



I-95 CORRIDOR COALITION MILEAGE-BASED USER FEE STUDY

Interoperability Between Mileage-Based User Fees and Toll Facilities

This Technical Memorandum (Tech Memo) discusses several mileage-based user fee (MBUF)-related issues as they relate to existing toll facilities, including the potential for interoperability and integration between the two revenue approaches. This memo has been prepared under Task 2.2 (Interoperability with Toll Facilities) of the I-95 Corridor MBUF project funded under the U.S. Department of Transportation (US DOT) Surface Transportation Systems Funding Alternatives (STSFA) grant program. The following sections and information are included in this document:

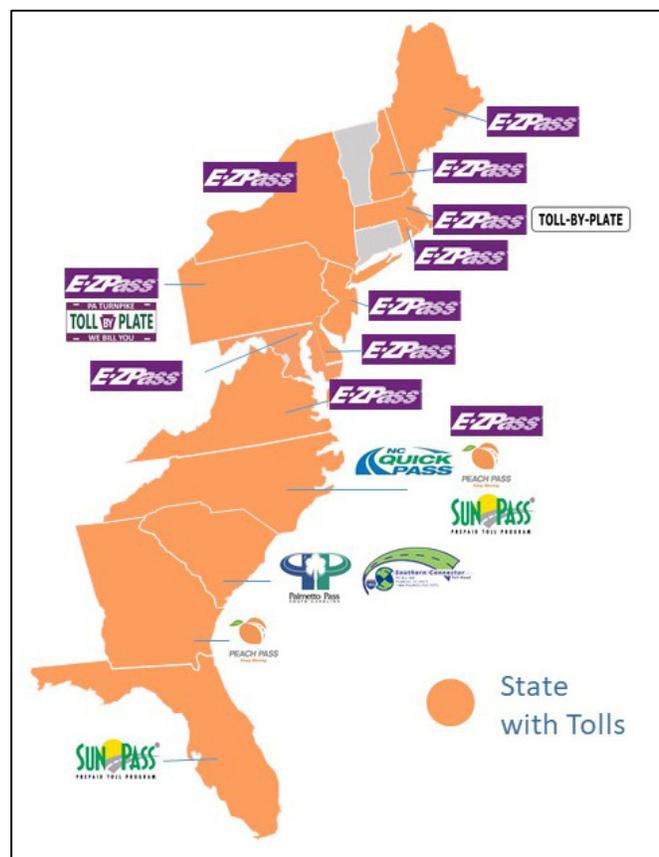
- Background information on existing toll facilities within the I-95 Corridor Coalition states.
- The potential of using MBUF technologies to also record and collect tolls on existing tolled facilities.
- Potential synergies and interoperability between tolling back office operations and MBUF processing.
- The extent to which mileage driven on toll facilities should be subject to MBUF.

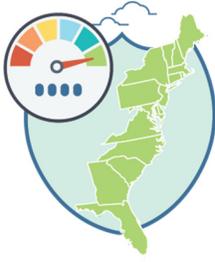
The I-95 Corridor Coalition recognizes that, per the STSFA authorizing legislation, “any revenue collected through a user-based alternative revenue mechanism established using funds provided under this section shall not be considered a toll.” This aspect of the Coalition’s MBUF analysis focuses on the potential of integrating MBUF charges with tolls **on existing toll roads** and facilities within the I-95 Corridor Coalition states. New tolls are not considered in this context.

BACKGROUND

It is difficult to drive far very within the I-95 Corridor Coalition states without paying a toll! All but a few states have toll facilities as shown on Figure 1. The major toll facilities and their mileage within the Corridor Coalition states are identified in Table 1.

