Commission Briefing Paper 5A-07

Evaluation of VMT Charges as a Transportation Revenue Source

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Introduction

This paper is part of a series of briefing papers to be prepared for the National Surface Transportation Policy and Revenue Study Commission authorized in Section 1909 of SAFETEA-LU. The papers are intended to synthesize the state-of-the-practice consensus on the issues that are relevant to the Commission's charge outlined in Section 1909, and will serve as background material in developing the analyses to be presented in the final report of the Commission.

This paper presents information on the concept of direct tolling based on the number of vehicle miles traveled (VMT tolling), an idea that has gained increasing attention as a potential replacement for state and federal motor fuel taxes. While motor fuel taxes have been a major source of revenues for highway maintenance and construction since the early 1900s, the fact that they are commonly levied on a per-gallon basis means that periodic tax hikes are required to offset the combined effects of inflation and improved fuel economy. The idea of increasing taxes has become increasingly unpopular in recent decades, however, and fuel tax revenues – measured in real dollars per mile of travel – have been allowed to wither at the federal level and in most states. This trend has stimulated significant interest in VMT tolling, a revenue instrument that could in principal overcome many of the challenges facing fuel taxes. The basic idea behind VMT tolling is to outfit vehicles with equipment capable of tracking the number of miles traveled by jurisdiction (e.g., by state). Fees would then be collected on a per-mile basis, and the revenues would be distributed among jurisdictions based on the amount of travel in each. A key rationale for VMT tolling is that the amount of revenues collected would not depend on the fuel economy of the vehicle. For that matter, it would also remain effective even as new alternative-fuel vehicles are introduced. Inflation would still be an issue, although the per-mile fees could certainly be indexed to increase with inflation. Another potential benefit of VMT tolling is that the required onboard equipment would enable other forms of pricing that could help combat congestion, pollution, or excessive road wear. For example, the per-mile charges could vary by time of day, by the emissions class of the vehicle, or by the axle load for heavy trucks. Such precisely targeted user fees would not be possible with traditional motor fuel taxes, even if they were to be raised considerably.

Background and Key Findings

To date, VMT tolling has been studied in several locations, but has not yet been implemented on a system-wide basis. While the prospect of VMT tolling is in many ways extremely promising, there are significant obstacles to consider as well. These have important implications for the short-term, medium-term, and long-term prospects for VMT tolling.

Key Advantages

- **Significant revenue potential:** The revenue potential for VMT tolling is limited only by political considerations. Per-mile fees could be structured as a revenue-neutral replacement for motor fuel taxes, or they could be set to increase total revenues.
- **Revenue stability:** VMT tolling revenues would be relatively stable, varying only with total vehicle travel. Because demands for road maintenance and expansion also vary with total vehicle travel, this characteristic should be acceptable.
- **Cost distribution equity:** VMT tolling represents a direct user fee. Much like the gas tax, though with greater precision, VMT tolling would charge drivers in direct proportion to their use of the road system. This can be considered far more equitable than non-user fee finance mechanisms such as local-option sales taxes, in which there is no relationship between taxation and the use of the system.
- **Revenue distribution equity:** VMT tolling would measure the amount of travel that occurs in different jurisdictions and distribute the revenues accordingly. This marks an improvement over the system of motor fuel taxes, in which vehicles (especially long-haul trucks) can fuel up in states with lower fuel taxes before driving through states with higher fuel taxes.
- **Economic efficiency:** As a user fee, VMT tolling would send a price signal encouraging drivers to ration their travel behavior, thus promoting economic efficiency. If VMT tolling technology were used to implement additional forms of pricing – such as per-mile fee increases for travel during congested periods – the economic efficiency of the system could be increased to an even greater extent.
- **Proven technology:** VMT tolling technology – including onboard computers equipped with global positioning system (GPS) receivers, digital maps, and some form of wireless communications – has been proven in pilot tests within the United States as well as in automated weight-distance truck tolls in Europe.

