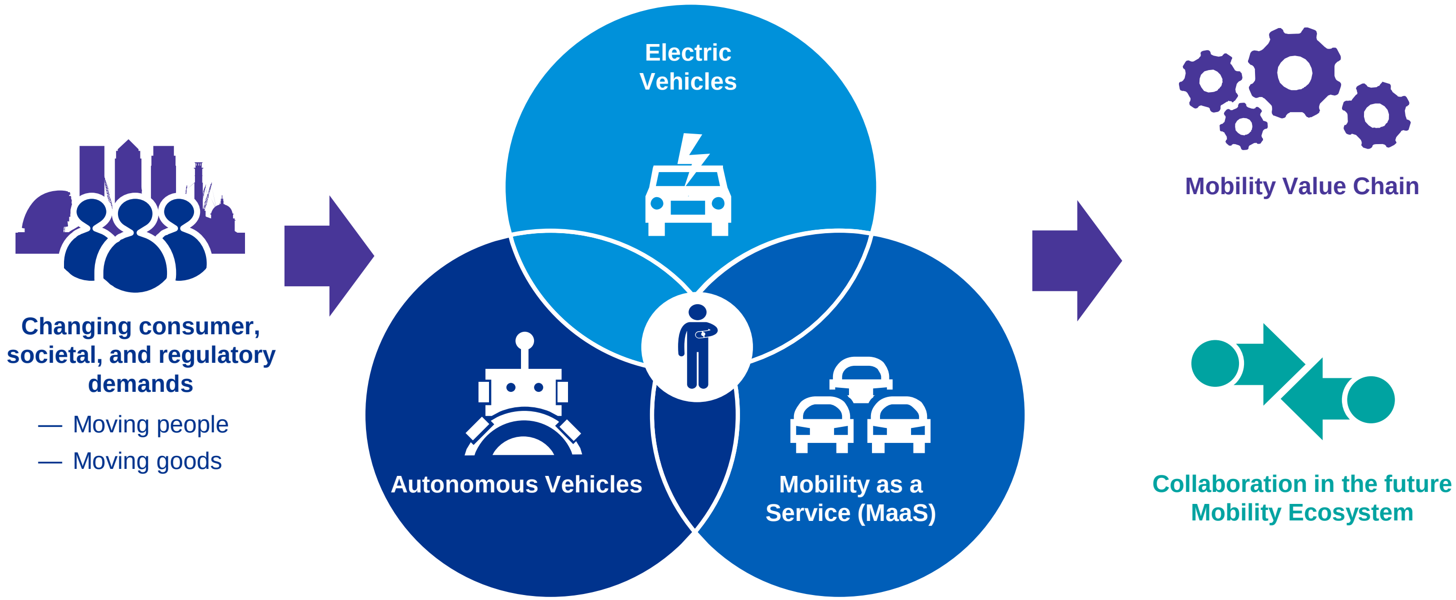
33rd Annual DBE Workshop and Secretary's Golden Shovel Awards Conference

