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# SMARTPHONE INNOVATION CHALLENGE REPORT

 **WA RUC**



UNIVERSITY *of* WASHINGTON



WASHINGTON ROAD USAGE CHARGE

# SMARTPHONE INNOVATION CHALLENGE



MOBILITY  
INNOVATION  
CENTER

at the  
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**WASHINGTON STATE TRANSPORTATION COMMISSION**

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**INTRODUCTION**

The Washington Road Usage Charge Pilot Project (WA RUC) is a proposed pay-per-mile charge system that is being considered as a potential future replacement for Washington’s gas tax. The road usage charge would raise transportation revenue for the state in the long term while increasing tax equity among drivers. The pilot project will test whether this strategy makes sense for Washington.

Background

The Washington Legislature has directed the Washington State Transportation Commission (WSTC) and an appointed Steering Committee to investigate the feasibility and potential for a per-mile charge, or road usage charge (RUC), as a potential replacement for the state gas tax.

The WSTC with advice from the Steering Committee have adopted principles and a policy framework to guide development of the RUC system and are ready to move forward with a state-wide pilot. The Steering Committee has also identified 18 policy “parking lot” issues that will be subject to additional policy analysis and legislative direction, if RUC system is implemented at some point in the future.

The year-long pilot project is being funded by a Federal Highway Administration grant (\$3.8M), and anticipates engaging 2,000 volunteers from geographically diverse areas of the state. It will study whether a road-usage tax could be a workable alternative to the gas tax and will test four different methods to measure road-usage, ranging from high-tech to low-tech approaches.

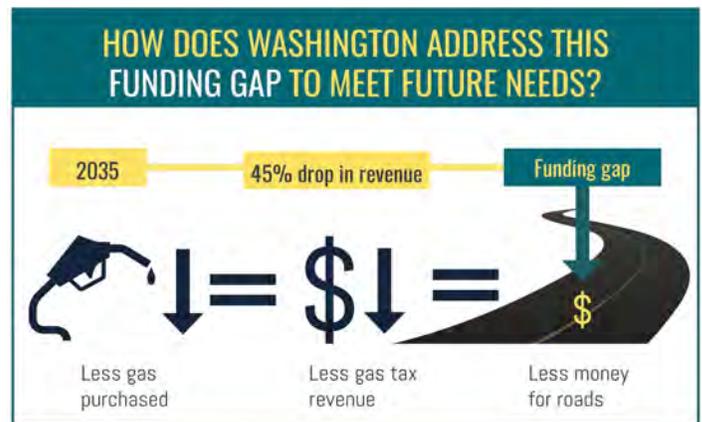


Image credit: waroadusagecharge.org

What is the problem with the Gas Tax?

Washington’s gas tax currently funds a large portion of the transportation budget, which pays for maintenance of state highways, ferries, and other infrastructure. As vehicles become increasingly fuel-efficient, gas consumption will continue to decrease; as a result, gas tax revenues will decrease.

Washington currently has a 49.4 cent-per-gallon state gas tax. For every 49.4 cents, after deducting bond repayments and other mandatory distributions to local agencies, only 8 cents are available for use on state highways, bridges, and ferries for maintenance and operations, preservation, and safety improvements. At the same time, a growing percent of the state’s portion of gas tax revenue is required to pay debt service. In fiscal year 2003, 39% of the state’s portion of gas tax revenue went to paying debt service. By fiscal year 2015, this increased to 69%, and by 2027, this is projected to increase to 70%. The gas tax would need to increase by about 1.5 cents per gallon, per year, on all vehicles from 2019-2043 to keep funding at status quo levels.

Fuel efficiency will continue to increase. Washington’s current

**THE GOALS OF THE PILOT ARE:**

- > Demonstrate an operational RUC
- > Identify and evaluate issues
- > Test the feasibility of the various mileage-reporting options
- > Solicit feedback and ideas



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state average fuel efficiency is 20.5 miles per gallon (MPG), and conservative forecasts suggest that Washington vehicles will reach a 35 MPG average by 2030. The U.S. Energy Information Administration predicts that by 2040, all new cars will have a fuel efficiency of 48 MPG, and fuel efficiency across all cars (new and old) will reach 37 MPG. In addition, electric vehicle usage is growing in Washington, and major auto makers have committed to increase production at a more rapid pace.

