Center for American Progress

Switching from a Gas Tax to a Mileage-Based User Fee

How Embracing New Technology Will Reduce Roadway Congestion, Provide Long-Term Funding, and Advance Transportation Equity

By Kevin DeGood and Michael Madowitz July 2014

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Introduction and summary

A billion here, a billion there, and pretty soon you're talking about real money.
— Sen. Everett Dirksen[1]

Former Sen. Everett Dirksen (R-IL) could not have been more right—especially when it comes to transportation. Since fiscal year 2008, Congress has transferred $54 billion in general fund revenues into the Highway Trust Fund, or HTF, to stave off insolvency. Real money, indeed.[2]

The most recent infusion came as part of the surface transportation authorization bill, Moving Ahead for Progress in the 21st Century, or MAP-21, which was intended to keep programs running through September 30, 2014. Yet the most recent estimates by the U.S. Department of Transportation, or USDOT, show the highway account within the fund will run out of money as early as July, with the mass transit account not far behind.[3] Without new revenues or another general fund infusion, federal funding for surface transportation infrastructure will grind to a halt. This sudden stop will be especially disruptive and will arrive during the heart of summer construction season.The Congressional Budget Office estimates that over the next 10 years, the HTF—which supports highway and public transportation programs—will need $172 billion in additional revenue to remain solvent.[4] In the absence of congressional action, states will receive no new contract authority in FY 2015, leading to an immediate drop in trust fund outlay of approximately $15 billion.[5] The shortfall results from the way in which the federal government raises revenue to fund surface transportation infrastructure.

The current approach traces its origins to the passage of the Federal-Aid Highway Act of 1956. This landmark legislation established the HTF and ensured its continued capitalization by depositing federal gasoline and diesel fuel taxes within the fund. Currently, the federal government levies a tax of 18.4 cents per gallon on gasoline and 24.4 cents per gallon on diesel.[6] These taxes were last raised in 1993.[7]

For more than five decades, gas tax revenues[8] have been sufficient to fund highway and transit programs.[9] However, dramatic improvements in vehicle fuel efficiency have significantly reduced the amount of revenue flowing into the fund. This situation will only get worse in the coming years. In 2012, the Obama administration finalized a rule that requires corporate average fuel economy, or CAFE, standards to increase from the current level of 29 miles per gallon to 54.5 miles per gallon by model year 2025.[10] This will approximately double vehicle fuel efficiency, thus cutting gas tax revenues in half and decimating the HTF in the process.

Inflation has also eroded the purchasing power of gas tax revenues. In inflation-adjusted terms, the current gas tax is worth only 11.5 cents per gallon.[11] If gas and diesel taxes had been indexed to keep pace with inflation, they would be 29 cents and 38 cents per gallon, respectively.[12] In effect, states and metropolitan regions face a growing demand for more transportation investments at the same time the real value of federal dollars is falling.

The need for additional revenue is clear. Without more funding, the federal government cannot serve as a strong partner to states and local governments or effectively set national transportation policy. However, funding is only part of the picture. Congestion, especially within metropolitan regions, remains the largest transportation cost, followed by fatalities and injuries, system maintenance, and environmental externalities.

TABLE 1

Highway trust fund user taxes

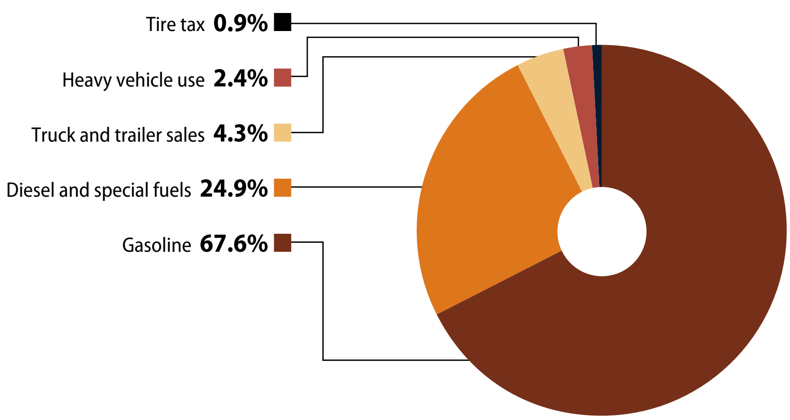
Federal highway user taxes				
		Distribution of tax		
Fuel type	**Tax rate, cents per gallon**	**Highway account**	**Mass transit account**	**Leaking underground storage tank fund**
Gasoline	18.4	15.44	2.86	0.1
Diesel	24.4	21.44	2.86	0.1
Gasohol	18.4	15.44	2.86	0.1
Special fuels				
Liquefied petroleum gas	18.3	16.17	2.13	-
Liquefied natural gas	24.3	22.44	1.86	-
M85/compressed natural gas	18.4	15.44	2.86	0.1

Truck related taxes, all proceeds to highway account	
Tire tax	9.45 cents for each 10 pounds
Truck and trailer sales tax	12 percent of sales price for tractors and truck more than 33,000 pounds and trailers more than 26,000 pounds
Heavy vehicle use tax	Trucks 55,000 pounds $100 plus $22 for each 1,000 pounds in excess of 55,000 pounds, max of $550

Source: Federal Highway Administration, "Highway Trust Fund and Taxes," available at https://www.fhwa.dot.gov/map21/factsheets/htf.cfm (last accessed April 2014).

FIGURE 1

Share of trust fund revenue by source

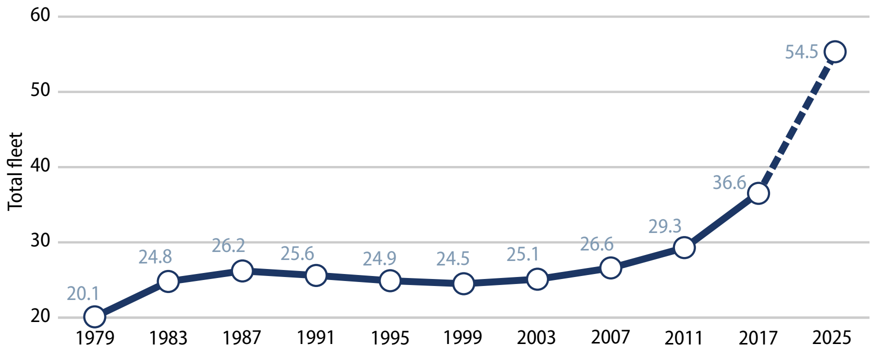


Source: Government Accountability Office, "Highway Trust Fund: Pilot Program Could Help Determine the Viability of Mileage Fees for Certain Vehicles," GAO-13-77, Report to the Subcommittee on Transportation, Housing, and Urban Development, and Related Agencies, Committee on Appropriations, House of Representatives, December 2012, p. 6, available at http://www.gao.gov/assets/660/650863.pdf.

According to research conducted by Texas A&M University, congestion added 5.5 billion hours of additional driving last year and wasted 2.9 billion gallons of fuel, for a total economic cost of $121 billion.[13] The Centers for Disease Control and Prevention reports that every 10 seconds, someone is involved in a vehicle accident and taken to the emergency room. Even more sobering, every 12 minutes someone dies as a result of a vehicle accident. The total economic cost of these losses tops $90 billion.[14] System maintenance, which dominates the discussion of transportation costs, is the third-largest expense at a combined $62 billion for all government levels.[15] Finally, environmental costs—while less straightforward and therefore difficult to calculate—are also significant. Research shows that each year, transportation-related pollution—mostly smog—costs the economy $50 billion.[16] As these numbers show, the policy challenges facing Congress are larger and more complex than the narrow issue of trust fund solvency and asset management.

FIGURE 2

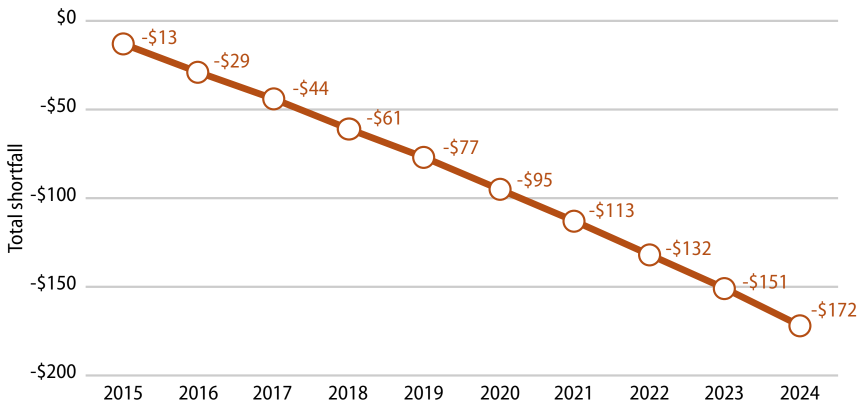
Combined CAFE standards for passenger vehicles and light trucks



Source: National Highway Transit Safety Administration, *Summary of Fuel Economy Performance* (U.S. Department of Transportation, 2011), available at http://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/2011_Summary_Report.pdf; Bill Vlasic, "U.S. Sets Higher Fuel Efficiency Standards," *The New York Times,* August 28, 2012, available at http://www.nytimes.com/2012/08/29/business/energy-environment/obama-unveils-tighter-fuel-efficiency-standards.html.