Potential Obstacles

- **Inflation:** VMT tolling is not inherently responsive to inflation. To combat the effects of inflation, it would be necessary to either index the per-mile fees from the outset or to institute periodic rate hikes through legislative action. This is similar to the challenge that confronts motor fuel taxes.
- **Capital expense:** VMT tolling would require a significant social investment. The required onboard equipment would likely cost around $100 per vehicle, and there would need to be additional investment in the information systems required to collect and distribute revenues. Once this initial investment is made, however, automation should make it possible to operate VMT tolling with a high level of cost-efficiency.
- **Evasion concerns:** It seems likely that some individuals with a high level of technical skills would seek ways to "hack" components of a VMT tolling system so as to evade tolls. While this problem is not insurmountable, it certainly requires careful attention.
- **Institutional framework:** The appropriate institutional framework for implementing VMT tolling is unclear. If VMT tolling were to be implemented at the state or national level, then an existing state or federal agency could in principle assume responsibility for the program. On the other hand, if a small collection of states – but not the whole country – were to implement VMT tolling, then it would be necessary to create a new institution for collecting and distributing revenues among the participating states.

- **Program phase-in:** With the high cost of retrofitting existing vehicles with VMT tolling equipment, it is likely that such a program would need to be phased in over time. New cars could be purchased with the required equipment already installed and would then be subject to VMT tolling, whereas older cars could continue to pay traditional fuel taxes until they are retired from the fleet. This phase in period, during which two revenue systems would need to be operated in parallel, would likely last around 20 years.
- **Popular objections:** Privacy advocates may be concerned that the necessary onboard equipment for implementing VMT tolling could be used by the government to monitor the travel patterns of individuals. Environmentalists, in turn, may be worried that replacing the per-gallon levy on motor fuels with a flat per-mile tax on all passenger cars would eliminate one of the few tax-related incentives for purchasing more fuel-efficient vehicles. While both of these objections can be addressed through technical and pricing strategies, it will take some educational effort to overcome these reasonable concerns.

Motivation for VMT Tolling

Motor fuel taxes offer two key benefits as a revenue source for highway maintenance and construction. First, they are relatively cheap and easy to collect. Second, they act as a user fee – charging travelers in rough proportion to their use of the road network – and this fosters both equity and economic efficiency (Sorensen and Taylor 2005a; Wachs 2003). Because of these advantages, motor fuel taxes have served as a principal source of transportation revenues in the U.S. for much of the past century. In 1919, Oregon became the first state to implement motor fuel taxes, and all other states followed suit within a decade. Federal taxes on gasoline were first introduced with the Revenue Act of 1932, although the proceeds were initially treated as general revenues. In 1956, the Federal-Aid Highway Act established the Highway Trust Fund and stipulated that 100 percent of the gas tax revenues be channeled into this fund. Beginning with the Surface Transportation Act of 1982, a small share of federal fuel tax revenues have been earmarked for transit projects. Even with this shift, however, motor fuel taxes remain the dominant revenue source for highway maintenance and construction in the U.S.

Despite their inherent advantages, however, fuel taxes are burdened with structural and political liabilities that may limit their continued effectiveness as a highway revenue source. Because they are typically charged on a per-gallon basis, fuel tax revenues – expressed as real dollars per vehicle mile of travel – are subject to erosion in the face of inflation and improved fuel economy. While this erosion can in principle be counteracted through periodic increases in per-gallon levies, political sentiment has in recent decades grown increasingly hostile to tax increases in any form. As a result, fuel tax hikes no longer keep pace with inflation and fuel economy, and the ability to raise sufficient highway revenues through fuel taxes has been compromised. In future years, this problem may be further compounded by the rise in popularity of fuel efficient vehicles such as hybrids as well as the potential for wider adoption of alternative fuel vehicles.

Faced with declining federal and state fuel tax revenues, many local governments across the country have instituted stop-gap finance strategies such as general obligation bonds and local-option sales tax measures to pay for needed road improvements (Goldman and Wachs 2003). Though politically feasible, such mechanisms break the link between the use of the system and the amount of taxes paid, thereby reducing both equity and efficiency in transportation finance.

In stark contrast to this gradual drift away from user fees, recent technology innovations – such as GPS and wireless communications – have stimulated proposals for the introduction of VMT tolling as a long-term replacement for the gas tax. In addition to overcoming the structural and political liabilities of motor fuel taxes, VMT tolling would also breathe new life into the user-fee principle around which transportation finance in the U.S. has traditionally centered.