Figure 1. Coalition States with Tolls





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Table 1. Major Toll Facilities Within the I-95 Corridor Coalition States

State	Major Tolled Facilities	Tolling Entities	Approx. Miles
Delaware	I-95, SR-1, US 301	Delaware DOT	76
Florida	Florida Turnpike, I-75, several state and county roads	Florida Turnpike, SunPass, Others	745
	Managed Lanes / Express Toll Lanes		40
Georgia	I-75 and I-85 Express Toll Lanes	Peach Pass	55
Maine	I-95	Maine Turnpike Authority	107
Maryland	Tunnels and Bridges (I-95, I-695, I-895, Chesapeake Bay Bridge), MD 200, I-95	Maryland Transportation Authority (MDTA)	27
	I-895 Express Toll Lanes		8
Massachusetts	I-90, Various Bridges and Tunnels in Boston	Massachusetts DOT	145
New Hampshire	I-95, Everett Turnpike, Spaulding Turnpike	New Hampshire DOT	86
New Jersey	NJ Turnpike, Garden State Parkway	NJ Turnpike Authority	190
	Atlantic City Expressway	South Jersey Transportation Authority	44
New York	New York Thruway (I-87), I-95	NYS Thruway Authority	534
North Carolina	Triangle Expressway, US 74 Bypass	NC Quick Pass	36
	I-77 Express Lanes		26
Pennsylvania	Pennsylvania Turnpike (I-76) NE Extension (I-476), Other Extensions	Pennsylvania Turnpike Commission	559
Rhode Island	I-95	Rhode Island DOT	43
	Various Bridges	RI Turnpike and Bridge Authority	3
South Carolina	I-185, US 278	South Carolina DOT	23
Virginia	Dulles Toll Road / Greenway, Chesapeake Expressway, Other	Various (e.g., Washington Airport Authority for Dulles Toll Road)	69
	Express lanes on I-64 (Norfolk), I-66, I-395, and I-495 (Beltway)	Virginia DOT	56
	Chesapeake Bay Bridge Tunnel	CBBT	23



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In addition to the facilities listed in Table 1, there are several bridges and tunnels that cross state lines, such as:

- Port Authority of New York / New Jersey: George Washington Bridge, Lincoln Tunnel, Holland Tunnel, Goethals Bridge, and Outerbridge Crossing connecting New Jersey and New York
- Delaware River and Bay Authority: Delaware Memorial Bridge connecting New Jersey and Delaware
- Delaware River Port Authority: Commodore Barry Bridge, Walt Whitman Bridge, Benjamin Franklin Bridge, and Betsy Ross Bridge connecting Pennsylvania and New Jersey
- And there are others.

The approximately 3,000 miles of toll facilities along the eastern seaboard carry significant amounts of passenger car and commercial vehicle traffic. Therefore, it will be critical to maximize the interoperability and integration of toll roads, bridges, and tunnels with any future MBUF system to the greatest extent possible.

USING MBUF TECHNOLOGIES TO COLLECT TOLLS

One area of potential synergy between tolling and MBUF is using MBUF technologies to also calculate existing tolls and accurately mimic E-ZPass (and SunPass, Peach Pass, and NC Quick Pass) toll collections. This approach is not viewed as MBUF necessarily replacing toll transponders, but rather providing another choice for users, and perhaps reducing the number of toll transactions requiring license plate reading and the associated costs. Such an approach could also result in an integrated invoice for all roadway-related charges, thereby helping to give drivers a clearer picture of the cost of travel.

Investigating this concept came about during the initial face-to-face MBUF Steering Committee Meeting in September 2016. The question was raised if E-ZPass could be used for MBUF. One of the tolling experts on the Steering Committee immediately responded with a resounding “no” – the cost of installing E-ZPass infrastructure (gantries with readers and video enforcement hardware, and the associated communications network) would be cost-prohibitive; *but perhaps MBUF technologies could be used as another alternative approach for collecting tolls*. Thus, began the Phase 1 pilot tolling proof of concept (POC) to examine and test if MBUF technologies could be used in this manner.