Driving the Future Mobility in the 21st Century

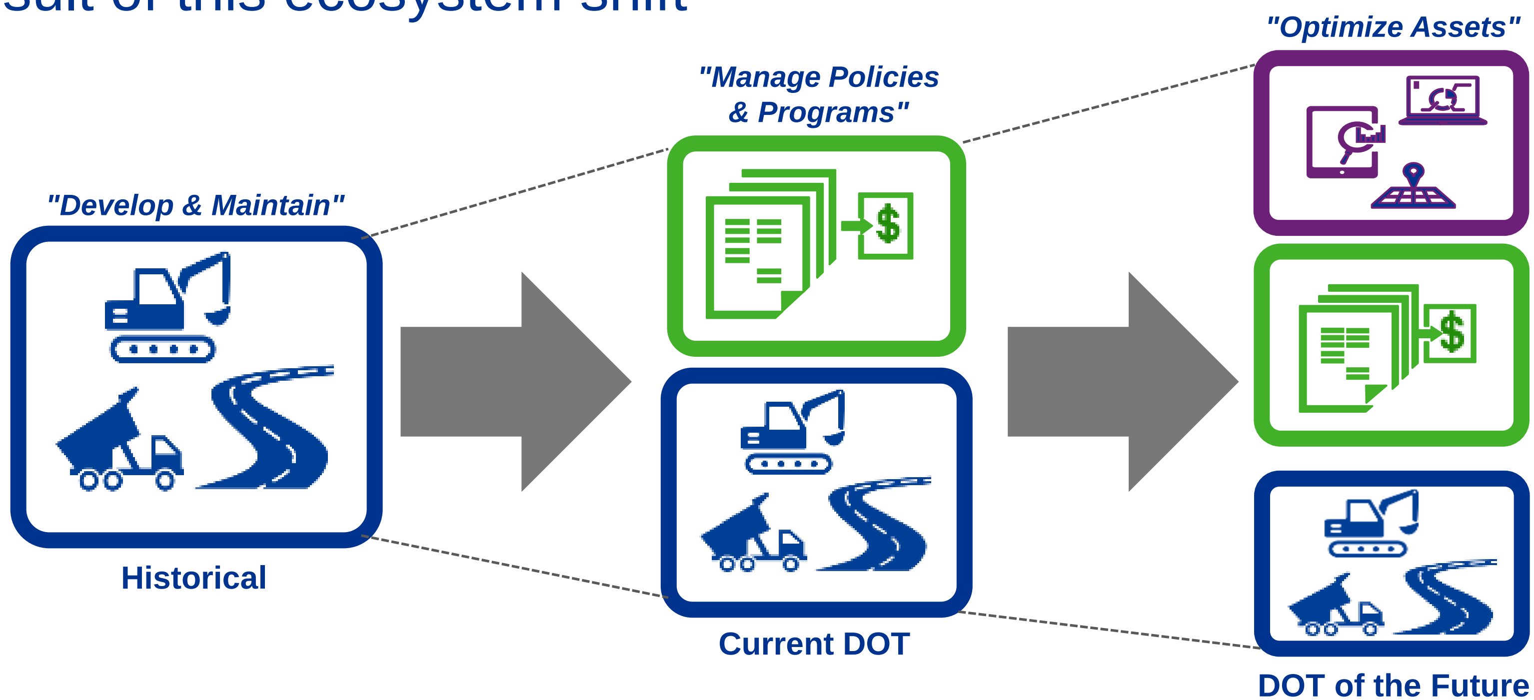
February 14 2019

KPMG’s View on Shifting Transportation Demand

A fundamental shift in mobility has been initiated, driven by three major forces



The role and operating model of the public sector, DOTs and planners is changing very quickly as a result of this ecosystem shift



Key insights

— Historically, DOTs have been large program developers, with a broad set of in-house engineering skills and capabilities

— In the recent past, reorganization and limited ability to capture the right skill base has required more focus on management of policies and programs to influence and guide development efforts

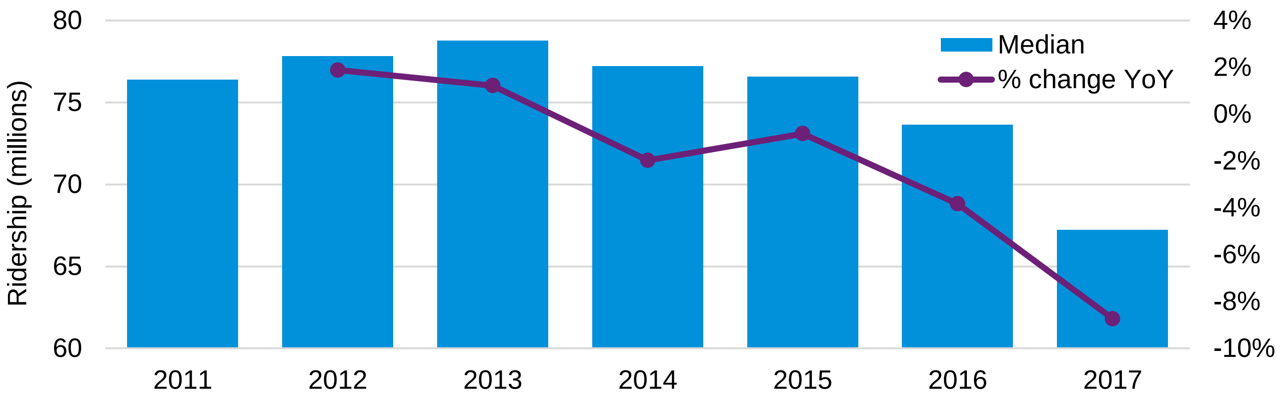
— The DOT of the Future will need to be a broad connector, bringing together a wide variety of stakeholders, modes, and data to ensure that every dollar is spent on the most effective possible project