Technical Approach to VMT Tolling

The basic idea behind VMT tolling is to measure the amount of mileage driven by each vehicle in different jurisdictions. Per-mile usage fees would then be assessed, and the resulting revenue would be divided proportionally among the jurisdictions in which travel took place. Although VMT tolling for passenger vehicles has yet to be implemented at a broad scale, there have been several important studies addressing their technical feasibility (e.g., Forkenbrock and Kuhl 2002, Whitty 2003). Implementation details vary from one proposal to the next, but the basic technical strategy works as follows. To measure and record road use, each car must be equipped with an onboard unit integrating a GPS receiver, a set of digital maps with jurisdictional boundaries, an odometer feed, a rate table for computing distance charges, and wireless communications technology for reporting billing data. During each trip, the computer repeatedly checks the GPS receiver to determine geographic coordinates, then compares this information with digital maps to establish the current jurisdiction. Each mile traveled (based on the odometer feed) is then sorted and stored by jurisdiction, and the computer uses this information, along with the rate table, to keep a running total of fees owed to different authorities (for example, different states or different counties within states). Periodically, the recorded road use information is transmitted to a billing agency so that charges can be levied and fees paid. This could occur via dedicated short-range communications when the driver refuels, in which case the fees could be simply added to the fuel bill. Alternatively, data could be uploaded to the billing agency via cellular communications on a periodic basis, and the vehicle owner would then be billed electronically.

To prevent toll evasion, the onboard equipment must be resistant to tampering. For example, the onboard units might be programmed to perform regular checks against the odometer to ensure that the metering equipment had not been disabled during any period of operation. Jurisdictions might also choose to mount roadside devices that can communicate with passing cars to verify that onboard units are installed and operational. Automated billing systems to support VMT tolling would likewise need to be secure.

As one might gather from the foregoing discussion, the implementation of VMT tolling would require considerable social investment. To begin with, each car would need to be outfitted with the required onboard equipment. This equipment may cost on the order of $100 per vehicle, though the required technology is becoming cheaper with time. In addition, it would also be necessary to implement a range of supporting information technology infrastructure – such as data collection and automated billing systems – that would facilitate the operations of VMT tolling. All told, capital outlays for implementing VMT tolling at the national level would likely total in the range of tens of billions of dollars. On the other hand, once all of the requisite systems are in place, much of the processing would be automated, such that the long term cost-efficiency of operating VMT tolling could be high.

Experience with VMT Tolling

While certainly ambitious from a technical perspective, VMT tolling would also represent a significant evolution in the mechanisms of transportation finance. It is perhaps not surprising, then, that general-purpose VMT tolling has yet to be implemented on a broad basis. On the other hand, the potential advantages of VMT tolling have stimulated considerable research attention and early experimentation by various jurisdictions and institutions. In the U.S., detailed feasibility analyses and pilot studies have been conducted by the University of Iowa, the Oregon Department of Transportation, and the Puget Sound Regional Council. Comparable efforts have also been undertaken in Europe, including studies in the Netherlands, in the cities of Copenhagen, Gothenburg, Helsinki, and Newcastle, and by the European Space Agency. In addition, several European nations, including Austria, Germany, and Switzerland, have recently implemented automated weight-distance truck tolling programs. Among these, the German TollCollect system utilizes onboard technology similar to that required for general-purpose VMT tolling, thus proving the technical feasibility of the concept. This section provides a brief introduction to the studies in Iowa, Oregon, and Puget Sound; a comprehensive review of other studies can be found in Sorensen and Taylor (2005b).

University of Iowa Study: Researchers at the University of Iowa, with pooled funding from fifteen state departments of transportation and the Federal Highway Administration, have developed a proposal for a VMT tolling system operating across multiple jurisdictions that would serve as a long-term replacement to fuels taxes for automobiles and trucks. In its simplest form, the proposed fee structure for automobiles would be based on the number of miles driven in each state, while for trucks it would be based on the number of miles driven by road class by state. At their discretion, individual jurisdictions could also choose to include additional fee criteria, such as congestion tolls, per-mile charges based on emissions class, and per-mile adjustments based on weight and axle configuration (for trucks). The initial feasibility study was completed and published in 2002, and efforts to develop a field trial are ongoing.

Oregon Department of Transportation Study: Under a mandate from the State Legislature, the Oregon Department of Transportation organized a Road User Fee Taskforce to conduct a pilot study of mileage-based user fees and area-wide congestion tolls, facilitated by on-board units featuring GPS receivers and short wave radio communications. The technology platform was successfully demonstrated in May of 2004, and a pre-pilot test involving 20 vehicles equipped with the onboard metering units was performed in the fall of 2005. The full pilot test, which includes 260 vehicles in the Portland area, was launched in the spring of 2006 and will continue until the spring of 2007. Within the pilot test design, one portion of the study group will pay distance charges only, while the remainder will pay both mileage fees (albeit at a reduced rate) as well as congestion tolls. To compensate for these fees, all participants will receive rebates on the standard fuels tax at the time of purchase. Depending on the results of the study, legislation to enact the mileage fee (and potentially introduce congestion tolls) on a statewide basis may be considered as early as 2009. Further details about the Oregon study are provided by Whitty (2003) and can also be found on the Oregon Road User Fee Pilot Program web site (http://www.oregon.gov/ODOT/HWY/RUFPP/mileage.shtml).