There is also an equity (fairness) challenge with the gas tax. Drivers with more fuel-efficient or electric vehicles pay less or no gas tax than drivers with lower MPG vehicles to use Washington's roadways, which means not all state drivers pay equally for use of these roads.

### What is a road usage charge?

A road usage charge is a per mile charge that drivers would pay for use of roads, rather than paying by the gallon of gas. It would function similarly to utilities in that people would pay different amounts based on how much they use the transportation system. This pay-per-mile charge system would also create a more

equitable (fair) system for state drivers and a more stable revenue base for reinvestment in the transportation system. Regardless of a car's fuel efficiency, drivers will pay the same tax for driving the same roadway miles.

A road usage charge is different than a toll. A toll is used for specific purposes – either to raise funding for a specific project, such as the SR 520 Floating Bridge or Tacoma Narrows Bridge, or to manage traffic congestion through the pricing of lanes or facilities by charging variable rates at different periods, such as the Express Toll Lanes on I-405 or the HOT Lanes on SR 167. Tolls are only collected when using that specific bridge or road, and revenues are only used to support that facility. In contrast, a road usage charge would replace the gas tax as the primary statewide funding source for transportation needs.

The road usage charge is intended to eventually replace the gas tax. During a transition time when the gas tax and road usage charge would coexist, drivers would pay one or the other but not both. Eventually, the road usage charge would replace the gas tax completely.

## THE PILOT PROJECT

In 2012, the Washington State Legislature directed the Washington State Transportation Commission (WSTC) to work with a steering committee in assessing a road usage charge as a possible replacement for the gas tax. After evaluating this potential path for several years, the 25-member Steering Committee and WSTC determined that a road usage charge would be feasible and that it could produce the revenue needed to meet the state's long-term transportation needs.

Starting in early 2018, WSTC will launch a pilot study of the road usage charge with the goal of assessing whether this system fits Washington long-term. This will be a chance for the public to try out the per-mile charge system at no cost to drivers and provide feedback on results to the state and decision-makers.

The project is planning to recruit at least 2,000 drivers throughout the state to participate in the pilot project. The pilot project is funded by a federal grant, and it aims to answer the following questions:

### PILOT PROJECT QUESTIONS:

- > Does a road usage charge work for different drivers throughout the state?
- > How do the reporting methods work for drivers?
- > Will a road usage charge enable us to better fund our transportation system in the future?



For the pilot project, the road usage charge is being considered as **a flat rate of 2.4 cents per mile** statewide. This is equivalent to what a driver pays today in gas taxes if the car's fuel efficiency is at the state average of 20.5 MPG.

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Mileage reporting

A key component of the pilot program is that people should be able to choose how they want to report mileage. Volunteers will be able to choose from one of four methods to record and report their mileage, with the methods ranging from no-tech to low-tech to high-tech.

Four reporting options for pilot participants:

		<b>Mileage Permit</b>	Pre-select a block of miles
		<b>Odometer Readings</b>	Report miles quarterly, electronically or in person
		<b>Plug and Play</b>	Automated mileage meter with GPS and non-GPS options
		<b>Smartphone App</b>	Smartphone app is used to collect and report miles

**SMARTPHONE INNOVATION CHALLENGE**

The Smartphone Innovation Challenge was a sponsored competition designed to improve smartphone approaches for mileage reporting in a road usage charge tax system. The competition asked IT engineers, software developers, and designers to create a prototype solution in the form of an app for mileage reporting using a smartphone. This app should allow drivers to use their own smartphone to record and report mileage, as well as allow drivers to decide whether or when to enable GPS.

From one-day hackathon to extended research opportunity.

The original WA RUC pilot project proposal called for a one-day event inviting talented researchers and software specialists to compete to develop a special smartphone application capable of recording vehicle mileage while allowing all privacy controls to remain with the driver, rather than controlled by the government or a private company.

**The original concept for an all-day “hackathon” or “developer codefest” evolved into something bigger.**

In discussing the magnitude of the effort required to develop a solution, the project team realized that an all-day competition would not produce the depth of research and results needed for the forthcoming statewide RUC pilot test. Instead, the team began collaborating with **CoMotion**, an organization within the University of Washington that helps public agencies and private firms partner with UW researchers to develop new ideas, services, and products.