For example, bus ridership has been declining nationally across major urban areas

KEY INSIGHTS

- In top urban areas, bus ridership has been declining every year since 2013
- Bus ridership has decreased nearly 15% in top urban areas since 2013
- From 2016 to 2017, alone, bus ridership declined approximately 9% in top urban areas
- In Los Angeles, bus ridership has declined almost 20% since 2013

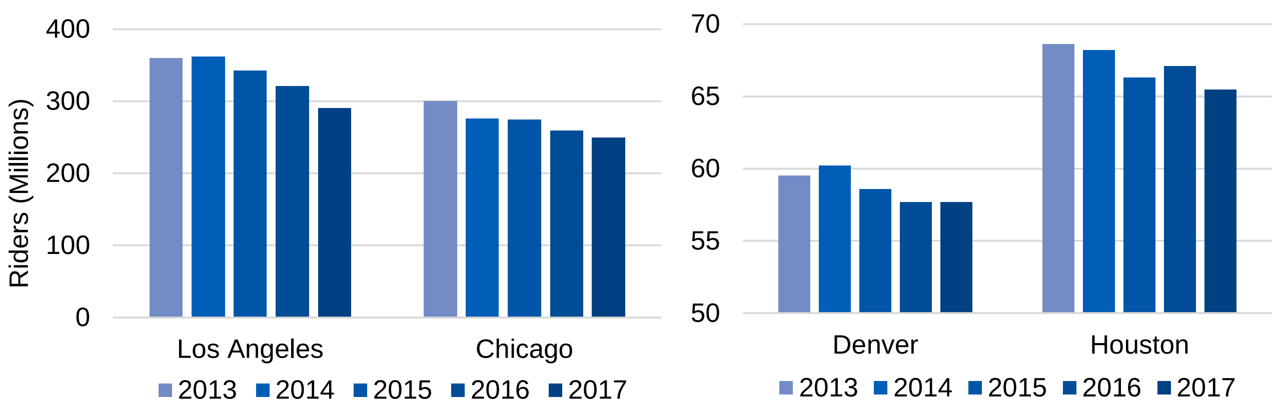
Bus ridership in top urban areas[1]



[1]Top urban cities includes Chicago, Denver, Los Angeles, Austin, Houston, Boston, Miami, San Diego, Seattle, Charlotte, and New York

Source: FTA adjusted database report

Bus ridership in select U.S. cities

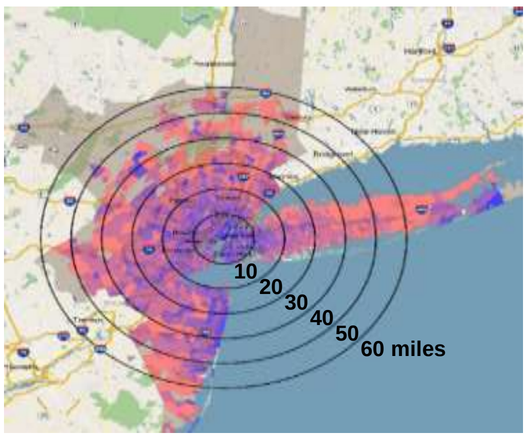


Source: FTA adjusted database report

Meanwhile, Mobility as a Service (MaaS) has grown significantly – dramatically shaping new transportation behaviors

New York City MSA

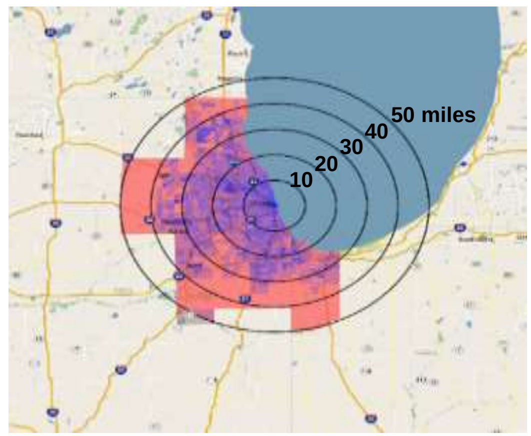
Type A: Dense urban center, large suburban metro area, high public transit usage