Puget Sound Regional Council Study: The PSRC recently conducted an ambitious test of area-wide congestion tolls covering all freeways and most major arterials in the greater Seattle

region. The study ran from July of 2005 through February of 2006 and included 400 volunteers. Vehicles were equipped with onboard units featuring GPS receivers, digital roadmaps, and cellular communications. Virtual congestion charges – based on prevailing congestion levels – were established for each link within the tolled network at different times of day, and each study participant was allotted a "travel budget" account with enough money to pay the congestion tolls for his or her expected travel patterns. During the course of the study, the onboard unit was used to detect travel on links subject to congestion tolls, and the corresponding charges were then subtracted from the pre-allotted travel budget. At the end of the study, participants were allowed to keep any remaining balance from their initial allocation, thus providing motivation to alter travel behavior so as to reduce congestion charges (in addition, each volunteer was paid $150 for their participation in the study). While findings from the study have not yet been released, additional details can be found on the PSRC "travel choices" study website (http://www.psrc.org/projects/trafficchoices/index.htm).

Revenue Implications for VMT Tolling

Because VMT tolling offers the opportunity to charge for every mile driven by every vehicle on every road, its potential for generating revenue is limited only by political considerations. Depending on the per-mile levy, VMT tolling could be structured as a revenue-neutral replacement for motor fuel taxes, or alternatively the fees could be set to enhance total revenues. For example, the federal gas tax is currently set at 18.4 cents per gallon, while the average fuel economy of the nation's existing passenger vehicle fleet hovers around 22 miles per gallon. This suggests that a per-mile fee of around 0.84 cents per mile would generate sufficient revenue to replace the existing federal fuel tax. If a higher per-mile fee were levied, total revenues would obviously be increased.

In addition to a flat mileage charge, various researchers investigating VMT tolling (e.g., Forkenbrock and Kuhl 2002; Whitty 2003) have also discussed the possibility of layering on additional per-mile charges for travel during congested periods or for highly polluting vehicles. If instituted, such add-on charges could be used either to augment total revenues or to lower the base per-mile charge without decreasing total revenues.

A compelling advantage of VMT tolling is that the revenue stream is not inherently dependent on the fuel economy of the vehicle. In contrast, motor fuel taxes grow weaker with improved fuel economy, necessitating periodic rate hikes that have become increasingly unpopular in recent decades. At the same time, VMT tolling functions effectively regardless of fuel type, whereas current motor fuel taxes are not well-equipped to handle rapidly developing alternatives such as battery-electric, bio-fuels, or hydrogen. Another benefit of VMT tolling is that the revenue stream is fairly stable, varying only with the number of miles driven by the population. Because the demand for road maintenance and new construction also varies with aggregate miles driven, the supply and demand for highway revenues should track one another fairly well.

One drawback of VMT tolling is that, similar to motor fuel taxes, it is not immune to inflationary erosion. This problem could certainly be overcome by indexing the per-mile charges based on an appropriate measure of inflation. That said, the difficulties with motor fuel taxes could also be largely overcome through indexing, yet to date that idea has received little political support.

One must wonder, then, whether the idea of indexing would prove more feasible with VMT tolling than it has with traditional motor fuel taxes.

Policy Issues for VMT Tolling

Policy debates on matters of taxation often focus on the question of equity, yet equity can be defined in different ways. One common approach is to consider the relative regressivity or progressivity of the tax burden among different income groups. Although lower income families travel less on average than higher income families, their transportation budgets typically constitute a higher percentage of their income. From this perspective, VMT tolling would be viewed as regressive. On the other hand, other popular transportation finance mechanisms such as motor fuel taxes and sales taxes are also regressive, so VMT tolling is not appreciably worse than its alternatives in this regard.