FIGURE 3

Cumulative highway trust fund shortfall



Source: Congressional Budget Office, "Projections of Highway Trust Fund Accounts Under CBO.s February 2014 Baseline" (2014), available at http://www.cbo.gov/sites/default/files/cbofiles/attachments/43884-2014-02-Highway_Trust_Fund.pdf.

How we pay for transportation infrastructure affects not only how much we build but also how well the system performs over time. In short, system finance and performance are intimately linked. Transportation financing options exist on a spectrum with some taxes and fees completely disconnected from system use while others are directly tied to use. The more closely the tax or fee is tied to system use, the greater its ability to reduce travel demand and improve system performance.

How we pay for transportation infrastructure affects not only how much we build but also how well the system performs over time.

For example, take three of the most common forms of transportation tax: vehicle fees, gas taxes, and tolls. Vehicle fees levied by states function like a property tax and are not connected to use. Vehicle owners pay an annual fee regardless of how much, when, or where they drive. These fees are attractive to many states because they provide predictable and stable revenue. After all, the total number of registered vehicles does not change significantly from year to year and tends to rise over time.

Gas taxes—both state and federal—fall in the middle of the spectrum, as they are tied to use, but only loosely. Significant differences in fuel-efficiency rates mean some light-duty vehicles can travel as many as 50 miles per gallon while others can only travel 15.[17] Moreover, gas taxes are collected not at the point of use but instead at the wholesale level, with most of the cost passed along to consumers. The resulting tax revenue supports a number of different highway and public transportation programs, with states determining how to allocate funds based on competing needs. Gas taxes provide a macro-level indicator of overall travel demand and fuel consumption, but they do not capture use by day, time, direction, or facility.

Tolls, by comparison, are directly tied to use and levied on drivers when they enter a specific facility. Tolls finance the construction and maintenance of specific roadways rather than surface transportation programs more broadly. Moreover, toll rates may be adjusted in real time to manage travel demand and ensure conditions remain free flowing. Unlike vehicle fees and gas taxes, tolling only works on highways with strictly controlled access and cannot be scaled up to finance federal surface transportation programs.

As Congress considers alternative mechanisms, four criteria should inform its final choice. First, the funding source must generate sufficient revenue to cover current needs and grow in the future to support an expanding economy and population. Second, the source should connect as directly as possible to system use. Third, the funding source should allow for active system management to provide the best system performance at the lowest cost. Fourth, the funding mechanism must be able to be implemented nationwide.

Simply raising additional revenue is not enough. In order to meaningfully address the growing costs of congestion, Congress must adopt a funding mechanism that not only raises new money but also ties closely to system use and allows state and local officials to effectively manage travel demand. The most promising, efficient, and fair alternative is a fee based on the number of miles a person drives in a year—often referred to as either a mileage-based user fee, or MBUF, or a vehicle miles traveled, or VMT, fee. These two terms will be used interchangeably throughout this report.

An MBUF meets all four criteria. First, it would raise substantial revenue and allow for growth over time. A mileage fee of 1.3 cents per mile would raise the same amount of revenue as the current gas tax.[18] A mileage fee of 2 cents per mile would raise the same revenue as a gas tax increase of 15 cents.[19]

Second, a mileage fee connects directly with system use by charging drivers based on the number of miles they travel each year. Gas taxes are only a loose approximation of system use, given the substantial differences in vehicle fuel efficiency. A mileage fee would address this shortcoming by accurately capturing how much each driver uses the system.

Third, the underlying technology used to assess the mileage fee could also allow the application of congestion pricing to help manage travel demand. States and metropolitan regions would have the option of adding a congestion charge in addition to the federal flat mileage fee to help manage travel demand. States and regions could also tailor their mileage charges to address important social and regional equity concerns unique to their regions.

Fourth, a mileage fee system could be implemented on a national scale over a number of years without expensive retrofitting of existing vehicles or other transportation infrastructure. For mileage-fee-participating drivers, state departments of transportation would use fuel-efficiency ratings based on the make and model year from the Environmental Protection Agency, or EPA, to estimate total fuel consumption. Using this figure, states would credit participating drivers for the gas taxes they have already paid at the pump, issuing a refund or bill depending on the balance of mileage charges. Once the entire vehicle fleet has adopted the new technology, gas taxes would be removed. Unlike tolling, a mileage system would not require the construction, maintenance, or staffing involved with expensive toll facilities.

A VMT fee also removes the incentive for states to penalize drivers of advanced technology vehicles with additional taxes since all users would pay the same per-mile rate regardless of vehicle technology. If we decouple system finance from fuel consumption, technology advances that promote a clean environment will no longer undermine infrastructure programs.

A mileage-based fee presents significant policy advantages over other potential revenue options, all of which fail to meet one or more of the four criteria listed above. Some advocates have called for raising revenue through nontransportation sources such as customs duties, energy royalties, and/or allowing multinational corporations to repatriate a share of their earnings at reduced tax rates. These potential revenue sources are disconnected from system use and would not allow for active system management. Moreover, their revenue generating potential is questionable.[20]

Policy recommendations for MAP-21 reauthorization

In 1956, the gas tax was an attractive financing mechanism because it generated robust revenues and conformed to the principals of sound tax policy—namely, that a tax should be feasible, enforceable, user friendly, and affordable to administer. In short, the gas tax produced needed revenues and conformed to the technological limitations of its time.

However, the same technology constraints do not apply today. In fact, one of the biggest differences between then and now is the development of advanced telecommunication and information technologies that enable the collection of alternative revenues that were unimaginable even a few years ago. Specifically, new technologies allow for drivers to be charged based on the number of miles they drive rather than on how much fuel they burn.

Transitioning to a mileage fee will require time. However, the fiscal cliff facing transportation is only a few months away. The trust fund needs immediate revenue to provide stability while a mileage system scales up. As discussed above, the current authorization measure will expire on September 30, 2014. Congress should therefore take the following steps:

- Raise the gas tax by 15 cents per gallon with an equivalent percentage increase on diesel in order to provide time for a transition to an MBUF.

- Authorize $100 million to fund state-based demonstration projects in 10 to 15 states to test different VMT technology platforms, administrative approaches, and privacy protocols.

- Establish a surface transportation revenue office within the Office of the Secretary of Transportation to facilitate demonstration projects, provide technical assistance, share best practices, and fund independent research on privacy standards for vehicle data.

Dramatic improvements in vehicle fuel efficiency have eroded the long-term viability of the gas tax as a primary source of transportation revenue. Raising the gas tax will stabilize the trust fund and provide transitional revenue to serve as a bridge to an MBUF system. Each penny in gas tax generates approximately $1.7 billion in annual revenue.[21] Current gas and diesel taxes produce approximately $37 billion in revenue—roughly $15 billion less than what is needed to sustain federal surface transportation programs at their current levels. A 15-cent increase would generate $25.5 billion in new revenue. This increase would not only cover the shortfall but would also allow for some programmatic growth in future years as the system changes over to a mileage fee.

The one thing Congress cannot afford to do is wait. The shortcomings of the gas tax are clear, and they will only get worse over time. Similarly, the challenges and economic costs of congestion will increase as our country continues to grow. States and metropolitan regions need a strong federal partner that provides predictable funding over many years in order to implement big, complex projects. A mileage fee would provide the funding certainty to build critical projects and the technological platform needed to effectively manage travel demand. Importantly, a federal MBUF would not involve any congestion pricing. Rather, states and metropolitan regions with the worst congestion could choose to levy additional charges separate from the flat federal fee.

Congestion

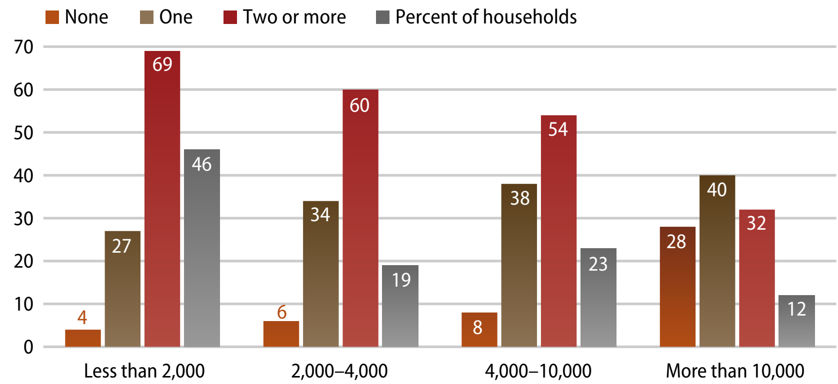
Congestion is the biggest challenge facing our surface transportation system. Each year, congestion costs our economy $120 billion.[22] Congestion leads to longer travel times and unpredictable spikes in delay that harm drivers and freight carriers. For systems stretched thin by near-constant high levels of demand, a modest incident can ripple throughout an entire region[23] and the problem will only grow worse with time.