The **Mobility Innovation Center**, housed at CoMotion, makes connections between research, technology, and public policy to tackle transportation challenges. With support from CoMotion and the Mobility Innovation Center, the RUC project team assembled and mentored four teams of student researchers across three departments with interest in working on road usage charge smartphone app design, software, and technology.

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What are the challenges of using a smartphone for mileage reporting?

**The RUC project team presented the primary challenges with using a smartphone for mileage recording to teams of students.**

When discussing options for recording and reporting mileage, drivers often ask whether they can use their own smartphone to keep track of their mileage. They are comfortable with their own phones, have full control over the features, and do not want to install additional equipment just for mileage tax reporting.

There are many software apps already available that record trips. However, road usage charging presents unique challenges that must be addressed.



**SMARTPHONE MILEAGE REPORTING CHALLENGES:**

- > How can drivers maintain full control over whether (or when) they want to use their phone's GPS for mileage recording?
- > How does the smartphone know when a driver is traveling in the specific vehicle registered with the driver's RUC account?
- > What if a driver forgets to bring (or turn on) the smartphone?
- > Will a special RUC app drain the battery, making the phone unusable during or after the trip?
- > Can a smartphone app do something more interesting and useful than just record mileage?
- > What happens if the vehicle drives into another state? How will the phone know to not add those miles to the driver's RUC account?

**Teams worked for six months on their proposed solutions.**

The four competing teams worked throughout winter and spring 2017 academic terms, supported by staff from the project team. Project team support included presentation of background materials, advising teams, discussing progress, and identifying and trouble-shooting issues.

Two teams from the UW Human Centered Design Engineering (HCDE) Department participated. Both teams focused on developing a user interface for a Washington RUC smartphone appli-

cation that provides drivers with the type of information they value most, while eliminating information and features that are unimportant or distracting, especially while driving. One team's app focuses on smartphone app design that appeals to the average driver. The other team's app, "Tongle," allows drivers to choose to categorize trips to self-analyze their driving habits, as well as allows drivers to quickly and easily contest their trips and request that a RUC account manager fix any incorrect mileage.

One team from the UW Electrical Engineering (EE) Department participated. They designed a Washington RUC smartphone app for the Android smartphone operating system. This app features a toggle on/off GPS mileage recording to ensure that out-of-state miles are deducted from a driver's RUC account. It also includes Border Proximity Detection, where an audible sound reminds drivers to activate the out-of-state mileage deduction feature as the vehicle approaches a state border. The team made a presentation at the EE department's end of year Capstone Project Fair held on May 30 on the UW Seattle campus. Faculty, students, and guests that attended the Capstone Fair received the project well.

One team from the UW Information School developed a working prototype of a smartphone app for the IOS (iPhone) operating system. The app, "WARUC," uses a simple, "no-look" swipe on the smartphone screen to activate or deactivate mileage reporting. In addition to their formal presentation, the iSchool team created a promotional video that is currently posted to YouTube. This team also received approval to distribute their app through Apple's iTunes App Store.

**All four teams completed the Smartphone Innovation Challenge.**

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On June 5, 2017, at an event at Fluke Hall on the University of Washington’s Seattle campus, the four teams that completed the Smartphone Innovation Challenge presented their designs and smartphone apps to a crowd of approximately 30 invited guests that included project partners and representatives from Challenge Seattle, the Mobility Innovation Center, CoMotion, UW Faculty Advisory Board, WSTC, the Washington State Department of Transportation, the Federal Highway Administration (FHWA), and several consulting firms.

For completing the Challenge and assigning the right to use their designs and smartphone app features in the Washington RUC pilot project, each team earned a Washington RUC Smartphone Achievement award, which includes a financial award of \$5,000.

In addition, two of the teams were tied for the Excellence Award, intended for the team that produced the best overall solution to the challenge of how to use a smartphone for mileage reporting. Because of the tie, two teams split the Excellence Award (\$10,000).

### Excellence Award Spotlight

The Human Centered Design & Engineering (HCDE) Team’s “Participatory Design” process involved the general public in designing a smartphone app for RUC. HCDE researchers describe their work this way:

**“Putting people first, HCD engineers focus on understanding humans needs and interests as they research, design, and build interactions between people and technology.”**

Rather than starting with technical specifications and software coding, the Participatory Design process used by the HCDE team first assembled a group of volunteers from the public willing to attend three two-hour workshops to help design a smartphone app for mileage reporting. Each of the three workshops had a specific focus.