The Phase 1 tolling POC occurred in Delaware along the following tolled routes:

- I-95 Barrier Plaza - two-way toll
- Delaware River Memorial Bridge - one-way toll entering Delaware



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- DE SR-1 - toll depends on where you entered and exited, with two-way barrier tolls at the beginning and end of the tolled segment. There are different rates on the weekends for the barrier plazas.

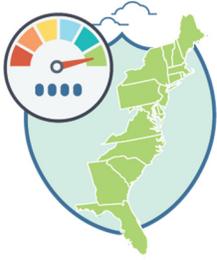
The work included identifying the geo-locations (i.e., global positioning system [GPS] coordinates) of the toll points along these routes, and then placing a “safe zone” around each point. A “safe zone” is one of the value-added amenities offered by Azuga and other account managers. The customer can place a circle of variable diameter around a location on a map. When the vehicle enters and/or exits the safe zone, the owner of the vehicle is automatically notified by email – a feature often used by parents with teenage drivers. The same logic was used to identify when a vehicle entered a toll zone and was therefore subject to a toll.

This approach was further enhanced by increasing the polling rate from once per minute, which works fine for a vehicle that is stopping within the safe zone (such as someone’s house) for a fairly long period of time, to once per second. The increased polling rate was necessary to account for the fact that vehicles seldom stop within a toll zone, and if they do, it is momentary at best to manually pay the toll and/or to wait for a gate to open.

Approximately 10 participants were involved with this proof of concept, which ran from July 1 to August 31, 2018. Copies of their monthly E-ZPass statements for this period were requested. The toll data as collected and processed by Azuga using the plug-in device with location, and it was then compared to the E-ZPass statements.

This initial tolling POC showed that using MBUF location-based technology to also calculate tolls is feasible. For example, the accuracy at the Delaware River Memorial Bridge was nearly 100%. However, the accuracy at the barrier toll plazas on DE SR-1 was only 64%, with the Azuga count always lower than the E-ZPass statements. The reason for these errors is primarily due to a combination of Euclidian geometry and time-space relationships, specifically:

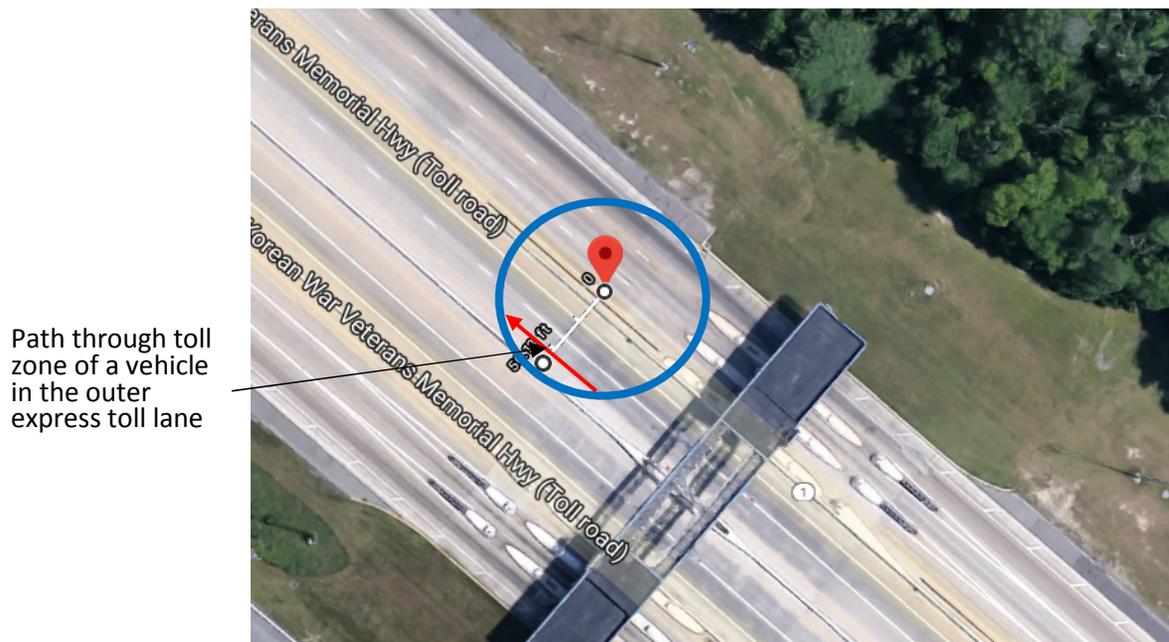
- The toll plaza coming off the Delaware River Memorial Bridge is physically separated from the northbound traffic lanes (which are not tolled). That allowed the zone to go beyond the limits of the roadway. Moreover, E-ZPass-equipped vehicles approaching the plaza must slow down, even at the E-ZPass-only lanes. As a result, most vehicles were captured within the 1-second polling rate.
- The barrier toll plazas on SR 1 – Biddles Corner and Dover – include express toll lanes (i.e., full speed with a speed limit of 65 miles per hour [mph]) for both northbound and southbound traffic. These express lanes, however, are adjacent to one another and separated by only a few feet. A 50-foot radius zone barely extended to the edge of the express toll lanes; and it was not possible to enlarge the zone without extending the zone into the express toll lanes for the opposite direction as shown on Figure 3. Applying a bit of geometry and algebra indicates that the length of the chord running thorough the circular toll zone at the most outer express lane is approximately 55 feet. A vehicle going through