Average Wait for Closest Uber: 6:09
n = 27,908

Chicago MSA

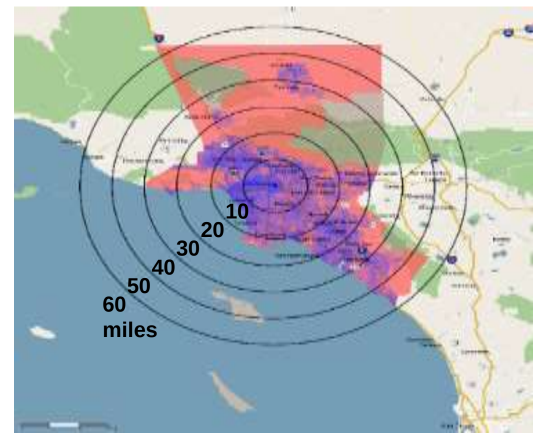
Type B: Significant urban center, sprawling suburban metro area, medium public transit usage



Average Wait for Closest Uber: 6:43
n = 12,928

Los Angeles MSA

Type C: Unclear urban center, vast suburban metro area, low public transit usage



Average Wait for Closest Uber: 5:24
n = 18,107

Minutes Wait: Less than 3:00 | 3:00 – 5:00 | 5:00 – 7:00 | 7:00 – 10:00 | More than 10:00 | Not Available

Note: Census tracts were sampled a minimum of four times. Those that returned an available Uber at least once were defined as having regular Uber service. Average wait time calculation is population weighted and only includes areas where Uber is available

A host of players continues to make strides to meet evolving mobility needs

On-Demand Mobility

Mobility services, requested on demand via app or other interface

- **Uber** (founded March 2009) develops, markets, and operates a ridesharing mobile app routed to crowd-sourced taxi drivers
- **Lyft** (founded June 2012) operates and markets a smartphone-based ridesharing and peer-to-peer transportation company that matches drivers with passengers who request rides.

On-Demand Public Transportation

Private mobility companies running routes based on customer demand, requested via apps

- **Arrivaclick** provides on-demand minibus services in Sittingbourne, Kent
- **Citymapper Black Bus** service runs low cost black taxis along fixed routes in London, shared with other customers with a mutual travel direction
- **Citymapper Smartbus** utilises app analytics to establish new fixed bus routes in London based on customer demand

Car Sharing

Car sharing services, often subscription or app-based

- **Zipcar** offers car rental by the hour or day, with a range of vehicle types placed in neighbourhoods, cities & airports globally. Provides freedom of accessing a car, without the expense of ownership
- **DriveNow** a car-sharing company between BMW and Sixt, allows the use of freely parked vehicles in the city area, can be unlocked using the app. Price inclusive of fuel, parking, insurance and rental

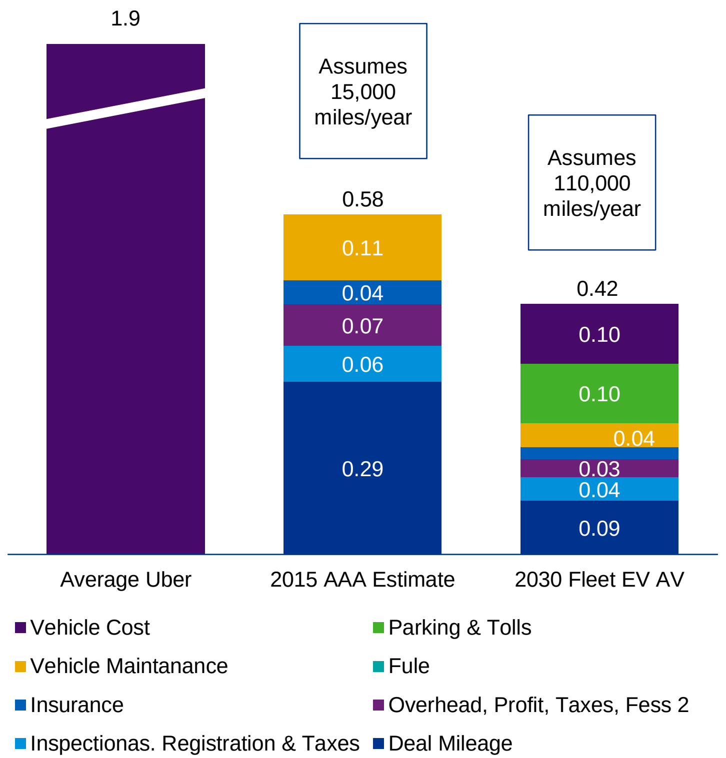
Multi-modal journey planning

End-to-end journey planning, maximising journey efficiency across multiple modes of transport will likely aggregate all of the above MaaS elements.