**Workshop 1** consisted of an exercise where volunteers identified and elaborated on all aspects of a RUC smartphone app that they would hate. They sketched out the worst possible solutions they could imagine. By using this negative design process, the team could more vividly contrast the difference in preferences of drivers against the needs of government for collecting RUC.



# Tongle

A high-tech mileage reporting system for use with Washington State’s upcoming Road Usage Charge

*How can road infrastructure be funded in a more inclusive way?*

**MEDIA INTEREST:** A local Public Broadcasting Station affiliate, KCTS Channel 9, has explored the possibility of running a feature on the unique collaboration between these UW student research teams and government (WSTC, FHWA) as they collaborate to solve a long-term transportation funding problem.

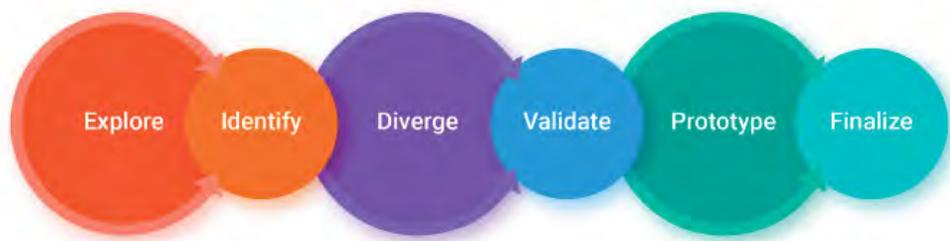
## Process

### Participatory Design

We sat down with 8 drivers from all over Washington State over the span of workshops to understand and incorporate their perspectives into the design process.

### Rapid Prototyping with User Values

Our participants’ perspectives revealed a core set of values to be addressed in our designs. Our prototypes sought to effectively address the tensions between those values.



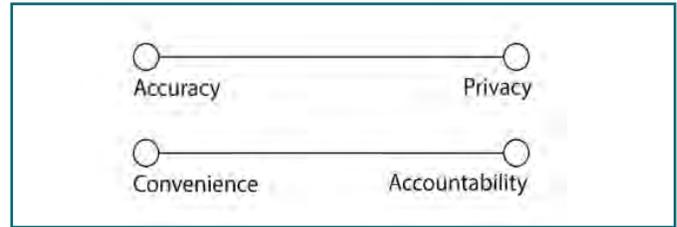
Workshop 1

Workshop 2

Workshop 3

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**Workshop 2** began to explore the differences between drivers preferences vs the state’s revenue collection needs, with the volunteers indicating their preferences by level of importance so they could be weighted as priorities. The researchers then took volunteers’ weighted preferences back to the design lab, where they reduced the concepts and preferences into a prototype of a RUC smartphone app that could be used in the Washington pilot project.



**Workshop 3** focused on the reactions of the volunteers to the conceptual smartphone app, including an exercise that “truth-tested” the design by dividing the group into two teams, then asking one team to “prosecute” (argue against) the prototype design, and the other team to “defend” the prototype design. These sessions were videotaped and the reactions taken back to the design lab for final adjustments.



Below are snapshots of two projects, Tongle (HCDE) and WARUC (Information School):

# Tongle

A high-tech mileage reporting system for use with Washington State’s upcoming Road Usage Charge

How can road infrastructure be funded in a more inclusive way?

### Problem

**Fuel-Efficiency & Gas Tax Revenue**  
(Source: WARUC)

**Road Usage Charge**  
With an increase in *average fuel efficiency*, funding roads with a gasoline tax is *no longer sustainable*. Washington State has proposed a per-mile tax based on miles driven, called the Road Usage Charge.

### Process

**Participatory Design**  
We sat down with 8 drivers from all over Washington State over the span of workshops to understand and incorporate their perspectives into the design process.

**Rapid Prototyping with User Values**  
Our participants’ perspectives revealed a core set of values to be addressed in our designs. Our prototypes sought to effectively address the tensions between those values.

### Prototype

Tongle pairs a smartphone app with an external device to ensure fair and convenient mileage recording. The external device, plugged into a car’s OBD-II port, records and stores a car’s trip data. The coupled app allows users to view, contest, and pay for their road usage.