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this outer lane at 100 feet per second (68 mph, and vehicles often drive through these express toll lanes faster speeds than that), will be in the zone for a half of second. At a polling rate of once per second, there is a 45% chance that the passage thorough the zone will not be identified by the MBUF system.

Figure 3: Toll Zone Configuration at NB Dover Toll Plaza on SR-1

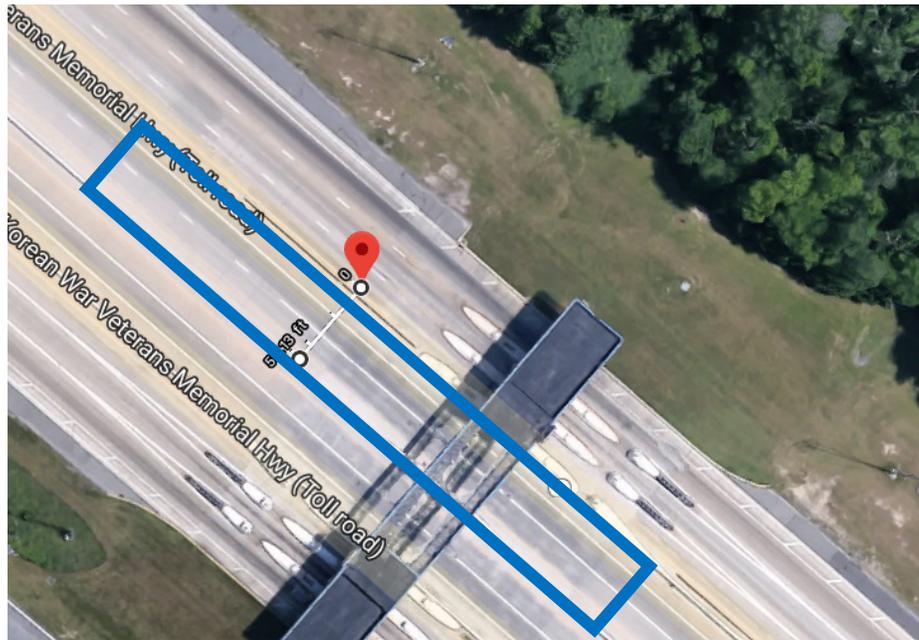


Given that the estimated capture rate (based on toll zone size, location of lanes within the zone, vehicle speed, and polling frequency) generally corresponded to the tolling accuracy at the various plazas in the POC, using MBUF technology to also calculate and charge tolls does appear feasible. It will be necessary to modify the approach, using rectangular tolling zones of variable dimensions – such as shown on Figure 4 for the NB Dover Toll Plaza – thereby increasing the likelihood of a vehicle being in the tolling zone during the polling period. This enhanced approach to defining toll zones will be applied as part of the Phase 2 MBUF Pilot. Additionally, the Phase 2 tolling POC will be expanded to include US 301 in Delaware, and the Pennsylvania Turnpike mainline and Northeast Extension.