By other measures of equity, VMT tolling excels. For example, with VMT tolling, the amount of taxes paid varies directly with the amount one travels. In other words, the costs incurred are directly proportional to the benefits received. While this is true of other user fees such as motor fuel taxes, it is certainly not the case for non-user fees such as local-option sales taxes. At the same time, VMT tolling facilitates equitable geographic distribution of revenues, in that the amount of revenue received by each jurisdiction depends on the number of vehicle miles traveled through that jurisdiction. This overcomes a problem with traditional fuel taxes in which vehicles – especially long-haul trucks – can fill up in states with cheaper fuel taxes and then travel through other states with higher fuel taxes without contributing their fair share to the cost of highway maintenance. In fact, this very issue has prompted the United Kingdom, a country with some of the highest fuel tax levies in Europe, to begin planning an automated weight-distance charge for trucks similar to programs in Austria, Switzerland, and Germany (Worsley 2004).

Another important benefit of VMT tolling is the promotion of economic efficiency. Because the tax burden increases with total travel, drivers are faced with a price signal that encourages them to ration their least valued trips, thus reducing aggregate travel and improving system-wide efficiency. This is also true of motor fuel taxes, but the same does not hold for general revenue instruments such as sales taxes or general obligation bonds.

While proposals for VMT tolling are clearly motivated by the desire to find a stable long-term replacement for the ailing system of motor fuel taxes, many analysts and policymakers are equally enthused by other forms of pricing that would be enabled by the underlying technology. For example, to combat congestion, the per-mile fees could be increased in crowded urban areas during peak hours of travel, an idea that is being explored in both the Oregon and the Puget Sound trial projects. To reduce the environmental externalities associated with automotive travel, additional per-mile fees could be charged for higher emission vehicles, thus sending a price signal to encourage drivers to purchase more environmentally benign vehicles. In fact, this idea has already been implemented in the German TollCollect program (Rothengatter and Doll 2002). Finally, to reduce damages to local roads, trucks could be charged a higher fee for travel on lightly engineered surface streets than for travel on heavily engineered highway links. In each of these cases, the marginal cost of implementing additional forms of pricing based upon VMT tolling technology would be relatively small; the political feasibility of such forms of pricing, on the other hand, remains unclear.

Institutional Issues for VMT Tolling

Procuring, operating, and administering a system of VMT tolling represents a challenging set of tasks, and the appropriate institutional framework within which to organize these tasks remains unclear. If VMT tolling were organized at the level of a single state or for the nation as a whole, then it is likely that an existing state or federal agency could assume responsibility for such a program. On the other hand, if a limited set of states decided to pursue VMT tolling as a group, it would be necessary to establish some sort of multi-jurisdictional organization to collect revenues and distribute them equitably among the participating states.

Another institutional challenge relates to the question of system phase-in. The cost of the in-vehicle technology required for VMT tolling – including an onboard computer, a GPS receiver, wireless communications, and the like – is non-trivial, and it is likely to be more expensive to retrofit existing vehicles than to install the equipment in new vehicles (Whitty 2003). For this reason, most VMT tolling proposals envision that the charging system would be phased in over time. From the inception of the program, new cars would come equipped with the required onboard technology and begin paying road use charges on a per-mile basis. Older vehicles, in contrast, would continue to pay traditional fuel taxes until they were retired from the fleet. For this reason, it would be necessary to operate two revenue instruments in parallel for a period of perhaps 20 years before the entire fleet was equipped with the required onboard technology (Forkenbrock and Kuhl 2002; Whitty 2003). Operating dual transportation revenue mechanisms is not necessarily problematic – for instance, some toll road users pay manually while others use transponders and are billed on a monthly basis – but it does increase administrative complexity.

A final institutional consideration pertains to the collection of revenue. Federal and state motor fuel excise taxes are collected at a relatively small number of fuel distributors within each state, which greatly simplifies the collections process. In contrast, VMT tolls might be collected at retail fueling stations (as in the Oregon pilot program) or alternatively from each individual user (as envisioned in the University of Iowa study). Although there are strategies for accomplishing these tasks, either of these scenarios would significantly increase the administrative burden of revenue collection.

