charge Accounting reports.
- Whether mileage reporting devices that provided by one vendor used with all transactions processor/account management system vendors.
- The capital and retrofitting costs that ODOT incurred starting up the Road Usage Charge Pilot Program.
- The operations and maintenance costs that ODOT incurred starting up the Road Usage Charge Pilot Program.
- The marginal costs of operating the Road Usage Charge system in multiple states.
- A documentation of any unexpected problems that arose, if they were resolved and how long it took to resolve them.

Vendors

Immediately following the pilot, the following data were collected:

- Miles traveled (by zone) and taxes owed and paid for each Participant (provided as part of road usage charge accounting records).
- Customer service logs and issue logs (included in Help Desk Logs).
- Logs of road usage charging transactions.

Road Usage Charge Accounting

Immediately following the pilot, the following data were collected:

- The total cost of operations by Road Usage Charge Accounting (RUCA) and Transaction Processor (TP) vendors.
- The marginal costs of operating the RUCA in multiple states.
- An estimate of quality of audits of Road Usage Charge Pilot participants.
- Whether required information for audit is available, and if not, what is missing.
- Whether the multi-state nature of the pilot complicated the auditing process, and if so, what system improvements could be made to support multi-state audits.