Congestion results from a mismatch between roadway supply and the quantity, time, and place of driving. Morning and evening peak periods serve up the perfect storm of a large number of vehicles trying to use the same roads at the same time. The problem is often framed as a simple matter of insufficient roadway supply, but the reality is more complex, as congestion is a dynamic interaction between supply and demand.

Let's start with travel demand. Between 1980 and 2012, the U.S. population grew 40 percent, from 226 million to 315 million people.[24] At the same time, the total number of registered vehicles increased by 57 percent, or 90 million.[25] The biggest growth of all came in total driving, which increased by 93 percent, from 1.5 trillion to 2.9 trillion miles.[26] Taken together, these statistics show that in the past 30 years, travel demand has grown dramatically. The Bureau of the Census estimates that over the next 50 years, the U.S. population will grow by more than 100 million people.[27] If per-capita vehicle registration rates continue at their current level, 85 million more vehicles will be vying for space on our roadway network.[28]

The rapid growth in driving is not merely the result of increased household income or individual preference. Driving rates are also deeply influenced by population density, the presence of high-quality public transportation, and land use. Low-density residential and commercial development, combined with over-reliance on highways to solve all mobility needs, increase driving rates. In 1950, the population density within metropolitan regions peaked at an average of 7,500 people per square mile. By 2000, this number had fallen to a mere 2,700 people per square mile.[29] Research also shows that over the past few decades, the average lot size for residential homes has grown significantly.[30] Between 1982 and 2003, the number of newly developed acres of land grew almost twice as fast as the population, pushing down overall density levels.[31]

FIGURE 4
Vehicle ownership by population density



Source: Federal Highway Administration, *2009 National Household Travel Survey: Summary of Travel Trends* (U.S. Department of Transportation, 2011), available at http://nhts.ornl.gov/2009/pub/stt.pdf.

Data from USDOT show that vehicle ownership rates are significantly higher for households located in low-density areas. These regions tend to have the least access to public transportation and possess land-use and development patterns that make alternatives such as biking and walking less practical options. In fact, households located in outlying counties within metropolitan regions drive, on average, 7,000 thousand more miles each year than their counterparts in core urban counties.[32] Density rates in outlying counties are three times lower than in core counties.[33]

When compared to travel demand, roadway supply has grown only modestly. We measure the roadway system in two ways: by centerline miles and by lane miles. Centerline miles measure total system length, while lane miles measure overall capacity. For instance, a roadway that connects two cities 10 miles apart with three travel lanes in each direction is said to have 10 centerline miles and 60 lane miles. Another way to think of this distinction is that centerline miles represent the extent of the system—the presence of new roadways over time—while lane miles measure capacity—how much we add to the roads we have already laid down.

Between 1980 and 2012, centerline miles increased 8 percent, while lane miles grew by 8.6 percent.[34] Urban principal arterial roads grew by an impressive 73 percent—though some of this growth came from the Bureau of the Census' reclassification of roadways, as those previously designated as rural became urban when the bureau included the areas within a metropolitan region.[35] While impressive given the many challenges of expanding urban highways and major roadways, this statistic must be placed in context. Urban arterials represent more than 4 percent of all lane miles.[36] In short, travel demand has increased at a substantially faster rate than system growth in the past 30 years.

TABLE 2

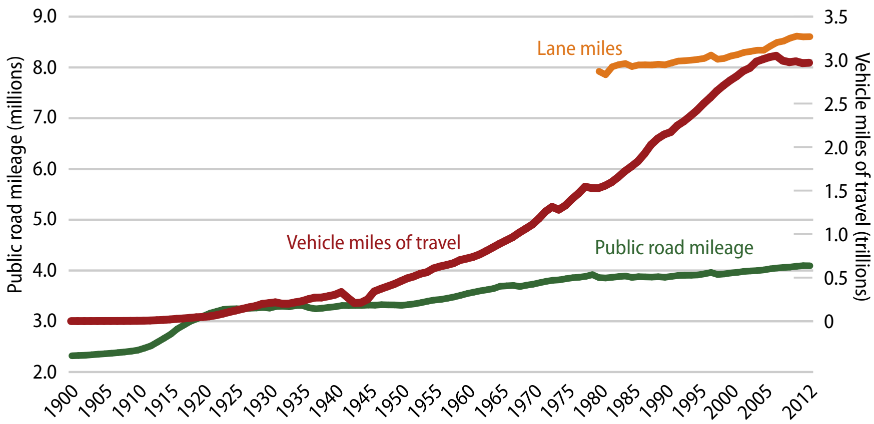
Changes in population, travel, and system capacity

	1960	1980	2012	Percent change 1960–2012
Population	180 million	226.5 million	315 million	76%
Registered vehicles	74.4 million	161.5 million	253 million	240%
Vehicle miles traveled	718 billion	1.5 trillion	2.9 trillion	313%
Centerline miles	3.5 million	3.8 million	4.1 million	15%
Lane miles	-	7.9 million	8.6 million	8.60%

Sources: Bureau of the Census, *Historical National Population Estimates: July 1, 1900 to July 1, 1999* (U.S. Department of Commerce, 2000), available at https://www.census.gov/popest/data/national/totals/pre-1980/tables/popclockest.txt; Bureau of the Census, *Monthly Population Estimates for the United States: April 1, 2010 to November 1, 2013* (U.S. Department of Commerce, 2013), available at http://www.census.gov/popest/data/state/totals/2012/tables/NA-EST2012-01.xls; Bureau of Transportation Statistics, Table 1-11: *Number of U.S. Aircraft, Vehicles, Vessels, and Other Conveyances* (U.S. Department of Transportation), available at http://www.rita.dot.gov/bts/sites/rita.dot.gov.bts/files/table_01_11.xlsx; Federal Highway Administration, *Public Road Mileage – VMT – Lane Miles 1920-2012* (U.S. Department of Transportation, 2012), available at http://www.fhwa.dot.gov/policyinformation/statistics/2012/xls/vmt421c.xls.

FIGURE 5

Public road mileage, vehicle miles traveled, and lane miles: 1920-2012



Source: Federal Highway Administration, Public Road Mileage - VMT - Lane Miles 1920 - 2012 (U.S. Department of Transportation, 2012), available at http://www.fhwa.dot.gov/policyinformation/statistics/2012/xls/vmt421c.xls.

This has resulted in a 192 percent increase in urban area congestion,[37] measured as increases in the total hours of delay for each auto commuter.[38] This effect is not limited to a handful of mega regions. Indeed, congestion has grown substantially in regions of all sizes.

The consequences of not addressing funding shortfalls and managing travel demand will lead to significantly more congestion in the future. As the following maps show, over the next 40 years, heavy congestion on the National Highway System, or NHS—which includes the interstate highway system and most principal arterials—will increase dramatically. In the absence of capacity improvements or better system management, congestion on the NHS will triple. Traffic will slow on 21,000 miles of the system and create stop-and-go conditions on an additional 40,000 miles.[39]

The NHS, which represents only 8 percent of system mileage, carries 43 percent of all vehicle miles traveled and an even larger share of all truck freight. An efficient NHS is essential to our continued economic growth and competitiveness.

In 2011, trucks carried more than 11 billion tons of goods valued at a staggering $10.5 trillion.[40] Over the next 30 years, truck freight will increase by 65 percent, rising to more than 18 billion tons annually.[41] Congestion will hit the freight sector hard. While long-haul trucks account for only 6 percent of total VMT in the United States, they absorb 26 percent of congestion costs.[42] Last year alone, congestion cost truck freight carriers $9.2 billion in additional operational costs.[43] The most significant cost was lost time, with truckers losing 141 million hours—the equivalent of 51,293 truck drivers sitting idle for one year.[44]

TABLE 3

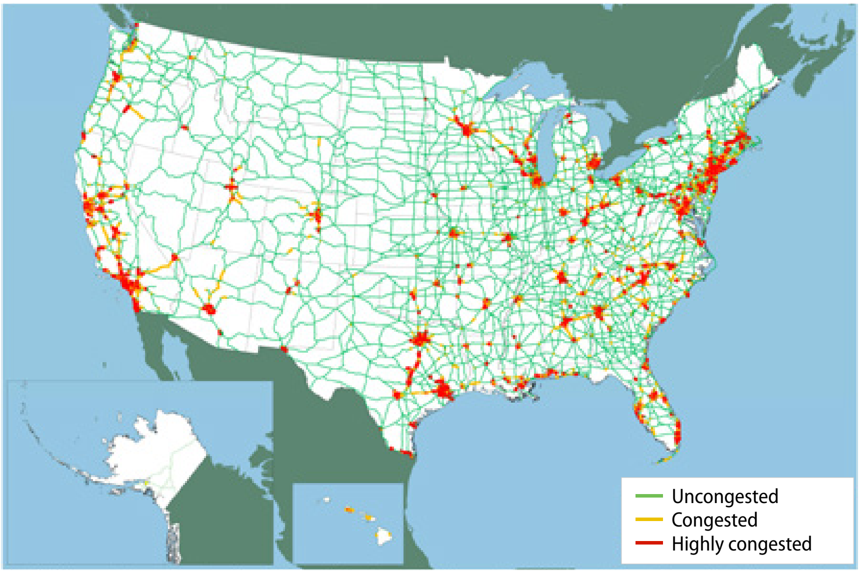
Truck freight congestion costs for top 10 states