Political Issues for VMT Tolling

As currently envisioned, VMT tolling proposals face at least two popular concerns that may, if not addressed, limit their political feasibility. First, many privacy advocates are concerned that the onboard equipment required for VMT tolling would enable the government to track drivers without their consent. Second, many environmental proponents worry that distance-based pricing schemes would take the form of flat mileage fees, accounting for neither fuel economy nor emissions. Replacing the existing fuel tax with such a flat fee would effectively eliminate one of the few tax-related policy incentives for purchasing more efficient vehicles. The potential potency of such arguments was illustrated in a public exchange that occurred in 2004 when the new California Department of Motor Vehicles chief suggested that the state must eventually consider a mileage-based fee. Responding to this idea in a letter to her constituents, then-Assemblywoman Fran Pavley, a politician known for her progressive stance on environmental issues, argued: "People who drive fuel-efficient, less polluting cars would have exactly the same tax burden as people driving huge gas guzzlers… Allowing the government to track Californians' movements everywhere they drive is a totally unacceptable Big Brother type intrusion…

Invading our privacy and providing a disincentive for people to drive clean-air vehicles would be a terrible U-turn in public policy. This one belongs in the scrap heap."

Yet when one digs deeper into the details of VMT tolling proposals, it becomes evident that both privacy and environmental concerns can be addressed through appropriate technical and programmatic design. In both the Oregon and the University of Iowa studies, for example, researchers have designed ingenious methods to protect user privacy (Forkenbrock and Kuhl 2002; Whitty 2003). In the Iowa example, drivers would periodically download billing data from the onboard unit onto a smart card, then upload the data to the billing agency via a card reader at a filling station or on a home computer. The transfer process would be divided into two transactions. The first would upload user identification and total amount owed. Then a second, anonymous connection would report the division of the bill to different jurisdictions. The revenues would thus be distributed appropriately, but the government would never know *where* or *when* any individual had traveled, only the total amount owed (Forkenbrock and Kuhl 2002).

To address environmental concerns, mileage-based tolls could easily be set to vary by vehicle-emissions class. As already noted, this approach has been employed in the German weight-distance truck-toll system, where the distance charge is fifty percent higher for the most polluting vehicles than for the least polluting ones within a given weight class (Rothengatter and Doll 2002). Such adjustments could certainly be applied to passenger vehicles as well as trucks.

It is, in a certain sense, ironic that many environmentalists resist the idea of developing the technical apparatus necessary to levy mileage fees. After all, many transportation analysts are intrigued by electronic tolling precisely *because* it permits variable charges to reflect the numerous costs – congestion delays, damage to road beds, vehicle emissions, etc. – that users impose on the system and on society. This point, however, gives rise to another set of political considerations. If VMT tolling is merely used to implement flat per-mile fees, the distribution of costs among alternate stakeholder groups will remain largely unchanged. On the other hand, if the technology is used to implement additional forms of marginal cost pricing – such as congestion tolls, axle-weight fees for trucks, or emissions penalties – then the relative burden of paying for roads could shift considerably. This would certainly intensify the political debate, with those who would be worse off under the new system lobbying fiercely against the new forms of pricing.

Conclusions

Given the significant capital costs for implementing VMT tolling, it is difficult to conceive that such a program could be put in place in the short term. However, the necessary equipment is becoming cheaper over time, and many of the required components – such as GPS receivers and onboard computers – may soon come standard with most new vehicles. If popular opposition to fuel tax increases persists, a switch to VMT tolling over the mid- to long-term, despite its costs, should be given serious consideration by transportation policymakers (in the shorter term, continued research and field trials may help to set the stage for such a shift). The logical alternative – increased reliance on non-user fees such as local-option sales taxes – will slowly but surely erode the equity and efficiency of transportation finance in the United States.

References

Forkenbrock, D., and J. Kuhl, 2002. *A New Approach to Assessing Road User Charges*. Iowa City, IA: Public Policy Center, University of Iowa.

Goldman, T., and M. Wachs, 2003. A quiet revolution in transportation finance: The rise of local option transportation taxes. *Transportation Quarterly, 57*(1): 19-32.

Rothengatter, W., & Doll, C. (2002). Design of a user charge for heavy-duty vehicles on German motorways considering the objectives of efficiency, fairness, and environmental protection: Findings from the EU research project desire. *IATSS Research*, 26(1), 6-16.

Sorensen, P. and B. Taylor, 2005a. Paying for roads: New technology for an old dilemma. *Access*, 6: 2-9.

Sorensen, P. and B. Taylor, 2005b. *Review and Synthesis of Road-Use Metering and Charging Systems.* Submitted to the Committee for the Study of the Long-Term Viability of Fuel Taxes for Transportation Finance, Transportation Research Board. Washington, DC: The National Academies.

Wachs, M., 2003. Improving efficiency and equity in transportation finance. *The Brookings Institution Series on Transportation Reform*. Washington, DC: The Brookings Institution.