**1) Drive your car**  
Tongle requires a convenient, one-time setup for each car

**2) Record Mileage**  
Tongle *accurately* and automatically records road usage

**3) Control Privacy**  
Tongle protects user *privacy* by letting users enable GPS for specific trips

**4) Pay for Trips**  
Tongle allows users to pay for their *fair* share of road usage from their phones

**5) Store Data**  
Tongle allows users to *securely* access their account data from the cloud

**Project by** Shin Young (Lucia) Cho, Molly Fallon, Michael Fernandes, Alex Gilbert

**Sponsored by** Washington State Transportation Commission with support from:   
 • DARTagman Consulting   
 • The Mobility Innovation Center

**WARUC** Bringing our transportation budget up-to-speed with modern vehicles.  
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### PROBLEM

Washington’s transportation infrastructure budget is failing. Gas taxes make up 60% of the budget and, without continued increases, will fall behind due to many drivers switching to hybrid or electric vehicles.

Planning ahead, a more adaptable, usage-based, solution is needed.

### APPROACH

Utilizing modern Bluetooth and OBD-II technology, our application can unobtrusively track and record mileage information, with no privacy or security issues.

Optimized application to minimize impact on battery, cellular usage, and driving experience.

Records mileage on public roads only

Uses a low-energy bluetooth connection to OBD-II to pair your device with the vehicle and receive trip information

Manual and Automatic Tracking

No location data recorded to ensure your privacy and security

Dylan Babbs, Jackson Brown, Jack Fox, Nick Nordale, & Ishani Saksena

Sponsored by WARUC

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What innovations were carried over to the full WA RUC pilot?

**Several features developed through the Smartphone Innovation Challenge will be incorporated into the statewide RUC live pilot test that begins January 2018.** The following approaches and features will be forwarded to the technology companies who will become the RUC Service Providers for possible integration and testing in the live pilot:

Application of Participatory Design principles in the development of a user interface for a RUC

Simple, “no-look” swipe on the smartphone screen to activate or deactivate mileage recording

Toggle on/off location-based mileage recording to ensure out-of-state miles are deducted from a drivers’ RUC account

Border Proximity Detection, where audible sounds remind drivers to activate the out-of-state mileage detection feature as the vehicle approaches a state border

“Contest this Trip” feature that allows drivers to view the mileage of recently completed trips to ensure accuracy, and if not, a feature that allows the driver to mark the trip as “contested,” and enter an explanation from a drop-down menu (for example “wasn’t driving my own vehicle”)

User-friendly “explainer” video with simple animation to help explain RUC, and possibly reduce driver apprehension regarding smartphone apps

Simple, clean design to use the smartphone’s camera to snap photo of the odometer as the primary basis for mileage charges, with out-of-state mileage recorded by the phone’s GPS and then deducted from the total mileage.

## CONCLUSION

**The Smartphone Innovation Challenge** provided an opportunity to develop a smartphone mileage reporting application for a road usage charge system. Given drivers’ concerns about privacy and accurate reporting, the Challenge crowdsourced ideas from student researchers to find innovative solutions that would address these challenges. With the support of Challenge Seattle, CoMotion, and the Mobility Innovation Center, the competition brought together student researchers with support and mentorship to develop valuable contributions to the smartphone mileage reporting option. Many of these innovative features will be incorporated into the WA RUC pilot program, helping to reflect drivers’ preferences and needs as a road usage charge system is tested across the state.

Learn more about the Washington Road Usage Charge Pilot Project:

[waroadusagecharge.org](http://waroadusagecharge.org)

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### About the Mobility Innovation Center

The University of Washington and Challenge Seattle are committed to advancing our region's economy and quality of life by helping to build the transportation system of the future. Together, they have partnered to create a multi-disciplinary Mobility Innovation Center. Housed at CoMotion at the University of Washington, the Center brings together the region's leading expertise from the business, government, and academic sectors to tackle specific transportation challenges, using applied research and experimentation. Cross-sector teams will attack regional mobility problems, develop new technologies, apply system-level thinking, and bring new innovations to our regional transportation system.

### About CoMotion

CoMotion at the University of Washington is the collaborative innovation hub dedicated to expanding the economic and societal impact of the UW community. By developing and connecting to local and global innovation ecosystems, CoMotion helps innovators achieve the greatest impact from their discoveries. We deliver the tools and connections that UW researchers and students need to accelerate the impact of their innovations.

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