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Figure 4: Example Future Toll Zone Configuration at Northbound Dover Toll Plaza on SR-1



Subsequent phases of the Coalition’s MBUF project will further explore this tolling and MBUF interoperability, including:

- Combining tolls for heavy trucks (as measured by in-vehicle mileage reporting hardware as provided by EROAD) with the mileage information that is required for IFTA and IRP.
- The ability of MBUF technology (with location) to differentiate between tolled express lanes and free general-purpose lanes. Many, if not most of, the toll facilities are geographically separated from other roadways by a relatively large distance. This is not always the case for express toll lanes, which typically run parallel to general purpose lanes. Moreover, the separation may be as little as a few feet, such as along I-495 shown on Figure 5. This aspect of the POC will examine the vehicle location tracking accuracy and determine the technical feasibility of differentiating between the two roadway types and charging the appropriate fee. A related POC will be the ability of MBUF to accommodate dynamic tolling (along the Express and high-occupancy traffic [HOT] lanes

Figure 5. Separation Between Express Lanes and General-Purpose Lanes: I-495





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on I-495 and I-95) where tolls can change as frequently as once every 10 minutes¹. This requires a link between the MBUF system and the toll system.

INTEROPERABILITY WITH ACCOUNT MANAGEMENT ACTIVITIES

MBUF account management and administration encompasses several activities, including:

- Setting up accounts
- Transaction processing (i.e., transforming the transmitted vehicle data into a per-mile charge through calculating and applying the appropriate fee per mile and any applicable fuel tax credits)
- Issuing invoices and statements
- Receiving payments
- Compliance and enforcement
- Managing accounts receivables
- Using location data as available to allocate MBUF by state
- Providing customer service activities
- Supporting audit activities

Similar activities are also performed as part of tolling back office processing. MBUF pilots have numbered less than 10,000 total vehicles over the past 6 years, with Oregon being the only state actually collecting MBUF funds (and only for about 900 vehicles at any one time). Tolling account management activities encompass millions of vehicles and billions of dollars. For example, the E-ZPass Group operates the largest toll interoperability network in the world, with more than 35 million toll transponders in use, collecting over \$12 billion in annual toll revenues of which more than \$9.8 billion is collected electronically and over \$4 billion transferred between agencies through toll reciprocity programs.

Given this experience, using the tolling back offices to perform these account management activities for MBUF in a multi-state mandated system could provide synergy and significant economies of scale. Because almost none of the existing tolling providers and concessionaires (e.g. Transurban, Transcore, Kapsch, Electronic Transaction Consultants, Cubic, emovis²) offer MBUF technologies or approaches, they would likely need to partner with or acquire one of the

¹ Express Lanes tolls can range from as low as \$0.20 per mile during less busy times, and up to approximately \$1.00 in some sections during rush hour. The tolls may rise significantly over the \$1.00 per mile for periods of time during unusually heavy congestion or a specific event like a lane(s) closure or severe weather.

² emovis does provide both tolling and MBUF services.