Whitty, J., 2003. *Road User Fee Task Force: Report to the 72nd Oregon Legislative Assembly On the Possible Alternatives to the Current System of Taxing Highway Use Through Motor Vehicle Fuel Taxes*. Salem: Oregon Department of Transportation.

Worsley, T., 2004. Preparation for a distance charge in the United Kingdom. In: *Managing Transport Demand through User Charges: Experience to Date*. European Conference of Ministers of Transport, London, January 23.

CONSOLIDATED COMMENTS FROM MEMBERS OF THE BLUE RIBBON PANEL OF TRANSPORTATION EXPERTS on PAPER 5A-07

Several reviewers combined their comments as follows:

This paper provides an excellent high-level overview of the policy issues that will need to be addressed if VMT charging systems were to be advanced as a major source of transportation revenue, or as a possible replacement to today's motor fuels tax. The paper points to the fact that technological approaches have been proven to function successfully in the U.S. and Europe, and highlights the advantages of VMT charging having significant and stable revenue potential, a promise for equitable distribution of costs and revenues, and the possibility of greater economic efficiency than today's transportation revenue streams. The paper does not mention that VMT charging systems may serve broader long-term national policy objectives in terms of favorable energy policy by uncoupling highway revenues from sales of petroleum fuels, as well as constructive steps in foreign policy by reducing U.S. dependence on foreign oil.

The paper identifies a number of well-founded obstacles to advancing VMT charging as a bonafide revenue system. Given that the paper captures the general nature of these issues so effectively, it would be valuable to discuss each in a bit more detail. In particular:

- Expenses – The expense of a VMT charging system is largely captured as the initial capital investment for on-board units in vehicles and information systems to collect and distribute revenues. The expense equation will also need to include customer service and enforcement aspects, that are given less attention as expense concerns, but will certainly be a major expense consideration, especially during a transition period from gas taxes to VMT charging. The current Oregon DOT VMT pilot test released some preliminary research findings that indicated that customer service needs were among some of the most pressing concerns from the demonstration project's participants. (See Ruffalo, TRB paper 07-1024, "Oregon's Road User Fee Pilot Project: Report On Start-Up.") It seems that looking toward electronic toll collection customer service centers, back office and information system costs could provide a valuable indication of the types of costs that multi-state VMT charging models might incur.

- Program Implementation and Transition – While much attention has been given to the technological aspects of VMT charging systems, there appears to be far less in the literature about implementation and transition hurdles. Knowing the difficulties that the Germany TollCollect system had in its implementation, this is an area that will need far more research and scrutiny. The Section 1909 Commission may consider encouraging more critical thinking on VMT charging implementation and transition issues, to understand the short- and long-term the costs and benefits of VMT charging, as well as the true viability of this approach. One critical area for consideration is the mix of private sector and government sector roles in building information systems and supporting technologies to deliver such a program across many states and jurisdictions.

- Privacy – While privacy concerns are cited throughout this paper as one of the major popular public concerns to be addressed for VMT charging, there is little discussion about the work

undertaken to date to address these through technology and business models. The University of Iowa's efforts are a good resource to consider in this light.

- The paper does not attempt to explore the potential of VMT charging systems as a means to build a foundation for more multi-modal electronic payments systems (EPS). Although more broad multi-modal EPS systems were beyond the scope of this paper, it would have been helpful if there had been a more expansive consideration of the linkage of payment systems throughout the transportation system by mentioning this potential. Given the investment that will be required to build supporting systems, some consideration of whether treatment of transportation system revenue and transportation system users' "purse" for user charges could be managed in a more comprehensive manner to elicit more rational mode choice decisions.

Specific Comments:

Page 1, Introduction – The word "counting" is a better and more accurate word than "tracking". A very important, directly related issue, is privacy, which is not mentioned here.

Page 2, Capital Expense – Only vehicle retrofitting is likely to cost in excess of $100 per vehicle. New vehicles are likely to already contain most, if not all, of the necessary components for a per-mile charge system (e.g., GM's Onstar system). While reconfiguring these components in the necessary manner will involve some engineering expense, the additional production cost should be very close to zero. This comment may affect the "Conclusions" paragraph as well.

Page 2, Evasion Concerns – How the on-board device is manufactured into the vehicle can minimize hacking or tampering opportunities. Also, with a system designed so that the gas tax is the default tax in a "no read" of the device situation, the marginal gain or hacking or tampering may prove to most not worth the effort.