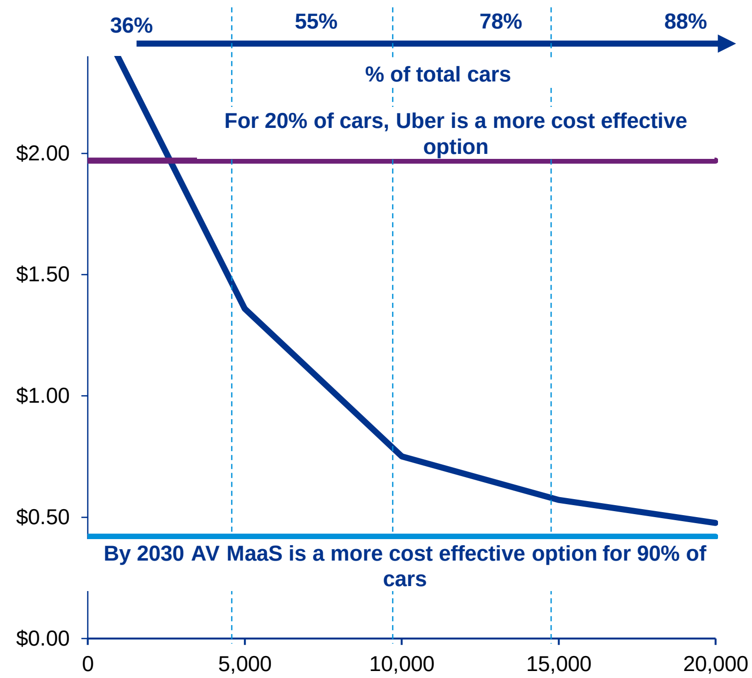
- **UbiGo** app service, initially in Gothenburg, combining public transport, car-sharing, rental car service, taxi and a bicycle system, producing single invoices, with 24/7 support and rewarding sustainable travel choices
- **Whim**, MaaS app cooperating with the largest public and private transport providers in Helsinki. Enables mid-journey replanning, grocery delivery etc. Different subscription models (e.g. unlimited use for business travel)

Once the driver is removed for on demand mobility options, there will be a drastic reduction in cost

Transportation Cost in $ per mile



By 2030 AV MaaS will be cheaper per mile than most personal vehicles[(a)]



Note: (a) Average Uber cost per mile for 5 mile / 20 min. trip in top 10 largest cities in US.
Sources: (1) AAA; (2) NHTS 2009 Survey; (3) Business Insider; (4) KPMG Analysis, (5) Uber

Understanding personal mobility is critical to forecasting change

Safe independence for the kids

Children will have the freedom to safely travel to meet up with friends or go to the movies or countless other activities

Convenience of “my time”

Working parents and young adults can travel further to work as AV technology allows them to be productive even during the commute

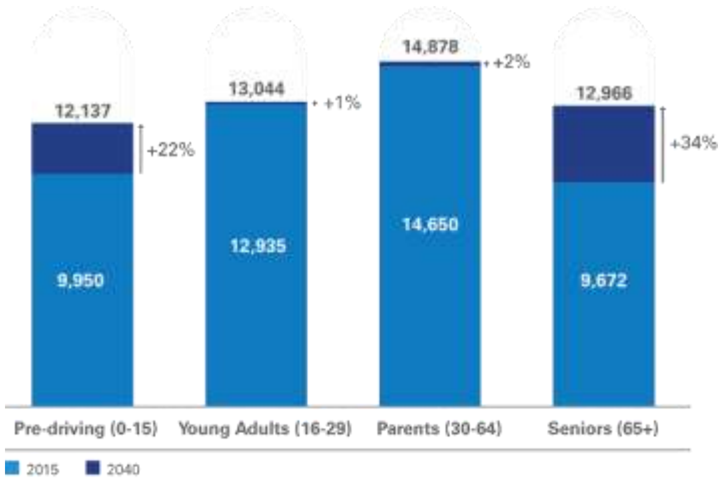
Independence for seniors

The safety of seniors driving as they age will no longer be a concern and they can continue being active