Rank	State	2013 Cost
1	California	$1,706,026,586
2	Texas	$1,053,129,673
3	New York	$845,521,677
4	Illinois	$498,022,538
5	Pennsylvania	$421,508,565
6	Virginia	$330,400,920
7	Maryland	$315,461,693
8	Georgia	$304,113,197
9	Massachusetts	$303,355,238
10	Florida	$256,075,805

Source: American Transporation Research Institute, "2013 Impacts of Congestion on Trucking" (2014), available at http://atri-online.org/wp-content/uploads/2014/04/ATRI_2013_Trucking_Congestion_Costs.pdf

FIGURE 6a

Peak-period congestion on the national highway system: 2007

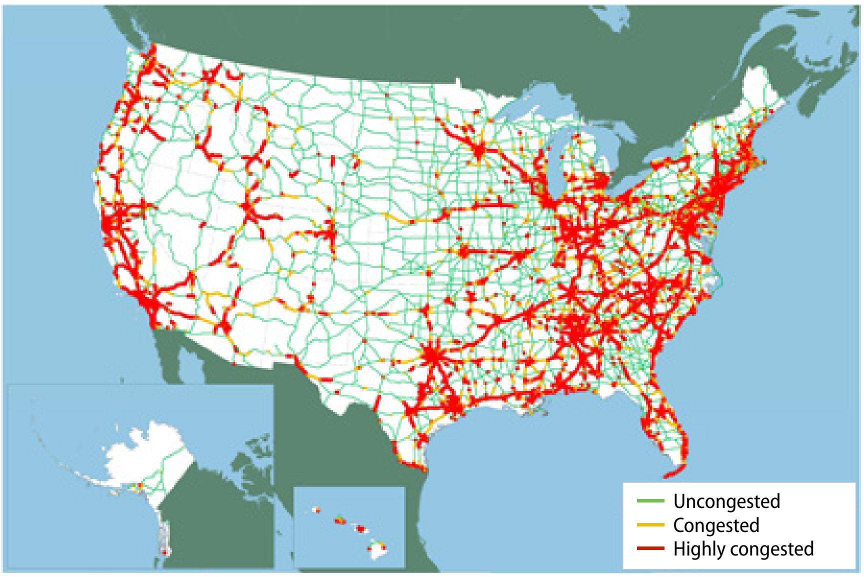


Note: Highly congested segments are stop-and-go conditions with volume/service flow ratios greater than 0.95. Congested segments have reduced traffic speeds with volume/service flow ratios between 0.75 and 0.95. The volume/service flow ratio is estimated using the procedures outlined in the Highway Performance Monitoring System Field Manual, Appendix N.

Sources: Federal Highway Administration, "Highway Performance Monitoring System," available at https://www.fhwa.dot.gov/policyinformation/hpms.cfm (last accessed June 2014); Federal Highway Administration, Freight Analysis Framework, version 3," available at http://www.ops.fhwa.dot.gov/freight/freight_analysis/faf/ (last accessed June 2014).

FIGURE 6b

Peak-period congestion on the national highway system: 2040



Note: Highly congested segments are stop-and-go conditions with volume/service flow ratios greater than 0.95. Congested segments have reduced traffic speeds with volume/service flow ratios between 0.75 and 0.95. The volume/service flow ratio is estimated using the procedures outlined in the Highway Performance Monitoring System Field Manual, Appendix N.

Sources: Federal Highway Administration, "Highway Performance Monitoring System," available at https://www.fhwa.dot.gov/policyinformation/hpms.cfm (last accessed June 2014); Federal Highway Administration, Freight Analysis Framework, version 3.4," available at http://www.ops.fhwa.dot.gov/freight/freight_analysis/faf/ (last accessed June 2014).

TABLE 4

Yearly hours of delay per auto commuter

	1982	2011	Change
More than 3 million			
Washington, D.C.	18	67	272%
New York, NY	11	59	436%
Boston, MA	15	53	253%
Chicago, IL	13	51	292%
Dallas, TX	7	45	543%
1 million–3 million			
Las Vegas, NV	8	44	450%
Columbus, OH	4	40	900%
Denver, CO	11	45	309%
Austin, TX	10	44	340%
Riverside, CA	4	38	850%
500,000–1 million			
Baton Rouge, LA	10	42	320%
Hartford, CT	7	38	443%
Oklahoma City, OK	8	38	375%
Bridgeport, CT	13	42	223%
El Paso, TX	4	32	700%
Less than 500,000			
Columbia, SC	5	30	500%
Brownsville, TX	2	25	1,150%
Greensboro, NC	5	27	440%
Salem, NC	5	27	440%
Little Rock, AR	5	26	420%

Source: Texas A&M Transportation Institute, "2012 Urban Mobility Report" (2013), available at http://tti.tamu.edu/documents/mobility-report-2012-wappx.pdf.

This raises an important question: Why have roadways not expanded enough to keep pace with population and travel demand growth? Some critics argue that people are reluctant to pay additional taxes and fees to fund sufficient expansion because they feel the government has previously failed to deliver results with their money. After all, congestion is increasing on a yearly basis, and there is no need to throw good money after bad.

While such voter frustrations are no doubt relevant, this explanation overlooks larger structural challenges to expansion. Attempts to expand urban highways and other arterial roadways confront the stark reality that land acquisition and property condemnation—especially in the most congested urban areas—are prohibitively expensive and politically treacherous. Overall public support for expansion may be relatively high in the abstract, but the challenges quickly mount when planners announce specific projects. Opposition to new construction cuts across traditional political fault lines, often under the banner of "not in my backyard."

Many traditional transportation stakeholders would like to see Congress enact an Eisenhower-esque Federal Aid Highway Act 2.0 and fund another 40,000 miles of new interstate capacity. This policy prescription actively ignores the social and political realities that limit expansion. Moreover, it attempts to solve a complex problem with one simple solution—more pavement—while ignoring the other half of the equation—demand. The issues surrounding how, when, and where people choose to travel are not resolved. Land use patterns, transportation choice, and better management of existing infrastructure through pricing all deeply affect demand. Transitioning to an MBUF will not only provide the funding necessary to preserve and expand the system, but will also send appropriate price signals to users about the true economic costs of driving. In short, charging drivers by the mile represents a sound and balanced policy solution that addresses supply and demand.

Recent driving trends and their long-term implications for congestion

Since the 1960s, both per capita and total VMT have grown rapidly, closely tracking with overall economic growth. In late 2007, just before the start of the Great Recession, this decades-long trend came to a halt as total driving peaked and then began to decline.[45] For per-capita driving, the peak occurred even earlier. Beginning in the summer of 2004, per-capita driving topped out at 900 miles per month and has fallen slowly by about 9 percent to 820 miles per month today.[46]

For much of the 20th century, increased economic prosperity translated into higher rates of vehicle ownership and ever-increasing driving levels.[47] From 1960 to 2000, registered vehicles as a share of the total population doubled from 40 percent to 80 percent.[48] In the past 10 years, the share has grown by only 1 percent.[49] At the same time, extensive low-density suburban development and transportation investments that focused almost exclusively on highway expansion further pushed people to drive more and more.

The prerecession timing of the driving decline strongly suggests that many people have reached a limit to how much they are willing to drive. At the same time, strong demand for urban and mixed-use development that provides access to affordable public transportation and more walkable, livable communities indicates an important social shift.

However, determining the magnitude of this change is difficult due to the severe and lingering effects of the recession. Driving trends within the Millennial generation provide a look at just how difficult it can be to disaggregate economic hardship from clear changes in mobility preferences. Opinion research shows that the Millennial generation prefers to drive less and favors communities that offer robust transportation options, including transit, ride sharing, car sharing, and bike sharing, among others.[50] Yet while Millennials demonstrate clearly different preferences than their Baby Boomer parents, economic hardship also plays a heavy role.

A study by the Pew Research Center found that young adults own fewer homes and cars than they did prior to the recession.[51] Moreover, the unemployment rate for Americans ages 16 to 24 stands at 16 percent, more than double the national average and almost three times higher than for people aged 35 and older.[52] These employment statistics—and their effect on income—are especially important when it comes to driving. Research from USDOT shows that household income up to about $60,000 leads to increased driving before tapering off significantly as income rises.[53] Data from the U.S. Bureau of Labor Statistics show that the average 16- to 24-year-old earns a little more than $24,000 per year.[54] At this level, small changes in income or economic outlook can heavily impact overall driving.