Page 4, Technical Approach to VMT Tolling – The following comments apply:

- A "rate table for computing distance charges" can be maintained by the central computer. This eliminates the need for on-board storage and the awkward problem of updating the on-board system for rate changes.
- Uploading to a "billing agency via cellular communications" and the associated billing process will be extremely expensive.
- While the onboard equipment should be tamper-resistant, one simple fix to the tampering problem is to maintain a very high fuel tax rate that is only paid when the equipment is inoperable.
- As outlined here, the primary capital expense for implementation would be retrofitting existing vehicles. However, VMT fees could be phased-in on new vehicles only, thus saving tens of billions of dollars.

Page 4, Technical Approach to VMT Tolling, First Paragraph – There is a reference to transition models that would allow payment of VMT charges through short-range communication at refueling stations as an option for collecting the VMT charge. It should be noted that the investment decision in such systems must consider whether refueling stations will remain as integral to our energy consumption profile in the long-run as new alternative energy sources emerge.

Page 4 – Although the technology exists or can readily be developed, it may not be so easy to implement. It would seem that there has to be at least a North America-wide single standard for communication between vehicles and the billing infrastructure that is built into vehicles upon manufacture and is highly resistant to tampering. As the paper notes, existing vehicles would likely be exempt (taxed instead through the fuel excise tax) until a critical mass of vehicles with original factory equipment existed, then the relatively few remaining vehicles could be retrofitted. Emerging On-Board Diagnostics (OBD-III) communication capability may be sufficient if modified. VMT (and/or congestion pricing) implementation will be unacceptable to the traveling public and commercial interests if they have to obtain different technologies just to drive from one state to another.

Page 6 – In the simplest iteration of a VMT – a per-mile-traveled fee – it sends no signals on time of travel, routes taken or vehicle choice (in this respect, it counteracts other policy goals regarding vehicle choice by treating a Prius and a Hummer exactly the same). So, this paper notes, one can "layer on" additional charges for travel in congested conditions or for highly-polluting vehicles. This possibility opens the door for tinkering for a variety of (possibly contradictory) objectives – which increases exponentially for congestion pricing (see commentary on Paper 5A-08). For example, this paper raises the possibility of increasing fees for highly polluting vehicles (usually older ones), a disproportionate number of which are owned by people of lesser economic means. However, it is also frequently suggested (see Paper 5A-08) that as a matter of equity, poor people should get reduced VMT or congestion pricing fees or a rebate. What will be the result in terms of public confidence in such a system?

Page 7 – Given the many possible variations in VMT implementation, the paper's assertion that "By other measures of equity, VMT excels" may be questionable. The costs incurred would not be directly proportional to the benefit received (when imposed on a simple per-mile basis), which, of course, tempts regulators into the types of tinkering described above.

Pages 8-9, Revenue Implications for VMT Tolling – It is quite reasonable to wonder "whether the idea of indexing would prove more feasible with VMT tolling than it has with traditional motor fuel taxes." The argument that some put forward is that VMT fees have a much greater user fee connection with consumers than a fuel tax; making it easier to index to or otherwise adjust for inflation.

Pages 8-9, Political Issues for VMT Tolling – privacy is directly addressed in an analytical way. However, privacy is an emotional issue. The need for sensitivity in dealing with the public on this subject cannot be overstated.

Page 9, Conclusions – The following comments apply to the last sentence:

- While local-option sales taxes have been used to build some high-profile projects, on a national basis, these have been relatively limited, and the opportunities to use them are relatively limited. In addition, local-option sales taxes are not generally used to fund highway maintenance, operations and preservation. A much better example is General Fund financing by both state and local governments.
- The fundamental issue becomes whether society wants to pay for transportation programs

through user fees or through general tax revenues (or its surrogates).

- Certainly, transportation providers prefer to fund projects through equitable and efficient revenue mechanisms rather than through inequitable and inefficient mechanisms. However, to both transportation providers and the public, the need to build and maintain infrastructure is much more important than how these activities are paid for.

References:

Ruffalo, "Oregon's Road User Fee Pilot Project: Report On Start-Up," TRB paper 07-1024. This is a preliminary report.

Whitty, J. and B. Imholt, 2005. *Oregon's Mileage Fee Concept and Road User Fee Pilot Program: Report to the 73rd Oregon Legislative Assembly*. Salem: Oregon Department of Transportation. This report provides a better reference both to the Oregon study and for general VMT fee implementation background.