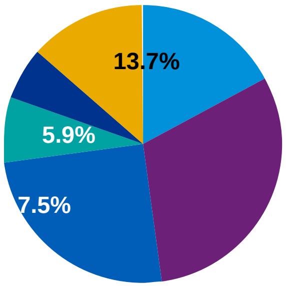
Core vs. Non Core Missions

Segmenting trip missions as core vs. non core will drive which are conducive to AV

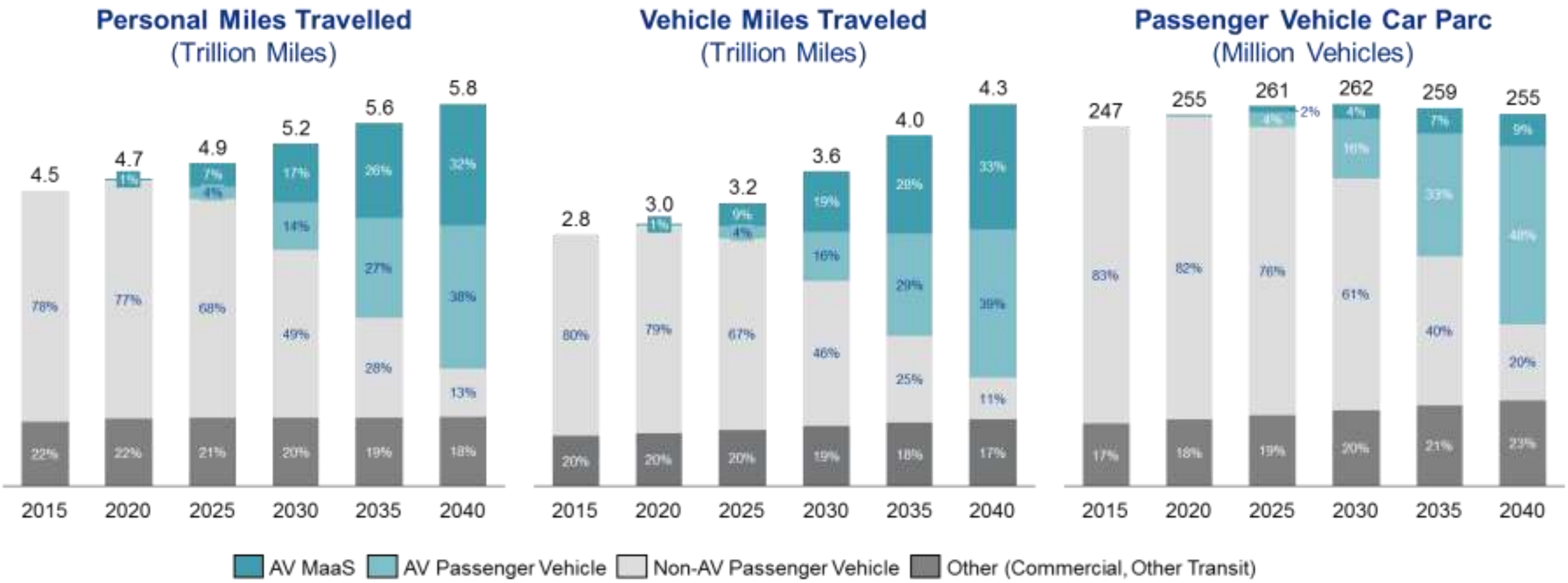
U.S. personal miles traveled (PMT) per capita



Driving Missions



One outcome is a “demand curve” through 2040, profiling key transportation segments and how they will evolve over time



This demand curve is customized to specific cities and regions based on localized trip data