National trends reinforce the notion that a meaningful share of the change in driving is the result of lagging employment growth. While the stock market has more than surpassed prerecession levels,[55] job recovery has taken far longer. In fact, the United States finally regained all the jobs it lost from the recession in May 2014. This is approximately six years after the start of the recession and twice as long as job recovery times for previous recessions.[56]

Driving forecasts by USDOT indicate that total driving will increase as the economic recovery deepens and the population continues to grow. Overall, USDOT estimates that growth will range between 1.36 percent and 1.85 percent annually.[57] While the rate of driving growth is likely to remain lower than in previous decades, the implications for transportation policy are clear: Congestion will rise in the long term in the absence of active system management through congestion pricing and investments in high-quality public transportation.[58]

System management through congestion pricing

At first pass, transportation revenue and system performance may seem disconnected, but they are deeply intertwined. At issue are the costs imposed by drivers for the trips they make and how closely transportation taxes and fees mirror those costs. Congestion pricing offers a powerful mechanism for capturing the externalities imposed by a driving trip. Importantly, a federal MBUF would not involve any congestion pricing. Rather, states and metropolitan regions with the worst and growing congestion could choose to levy additional charges separate from the flat federal fee.

For too long, the debate over transportation revenue has focused almost exclusively on maintenance. This overly narrow view of cost misses a fundamental reality about transportation: Our roadway network has finite capacity, and the most precious commodity is space, not the quality of the pavement. The location and time of day affect the total cost of a vehicle trip dramatically more than does the weight of the vehicle. The economic impact of this congestion is twice as costly as system maintenance.

A few numbers help highlight this point. USDOT research shows that roadway wear and tear increases exponentially with vehicle weight. However, the damage imposed by light-duty vehicles, which includes cars, sport-utility vehicles, and light-duty trucks, is statistically indistinguishable from zero.[59] The impacts grow rapidly for vehicles in higher weight classes. In fact, an 80,000-pound commercial truck produces the same amount of roadway impact as 24,000 passenger cars.[60] The same USDOT study found that the heaviest trucks pay only 50 cents for every dollar of damage they do, while light-duty vehicles contribute slightly more than they produce in wear and tear.[61]

But before we start mailing drivers a refund and truckers a bill, consider the following: Of the 2.9 trillion miles driven in the United States last year, 90 percent were driven by light-duty vehicles, and only 10 percent were driven by commercial trucks[62] Given this ratio, it becomes clear why the economic costs of lost time, wasted fuel, and disrupted supply chains far exceed the unfunded roadway damage done by trucks. This is not an argument against trucks paying their share—far from it. But it does reveal the extent to which our system is burdened less by deterioration than by demand for the finite resource of space.

Not all trips have the same impact on the system. During morning and evening rush hours, highways and major arterials slow as more and more drivers enter the roadway. Eventually, the system experiences what engineers refer to as a breakdown—when traffic slows significantly or stops moving. As roads reach their capacities, the congestion-producing effect of an additional vehicle is exponentially greater than when the system is operating well below capacity. In effect, the marginal cost of one more vehicle is much higher during rush hour because the resulting congestion affects many more drivers. Conversely, small changes in the time of day when even a small portion of vehicles use the road can dramatically reduce congestion during rush hour.[63] Given the fiscal and political challenges of preventing significant highway expansion, the question becomes one of how to allocate limited space.

Only 4,841 miles of U.S. roadways are tolled—less than 1 percent of the more than 4 million miles of public roadways in the nation.[64] With the exception of these few toll roads, our transportation system is defined by free access at the time and place of use. Instead of directly taxing use, the majority of funding for roads and highways comes from gas taxes and vehicle fees.[65] Gas taxes are a loose approximation of system use, since the more a person drives, the more they pay in gas taxes. However, gas taxes do not capture congestion costs. Furthermore, vehicle fees are totally disconnected from system use, as owners must pay them regardless of how much they drive.

The reality is that free access at the place and time of use fails to send appropriate signals to drivers regarding the negative impacts that result from driving during the morning and evening rush hours. The technology underlying a VMT fee would allow states and metropolitan regions with the most severe congestion to seamlessly integrate variable pricing on top of the base per mile fee to help manage demand.

Data from USDOT show that even during the morning and evening rush hours, the majority of drivers on a typical highway are not commuters.[66] Instead, these drivers are taking trips for other purposes that are often not tied to a specific time schedule. As a result, they may be easily shifted to another, less congested route or time of day. These trips are often referred to as discretionary. Removing even a small fraction of discretionary trips during rush hour—as little as 5 percent—would allow highways and other arterials to flow more freely.[67]

Congestion pricing in the United States has been limited to express lanes that allow vehicles with multiple passengers to travel for free but charge single-occupant vehicles a fee. These facilities are also referred to as high-occupancy toll, or HOT, lanes. Typically, toll rates vary either by time of day or by the level of demand for the dedicated lane. As demand for the lane increases, so does the price. This causes some drivers to remain in the free general-purpose travel lanes. Consequently, variable prices ensure the HOT lane remains at—or near—free-flow speeds even during peak periods of demand.

TABLE 5

High-occupancy toll lane length and cost

Route	Location	Length	Maximum toll	Maximum cost per mile
SR 91	Orange County, California	10 miles	$9.55	$0.95
I-495	Capital Beltway, Northern Virginia	14 miles	$8.90	$0.64
I-680	Alameda County, California	14 miles	$7.50	$0.54
I-15	San Diego County, California	16 miles	$8.00	$0.50
I-95	Miami-Dade County, Florida	9.5 miles	$7.10	$0.75
I-25	Denver, Colorado	7 miles	$5.00	$0.71
I-15	Wasatch Front, Utah	62 miles	$6.00	$0.10
I-10	Harris County, Texas	12 Miles	$3.20	$0.27
I-394	Minneapolis, Minnesota	11 Miles	$8.00	$0.73
SR 167	Seattle, Washington	10 miles	$9.00	$0.90

Sources: Express Lanes, "Toll Schedules," available at http://www.91expresslanes.com/schedules.asp (last accessed April 2014); Robert Thomson, "I-95 HOT lanes halfway done as Beltway counterpart approaches first anniversary," *The Washington Post,* October 23, 2013, available at http://www.washingtonpost.com/local/trafficandcommuting/i-95-hot-lanes-halfway-done-as-beltway-counterpart-approaches-first-anniversary/2013/10/22/17ab6b5c-376d-11e3-80c6-7e6dd8d22d8f_story.html; Alameda County Transportation Commission, "FAQs," available at http://www.alamedactc.org/app_pages/view/11404 (last accessed March 2014); FasTrak, "I-15 Express Lanes," available at http://fastrak.511sd.com/san-diego-toll-roads/i-15-express-lanes (last accessed April 2014); Federal Highway Administration, *95 Express – I-95, Miami, FL, HOV to HOT Conversion Project* (U.S. Department of Transportation), available at http://ops.fhwa.dot.gov/freewaymgmt/publications/documents/nrpc0610/workshop_materials/case_studies/miami.pdf; Colorado Department of Transportation, "Toll Rates/Violations," available at http://www.coloradodot.info/travel/tolling/i-25-hov-express-lanes/rates-violations#howmuch (last accessed April 2014); Utah Department of Transportation, "Express Lanes," available at http://www.udot.utah.gov/expresslanes/Faqs.aspx (last accessed March 2014); Harris County Toll Road Authority, "Toll Rate Schedule" (2013), available at https://www.hctra.org/katymanagedlanes/media/Katy_Toll_Sched.pdf. Minnesota Department of Transportation, "Mn/PASS I-394 'HOT' Lanes," available at http://www.dot.state.mn.us/guidestar/2006_2010/mnpass_i394_hot_lanes.html (last accessed March 2014). Washington State Department of Transportation, "SR 167 HOT Lanes Pilot Project: Third Annual Performance Summary May 2008 – April 2011" (2011), available at http://www.wsdot.wa.gov/NR/rdonlyres/C198671E-7B2F-4186-9912-A41A0B274103/0/SR167_AnnualPerformanceSummary_113011_FINAL_WEB.pdf; Washington State Department of Transportation, "SR 167 HOT Lanes Toll Rates," available at http://www.wsdot.wa.gov/Tolling/SR167HotLanes/HOTtollrates.htm (last accessed March 2014).

Compared to driving in a general travel lane, HOT lanes are quite expensive. According to research by the Oak Ridge National Laboratory, the variable cost of operating a vehicle, which includes fuel and maintenance expenses, is 19 cents per mile for the average driver.[68] When fixed costs are added, such as financing and insurance, the total cost of operating a vehicle increases to 77 cents per mile.[69] The cost of driving on some HOT lane segments during peak demand is equal to or greater than the total per-mile cost of operating a vehicle. Given this cost, many drivers choose to remain in a general-purpose lane.