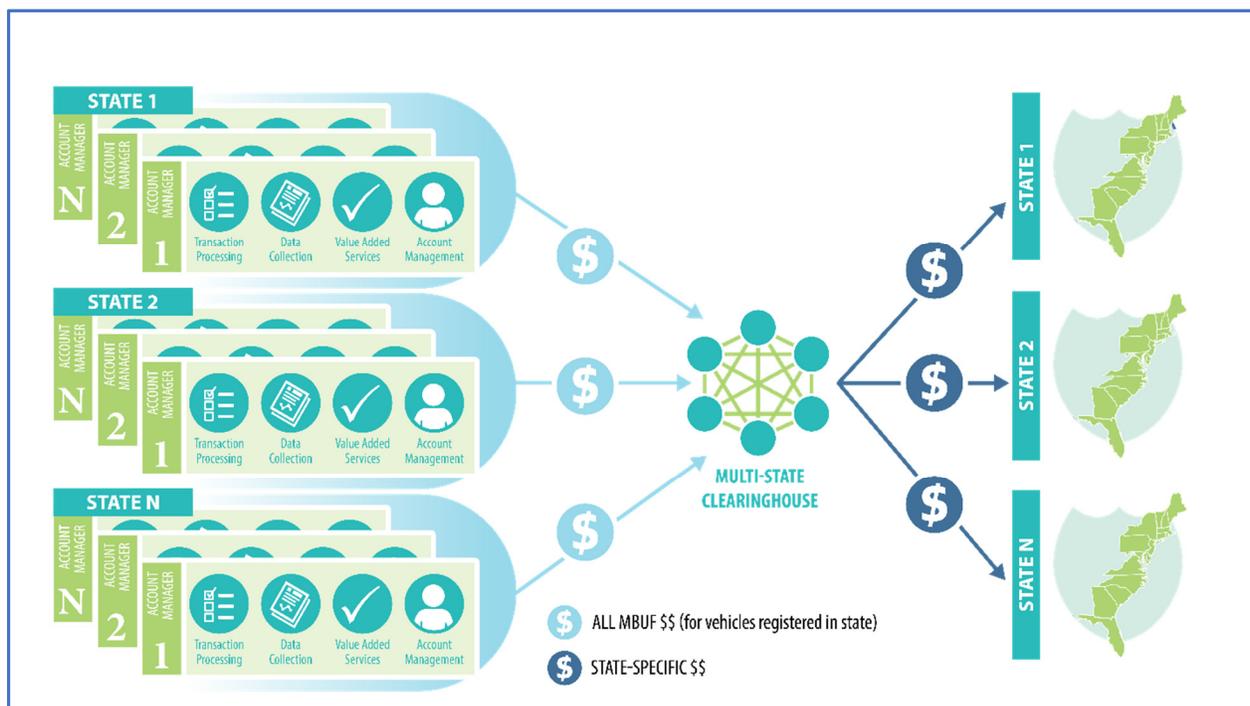


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firms providing MBUF technologies and account management services (for both passenger vehicles and commercial trucks). It would not be surprising to see one or more of the tolling companies become more interested in MBUF in the next few years, particularly if it appears that MBUF will become the primary means for financing the nation's transportation network.

Another consideration in this regard is the potential need for a multi-state clearinghouse. To effectively manage the distribution of MBUF revenues between states, based on out-of-state mileage and, possibly, where and how much fuel was purchased. It is envisioned that this clearinghouse would receive funds from account managers and redistribute funds between states such that each agency receives the net revenues it is owed (not unlike IFTA does for heavy trucks). Figure 6 shows such a multi-state MBUF architecture. The multi-state clearinghouse could also perform account manager certification and auditing functions on behalf of the states. Some sort of cooperative agreement would also need to be developed between the states to address the operation and funding of the multi-state clearinghouse.

Figure 6. Regional Clearinghouse Focused with Different Set of Account Managers for each State



The E-ZPass Group and the International Bridge, Tunnel, and Turnpike Association (IBTTA) are both investigating similar clearinghouse-type functions for tolling. The opportunity to combine tolling and MBUF clearinghouse functions warrants further investigation.