Congestion pricing would be effective even when set at a low per-mile rate because most drivers are sensitive to small changes in price. An extensive review by researchers at the National Academy of Sciences found the following:

> *Because most travelers have a relatively low willingness to pay, any price that affects all travelers, such as a general toll for all lanes of a highway, may influence demand at fairly modest levels. In contrast, prices for high-occupancy toll (HOT) and express lanes can be set at fairly high levels and adjusted to attract a relatively small percentage of travelers with the highest willingness to pay.*[70]

This indicates that the response on the part of drivers varies substantially depending on whether paying a charge is optional or mandatory. Typically, when using a HOT lane is an option, only those drivers with a high tolerance for incurring an extra cost will choose the express lane. To borrow a term from economists, these drivers are said to have less elastic demand—meaning that they have less sensitivity or behavioral change when confronted with a higher price. By comparison, drivers in the remaining lanes are said to have more elastic demand, as they change their behavior in response to a small increase in cost.

The implications of this finding for transportation policy are profound. Congestion pricing provides a mechanism to manage what appears at first to be an inevitable and economically costly crush of increasing population and travel demand forced to compete for space on a finite roadway network. Prices provide a means to allocate a scarce resource more efficiently. USDOT estimates that the adoption of congestion pricing on a large scale could reduce the amount of investment needed to keep our system operating at current levels by 25 percent.[71]

Expanding public transportation to provide drivers with affordable options

The idea of paying a congestion charge is one that many drivers will no doubt dislike at first. However, research shows that raising user fees is more palatable than general tax increases.[72] Moreover, support for user fees such as tolling and congestion pricing increases when the public understands the need for new revenues and how the money will be spent.[73] A comprehensive review of public opinion results by the Transportation Research Board shows that "Use of tolling revenues is a key determinant to the acceptance or rejection of tolling and road pricing. Revenues should be linked to specific uses not to specific agencies."[74]

This raises two important points. First, public support for new revenues is linked to need. All too often, need is defined at a very high level or from the perspective of a particular sector such as freight carriers. These are important justifications, but they fail to define need in a way that speaks to drivers. Congestion pricing offers a unique opportunity to frame the issue for drivers as one of cost and choice.

The truth is that growing congestion forces a cost onto drivers in the form of lost time. In the largest metropolitan regions, annual hours of delay now exceed a full workweek.[75] With the exception of a few HOT lane segments, drivers have no choice but to slog through a slow and unpredictable commute. A congestion price would shift travel demand to nonpeak times or to less heavily traveled routes. As a result, drivers could count on a more reliable and fast roadway network.

Second, congestion pricing could provide additional revenue to invest in high-quality public transportation services to provide drivers with an affordable alternative to paying a congestion fee. By adding public transportation service in the form of new routes, expanded hours, and shorter wait times, congestion pricing revenues could provide drivers with real choices about how they travel. Expanded service would reduce roadway demand—which helps drivers[76]—and provide an affordable option for meeting daily mobility needs. Instead of congestion and lost time without the option to switch to public transportation, drivers would have a speedier and more reliable roadway network, as well as access to affordable transit service. Also, transit services would not be limited to traditional downtown bus routes. Congestion pricing revenues could support commuter rail and bus services targeted at drivers who would otherwise travel longer distances often not serviced by traditional transit services.

Congestion pricing and transportation options in San Diego, California

Southern California is notorious for traffic congestion, and San Diego is no exception. Historically, states have attempted to alleviate congestion by constructing additional general-purpose travel lanes open to all vehicles, regardless of the number of occupants. Beginning in the late 1980s, the California Department of Transportation, or Caltrans, working closely with the region, decided to try something different. Rather than add new general-purpose lanes on I-15, a major north-south corridor, Caltrans decided to add one lane in each direction exclusively for high-occupancy vehicles carrying two or more people.[77] By requiring cars to carry more than one person, the lanes would have a much higher carrying capacity and a greater impact on congestion.

Unfortunately, the HOV lanes were underutilized in the first few years. Beginning in 1991, the San Diego Association of Governments, or SANDAG, decided to study the feasibility of converting the HOV lanes to HOT lanes that would allow single-occupant vehicles to enter for a fee. The conversion would ensure that the lanes were fully utilized and that they generated surplus revenue to support expanded public transportation.[78] The converted HOT lanes opened to the public in 1996, and traffic within the lanes quickly doubled.[79]

The I-15 express lanes remain free for vehicles carrying two or more people while the fee for solo drivers entering the road varies from between $0.50 and $8 depending on the length of the trip and demand for the lane.[80] The variable price ensures that the express lanes remain at or close to free-flowing traffic levels.[81] Importantly, congestion pricing for the express lanes was paired with expanded transit service to provide residents with an efficient and affordable option besides driving.

Revenue from the express lanes supports the commuter bus service known as Premium Express.[82] Over three months in 2012, about 20,000 cars traveled on the HOT lanes per day, with just more than 3,000 solo drivers paying a fee to enter the facility.[83] The toll revenue projected for the current fiscal year is about $4 million, with approximately $1 million available for the Premium Express bus service.[84] The Premium Express service offers five routes that take advantage of direct access to the I-15 express lanes through exclusive on-ramps that bypass the general-purpose travel lanes.

Since the original congestion plan went into effect, the express lanes have expanded from 8 miles to 20 miles in length.[85] The expansion has resulted in a significant reduction in delay along the I-15 corridor. In fact, drivers using the express lanes can reduce their travel time by as much as 20 minutes.[86] Such benefits are not limited to express lane users. In the past 10 years—due in part to the expansion of the express lanes—congestion delays have fallen by 80 percent in the untolled general-purpose lanes.[87] SANDAG data show that commuters are spending less time on freeways despite the fact that their numbers have increased and much of this can be attributed to an increasing share of travelers who pay to access express lanes.[88]

Ensuring privacy through system design

Privacy is fundamental to liberty. In 1963, former Supreme Court Chief Justice Earl Warren stated as part of his concurring opinion in *Lopez v. United States*—a case that involved a federal agent who used a concealed tape recorder as part of a formal investigation—that "the fantastic advances in the field of electronic communication constitute a great danger to the privacy of the individual."[89] Given the state of technology at the time, his conclusion would seem quaint if it weren't so prescient.

Recent revelations about National Security Administration operations raise fears that the federal government is quietly tucked away in every corner of our lives, jotting down notes and building a database. Not surprisingly, these fears can cause discussions about a mileage fee program to fall apart quickly, as building and maintaining roads and transit systems hardly seems to justify Big Brother coming along for the ride. Yet privacy fears are misplaced. The technology involved in the assessment of a mileage fee would lack the features needed to engage in vehicle tracking. In fact, driver privacy would not rely on policies, procedures, or good will—rather, it would arise from the system's design. Moreover, vehicle owners would have control over what data are collected, as well as how and when they are transmitted for billing purposes, a process that need not be administered by the government at all.

For nearly a century, automobiles have remained separate from other forms of technology: The car sitting in the driveway has had nothing to do with the phone on the wall or the computer in the den. Today, this division no longer holds true, as advanced telecommunication and information technology systems are migrating to vehicles and providing increased performance and a range of new services. Collectively, these different systems are referred to as telematics. Many auto manufacturers also offer consumers the chance to purchase vehicles with anti-theft protection, remote access, roadside assistance, and turn-by-turn navigation. For example, the OnStar system offered by General Motors has the ability to remotely disable the ignition or slow a vehicle's speed after it has been officially reported as stolen.[90]

In order to provide these services, manufacturers or third-party data companies must have access to real-time information about the location, direction, and speed of a vehicle. However, a mileage fee system would work very differently. In order to understand how the technology involved in the assessment of a vehicle miles traveled fee differs from onboard telematics, it helps to look at one of the most common advanced technologies of our day: cell phones. The essential difference between a cell phone and the technology involved with a mileage system is how and when each transmits data. At the most basic level, a cell phone is a radio capable of receiving and transmitting data over extended distances using radio waves. Most cell phones can transmit data using multiple signal strengths depending on the proximity of cell towers, and many of them have more than enough power to communicate with cell towers designed to cover a range of 10 square miles.[91] Under optimal conditions, a cell phone can communicate with cell towers over significantly longer distances.[92]

An essential characteristic of cell phones is their constant transmission of location information. When a cell phone is switched on, it connects with the cellular network. Without location data, the service provider operating the network does not know where to route incoming calls. As a person moves around town, the phone is passed from one cell tower to the next. Location information is available in real time and it may be stored to reconstruct movement after the fact. A mileage system would not have this capability.

Indeed, a mileage system would differ in two fundamental ways. First, the system would not have the ability to transmit data over long distances. Unlike a cell phone, the vehicle would emit a weak signal capable of traveling only a few feet. Second, the onboard system would only transmit data under controlled circumstances rather than on a continual basis. Data transmission could occur multiple ways, including—though certainly not limited to—over a home Wi-Fi connection, at designated collection points such as gas station pumps outfitted with a receiver, or through a Bluetooth signal to a driver's cell phone. However, regardless of how the data are transmitted, the onboard system would send only the limited data needed to assess a mileage fee.

Thick and thin client devices

Consumer choice and control over data collection and transmission are essential to implement a successful mileage fee system. The most important choice drivers will make is how much data to report. A system that provides total privacy is one that transmits only summary travel data and total charges, leaving no data trail. However, without historical data—or data reported after the fact—on miles, location, and time of day, disputing a particular fee becomes difficult. The key to addressing this challenge is to provide multiple options for both data collection and transmission. For some people, the optimal choice will be to transmit only summary driving and total charges. For others, the optimal choice will include additional data that give drivers the ability to dispute charges they feel are in error. Critically, none of the data collection and transmission options would alter the fundamental safeguards against tracking inherent in the design of a mileage fee system.

Drivers would exercise this control through their choice of onboard mileage device. In technology terms, drivers would choose between a "thick client device" and a "thin client device." A thick client device is hardware capable of running software applications and performing advanced computations independent of other systems. By comparison, a thin client device cannot run applications or perform advanced calculations. Instead, the thin device collects and stores data that is then transmitted to an outside system for processing.

A thick client devise ensures total privacy because calculations involving miles, location, time of day, and other information occur onboard the vehicle. This allows the driver to transmit only their summary travel statistics and total charges. A thin client device would collect and transmit information on miles, location, and time of day for calculation of total charges to either a state department of transportation or a third-party company. Federal regulations would strictly govern storage, access, analysis, and destruction of historical driving data. Each driver would have the ability to choose the level of privacy and data collection with which he or she felt most comfortable.

Global positioning systems and national scale

Thick client devices also permit the use of global positioning system, or GPS, data without fear of tracking. GPS systems rely on signals that constantly stream from a group of satellites orbiting high above the Earth.[93] The slight difference in the length of time required for the signals from different satellites to reach the GPS receiver allows the onboard system to precisely calculate location. GPS technology is more like satellite television—where an antenna passively receives signals—than cell phones, where the device also transmits location information. The military initially developed GPS technology to provide soldiers, airmen, and sailors the ability to locate themselves without the possibility of transmitting their whereabouts to the enemy. The same safeguards that protect the military would also apply to a mileage system. The onboard, thick client device would compute the VMT fee by comparing location and time-of-day information to a table of charges. Only the total mileage fee would ever be transmitted—never any location information. Once the most recent mileage-charge information had been transmitted, the system would reset and begin to count miles again.

For example, a state may choose to impose a congestion charge of 6 cents per mile for driving on a section of urban interstate during the morning and evening rush hours and a base fee of 2 cents per mile at other times. The onboard system would have a comprehensive schedule of charges to capture this and any other congestion pricing that a state or metropolitan region may choose to apply. Using GPS signals, the onboard system would calculate location, time of day, and miles driven and then compute a total charge for that trip. Then, the next time the driver connected to his or her secure home Wi-Fi signal, the onboard system would transmit only total mileage charges to the state department of transportation or a third-party company.

If a driver chose to use a thin client device, the onboard system would collect data on miles, location, and time of day and store it until the next transmission. Either the state department of transportation or a third-party company would use this information to compute charges. Again, using a thin client device would not allow for vehicle tracking because the data is provided long after the trip has taken place. Once the driver made his or her mileage payment, all historical data would be destroyed.

Given the multiple steps involved in instituting a mileage fee, it seems natural to ask, "Why bother?" After all, other less complex options—such as simple odometer readings or flat per-vehicle annual charges—exist. The answer is scalability and financing equity. Currently, the federal gas tax provides approximate information on how much driving occurs within each state. The federal government accounts for where gasoline is sold and how much revenue each state generates for the HTF. Mileage and gas tax revenue totals by state underpin, in part, the allocation of federal highway funding. If an MBUF system lacked the ability to tie driving to a particular state, all mileage charges would accrue to the state in which the vehicle was registered.

According to data from USDOT, 30 percent of truck freight by weight travels more than 250 miles[94] and 31 percent of all vehicle miles occur on trips more than 50 miles in length.[95] Although not a direct reflection of all interstate travel, these statistics show that a large share of driving crosses state lines. A mileage system unable to accurately attribute driving totals to each state would undermine basic financing equity. This is particularly troubling for states that must maintain infrastructure that supports a disproportionate share of freight or interstate travel but have a relatively small number of registered vehicles.

New Jersey, for example, has only 7.9 million registered vehicles and some of the most important highway facilities in the nation.[96] The state serves as a crossroads for travel along the Northeast Corridor and to major population centers in the Midwest. A mileage fee system that does not reflect through traffic would disadvantage New Jersey and many other states, undermining the legitimacy and efficacy of a VMT fee. By comparison, a mileage system that incorporated location information would allow states to easily remit VMT charges to the federal HTF and to other state and metropolitan areas. This approach would require vehicle owners to interact only with their home state department of transportation or third-party data management company.

No state has done more to test alternative forms of an MBUF than Oregon. Currently in its third pilot testing round, Oregon has worked through several different technology approaches that provide residents with both technological and administrative choices. Two resources from the Oregon Department of Transportation that provide additional details on the program are "Oregon's Mileage Fee Concept and Road User Fee Pilot Program"[97] and "Road Usage Charge Pilot Program Preliminary Findings."[98]

The coming vehicle technology revolution

A technology revolution is coming to transportation, regardless of what ultimately happens with the unresolved questions surrounding system finance. The bright line between vehicles and information technology, or IT, is rapidly disappearing. Today, advanced IT is mostly limited to in-vehicle applications and services. For instance, a number of major automobile manufacturers offer onboard navigation, remote vehicle access, theft response, and other services. In addition, some new vehicles have first-generation sensors that alert drivers to dangers such as stopped traffic or a vehicle located in a blind spot. This is only the tip of the iceberg.

Current safety systems are based on sensors and technology that treat the car as an independent and self-contained actor on the road. The primary benefit of these systems is that they have much quicker reflexes than people do, but they are still reactive to sudden changes in the environment.

All this is about to change. In the not-too-distant future, vehicles will use dedicated short-range communications to gain a full picture of the location and actions of other vehicles on the road. The resulting situational awareness will allow vehicles not simply to respond once something goes wrong but instead to anticipate potential problems, such as a stop light about to change from yellow to red or a vehicle trying to merge into a congested lane from an on-ramp. In addition, vehicles will receive information about surrounding infrastructure. Imagine a roadway that alerts approaching vehicles that a winter rain has started to freeze and form a dangerous, thin layer of barely visible ice.

These safety systems would not only provide drivers with warnings about dangerous conditions but could also take control and perform crash avoidance actions in a split second. The situational awareness that would result from connected vehicles and related technologies has the potential to eliminate up to 80 percent of unimpaired driver crashes, or those not involving alcohol or other controlled substances. It could also eliminate billions of hours of delay due to traffic congestion.[99]

The number of lanes and the distance between cars limit a roadway's capacity. At maximum speed, drivers must preserve a lengthy distance between their cars and the cars ahead of them in order to allow for safe braking. Advanced cruise control systems that benefit from situational awareness would allow vehicles to travel at high speeds with much shorter separation distances. Research shows that if all vehicles on the road had this type of advanced system, roadway carrying capacity would double, and congestion would be significantly reduced.[100] USDOT is currently funding a study with 3,000 cars, trucks, and buses in Ann Arbor, Michigan, to test the effectiveness of these systems and to identify remaining technological, administrative, and other challenges.[101]

Advanced IT adapted to vehicles will deliver enormous safety and efficiency benefits. However, these improvements cannot happen in an information vacuum. Implementation will also require that policymakers develop new standards to govern data collection, storage, sharing, and destruction. No doubt, this will involve difficult trade-offs between achieving the maximum possible benefits and protecting driver privacy.

While much work remains to be done, one thing is for sure: The IT genie will never return to the transportation bottle.

Mileage fees and equity

Transitioning from a gas tax to a MBUF would improve the equity of transportation finance. At issue are two different types of equity: fiscal and geographic. The principal factor influencing equity by income and geographic region is variation in vehicle fuel efficiency. The second factor is total driving.

Currently, drivers are taxed based on how much fuel they consume, which is only a loose approximation of how much they use the system. As a result, people who drive older or heavy-duty vehicles—which on average are less fuel efficient—pay more in gas taxes for the same amount of mileage. The average age of a car in the United States is 11 years.[102] A few numbers can help put this into context.

Assuming 11,300 miles of driving per year,[103] a driver with a hybrid gas-electric vehicle that averages 40 miles per gallon pays a total of $52 dollars in federal gas taxes annually.[104] A driver of a sedan that averages 20 miles per gallon pays $104 per year. Finally, someone with an older vehicle or a heavy-duty pickup that averages 16 miles per gallon pays $130 per year.[105]

Research shows that low-income and rural households tend to drive older and heavier-duty vehicles, respectively.[106] A Texas A&M University study found that, on average, Texas households in lower-income ZIP codes drove less efficient cars than households in middle- and high-income ZIP codes.[107] In addition, households in rural areas drove heavy-duty vehicles such as pickup trucks and sport-utility vehicles.[108] In fact, the share of heavy-duty vehicles in rural areas was almost twice as much as the share in large urban areas.[109] Recently, the Oregon Department of Transportation confirmed this result when it looked at the distribution of heavy-duty vehicles in its state. They found that rural areas had higher rates of ownership than their urban counterparts.[110]

At the same time, wealthier households tend to drive more fuel-efficient and advanced-technology vehicles. A report funded by the U.S. Department of Energy showed that 79 percent of Nissan Leaf and Chevy Volt drivers had household incomes of more than $100,000 per year.[111] In a national survey of 1,000 hybrid owners, Scarborough Research found that 42 percent reported an income of more than $100,000.[112] According to the Bureau of the Census, the median household income in the United States is $53,046.[113] Therefore, the most affluent drivers pay less on a per-mile basis to finance the transportation system.