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CHARGING MBUF ON TOLL FACILITIES

Another tolling-related consideration identified during the Phase 1 Project centers on whether MBUF should be charged on toll facilities. There are two opposing arguments to this question, both voiced by different members of the tolling community during interviews:

- **“No”** – drivers are already paying a fee – the toll – for using these facilities, with the toll typically correlated with the number of miles driven on the toll road. Charging an additional per mile fee (through MBUF) for travel on these facilities is a form of “double taxation.” Moreover, the MBUF collected for toll road use would go to the state; not the toll agency.
- **“Yes”** – drivers of vehicles with internal combustion or diesel engines are already paying gas taxes for their mileage driven on a toll facility. Consider a vehicle that gets 20 miles per gallon (mpg) driving 50 miles on a toll facility. The vehicle will use 2.5 gallons of fuel, for which it paid the state and federal gas tax when it last filled up. Moreover, when drivers fill up at a service plaza located on a toll road (e.g., I-95 in Delaware, Pennsylvania Turnpike, New Jersey Turnpike), the state gas tax paid at these plazas generally goes to the state, not the toll facility.

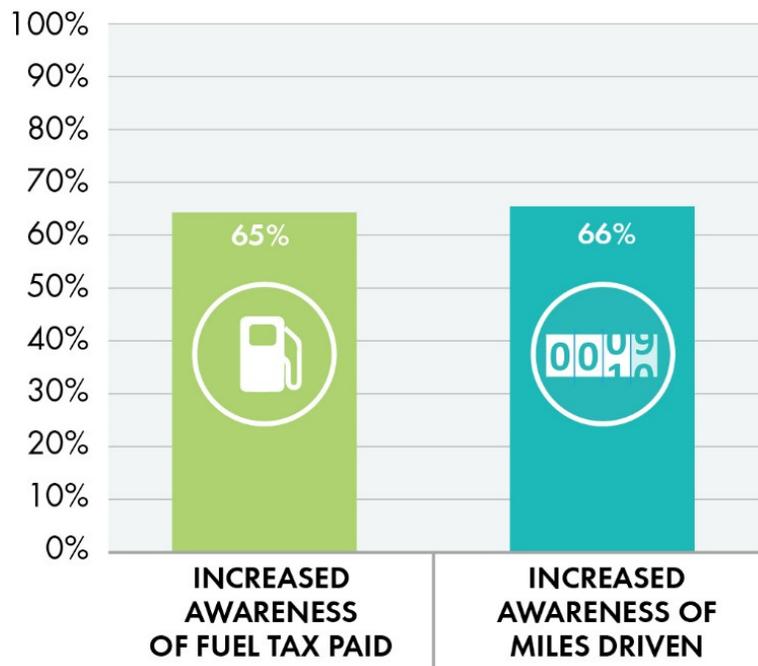
One potential drawback with the “yes” argument may be that many drivers have not fully made the connection between paying gas taxes and then using that fuel on a toll facility. With the MBUF approach, this connection between being charged the toll plus an additional per-mile fee is more direct and obvious. As an example, the Phase 1 Pilot participants also had an increased awareness of how much they pay in state fuel taxes. As shown in Figure 7, 65% of participants had a high level of agreement that after the pilot they were more aware of the amount they pay in state fuel taxes to maintain and operate the roads, and 66% agreed the pilot increased their awareness of how much they drive. Increased awareness may also impact the ability to charge MBUF on toll facilities.

Identifying if a vehicle is driving on a toll facility requires MBUF technology with location capability. One possible approach to this future dilemma is to charge a reduced per-mile rate for travel on toll facilities. This discount could only be provided to drivers with a location-based MBUF approach, thereby providing an incentive to choose location-based technology, which in turn would provide more complete data on the levels of out-of-state mileage.



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Figure 7. Participant Survey Results of Increased Awareness of Taxes Paid and Miles Driven



Note: Chart shows ratings of 4 or higher with scale of 1 (strongly disagree) to 5 (strongly agree)