A mileage fee would improve equity by leveling the playing field so that all drivers are charged the same rate for their system use. The following table presents gas tax and mileage fees based on 11,300 miles of annual driving and a VMT fee of approximately 1 cent per mile. At this rate, a VMT fee would generate the same level of revenue as the current federal gas tax.

TABLE 6

Comparison of gas tax and mileage fee for multple vehicle categories

Vehicle type	Miles per gallon	Annual gas tax	Annual mileage charge	Change
Hybrid	40	$52	$108	$56
New sedan	30	$69	$108	$39
Older sedan	20	$104	$108	$4
Pickup/SUV	16	$130	$108	-$22

Source: Government Accountability Office, "Highway Trust Fund: Pilot Program Could Help Determine the Viability of Mileage Fees for Certain Vehicles," GAO-13-77, Report to the Subcommittee on Transportation, Housing, and Urban Development, and Related Agencies, Committee on Appropriations, House of Representatives, December 2012, available at http://www.gao.gov/assets/660/650863.pdf.

Transportation taxes and advanced-technology vehicles

Buying a vehicle is a big decision. A primary consumer concern is cost—both the initial purchase price and ongoing operating expenses. Beyond monthly vehicle lease or financing charges, the single-largest cost to owners is fuel. The average vehicle owner today drives approximately 11,300 miles per year.[114] The average fuel efficiency of a vehicle on the road today is 23.5 miles per gallon. By comparison, hybrid gas-electric vehicles average about 50 miles per gallon.[115] With new car buyers holding onto their vehicles for almost six years,[116] the difference in fuel costs between a new hybrid vehicle and the average vehicle is substantial. At the current average fuel price of $3.70 per gallon,[117] this translates to more than $5,600 in savings over the typical owner's use of a vehicle. Over those six years, a hybrid vehicle owner stands to pay approximately $281 more in mileage fees than they would under the gas tax system. The savings from improved fuel economy are more than 20 times greater than the additional cost of the mileage fee. In addition, when compared to the manufacturer suggested retail price, or MSRP, for a hybrid vehicle the mileage fee represents only 1 percent of MSRP.[118]

In short, advanced-technology vehicles put money in consumers' pockets because they save fuel, not taxes. Transitioning to a mileage fee system of transportation finance would have negligible effects on the demand for advanced-technology vehicles.

When compared to gas taxes, a flat mileage fee would essentially hold constant or reduce transportation taxes for households driving older or heavy-duty vehicles. At the same time, drivers of the most efficient vehicles would pay more.[119] While both gas taxes and mileage fees are regressive, switching to an MBUF would result in higher-income drivers paying a larger share of the transportation financing burden. Moreover, as fuel-economy standards increase in the coming years and more advanced-technology vehicles enter the market, the disparity between high- and low-income drivers will only grow. A mileage fee would reverse this trend.

In addition to fuel efficiency, transportation taxes are tied to total driving. Critics of a mileage fee often argue that it would disproportionately affect rural drivers. After all, rural drivers must travel farther to meet their daily needs. The same study from the Oregon Department of Transportation that looked at vehicle ownership by region also examined overall driving levels by county. The study grouped counties into three categories: urban, mixed, and rural. The results showed that rural and urban drivers have virtually identical driving levels: "Although rural residents tend to drive longer distances for typical errands such as grocery or clothes shopping, school, and medical appointments, they also tend to engage in such activities less frequently than their urban counterparts."[120]

Interestingly, rural survey participants also reported driving an average of 1,090 miles off-road each year. Under the current gas tax system, there is no way to distinguish between miles driven on public roads or on farmland. Another advantage of a mileage fee system is that it would only apply to driving that takes place on public roadways. This means that farmers and other workers would not be charged for miles incurred as a result of off-road agricultural or other activity.

TABLE 7

Averge vehicle miles traveled by geographic type

Geography	Average annual mileage
Urban	12,843
Mixed	13,865
Rural	12,511
Total	12,962

Source: Oregon Department of Transportation, "Report on Impacts of Road Usage Charges in Rural, Urban and Mixed Counties" (2013), available at http://www.oregon.gov/ODOT/HWY/RUFPP/docs/FINAL_Report_Impacts_RoadUserCharges_Rural_Urban_Mixed_Counties_Jan_2013.pdf.

Reaching full implementation

Implementing a national MBUF system will take time. Fortunately, the technology changeover involved does not have to happen all at once and would not require retrofitting vehicles—though some drivers may choose this option. This is a significant benefit, as the U.S. vehicle fleet turns over very slowly. Research by Oak Ridge National Laboratory shows that the average age of a car in the United States is 11 years, with an average useful life of 17 years.[121] For light-duty trucks, the average age is 10.4 years, with a useful life of 15.5 years.

The reason that an MBUF system would not require expensive retrofitting of existing vehicles is that it would be able to operate parallel to the current gas tax regime. This means that drivers of older vehicles would continue to pay the gas tax while drivers of newer vehicles would pay the mileage fee. New model vehicles would be required to carry the MBUF technology platform and eventually the entire fleet would pay a mileage fee.

State and federal gas taxes are collected at the wholesale level and the cost is passed along to consumers at the pump. Because there are few distributors, collecting taxes at wholesale is simpler than trying to collect from thousands of individual gas stations. This reduces collection costs and opportunities for fraud. The key to implementing a mileage fee is crediting drivers for the gas taxes they have already paid at the pump and then issuing a refund or a bill for the difference.

Calculations would be based on the make and model year of the vehicle participating in the mileage fee program using fuel-efficiency ratings from the EPA. Once a driver reports his or her total mileage, either the state department of transportation or a third-party data company would calculate gas tax contributions and send the driver a bill or refund depending on the balance of charges.

The most practical approach to implementing an MBUF system would be to mandate that the technology be included beginning with a certain model year. For example, Congress could mandate that beginning with model year 2025, all new vehicles sold in the United States include VMT technology. Individuals would have the choice of purchasing a vehicle with either a thick or thin client device depending on their preferences surrounding data collection and privacy. Given the length of time that vehicles remain on the road, full implementation would take at least 17 years after the first model year requiring the technology. Once all vehicles were participating in the mileage fee system, gas taxes would be removed.

Unfortunately, the one resource the federal program lacks is time. The insufficient revenue generated by current gas and diesel fuel taxes means that the HTF will become insolvent as early as July 2014. For this reason, Congress should raise the gas tax by 15 cents per gallon and raise the diesel tax by 19.9 cents. The resulting tax revenues would return the trust fund to solvency and provide the time the government needs to begin to implement a mileage program.

Conclusion

Dramatic improvements in vehicle fuel efficiency have eroded the long-term viability of the gas tax as a primary source of transportation revenue. This summer, Congress has a unique opportunity to set federal surface transportation programs on a path to long-term stability by taking three important steps.

First, Congress should increase the gas tax by 15 cents per gallon with an equivalent percentage increase on diesel. Raising the gas tax is essential to stabilize the trust fund and to provide time to transition to a mileage-based user fee model of transportation finance. Second, Congress should authorize $100 million as part of the surface transportation authorization bill to fund state-based MBUF demonstration projects in 10 to 15 states. Pilot projects will allow states to test different VMT technology platforms, administrative approaches, and privacy protocols. Third, Congress should establish a surface transportation revenue office within the Office of the Secretary of Transportation to facilitate demonstration projects, provide technical assistance, share best practices, and fund independent research on privacy standards for vehicle data.

Transitioning to a VMT fee will not only produce a more reliable source of revenue, but it will also provide a technology platform that will allow states and metropolitan regions to actively manage their roadway networks through pricing. While other revenue sources could potentially fill the funding gap they lack a direct connection to system use and would not provide a sound policy tool to manage growing congestion. By comparison, congestion pricing provides a means to efficiently allocate the scare resource of highway lane miles. In addition to improving system performance, the revenue generated by congestion pricing could provide a significant boost to public transportation services, providing people with an affordable, safe, and timely alternative to driving.

The alternative is a trust fund that lurches from one crisis to the next. States will be unable to engage in long-term planning because of ongoing uncertainty regarding the strength and reliability of their federal partner, and failure to act will cause immediate economic pain and undermine our national economic competitiveness. American workers, their families, and their businesses deserve a long-term policy solution. An MBUF is the most effective, fair, and powerful tool to build and maintain the infrastructure we need to support our economy for decades to come.

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