Trips Overview

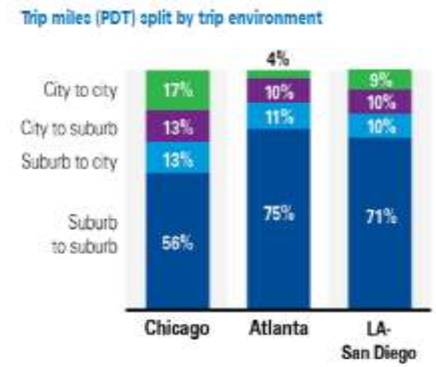
Atlanta

Chicago

Los Angeles/ San Diego

Underlying Trip Data

(PDT= Personal Distance Traveled)

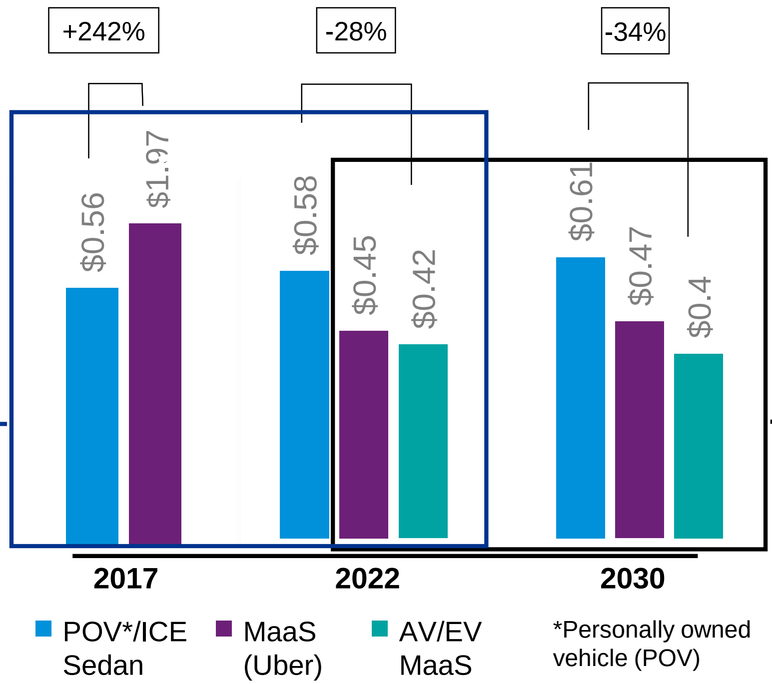


Removing the driver from the vehicle will also accelerate mass market pull for electrification

Levelized cost per mile

Ownership: *The First Transition*

- Cost per mile of MaaS is initially higher, because of convenience factor
- Increased MaaS adoption reduces value of personal vehicle ownership



*Personally owned vehicle (POV)

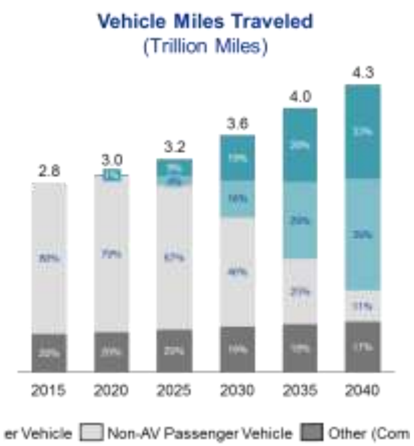
Driver Removed: *The Second Transition*

- High utilization of vehicles in AV MaaS in fleet settings will lead to EV cost per mile advantage
- Battery cost and range continue to improve, magnifying this effect

Note: (a) Average Uber cost per mile for 5 min to 20 min trip in top 10 largest cities in U.S in 2015 (b) AV MaaS and POV assume 5 year TCO (MaaS - 70k miles/year, POV – 15k miles/year) (c) AV/EV vehicle used for comparison is 2018 Chevrolet Bolt, AV/ICE is 2018 Prius (d) 2.2% historical price growth CAGR applied to ICE sale price forecast (e) 50% drop in EV battery price between 2017-2025 (from $250/kWh to $125/kWh), range = 240milies/60kWh Battery (f) AV MaaS includes 30% operator profit margin (g) Fuel Assumptions = $3.00/gal ICE (10 year national historical average), $0.12/kWh EV
Sources: (1) Uber (2) Business Insider (3) AAA (4) Kelley Blue Book (5) KPMG Analysis

VMT data can then be translated into EV adoption over the forecast period

VMT Data → **Rule Based Allocation to EVs** → **EV Adoption Forecast** (By mode, geography, powertrain, etc.…)



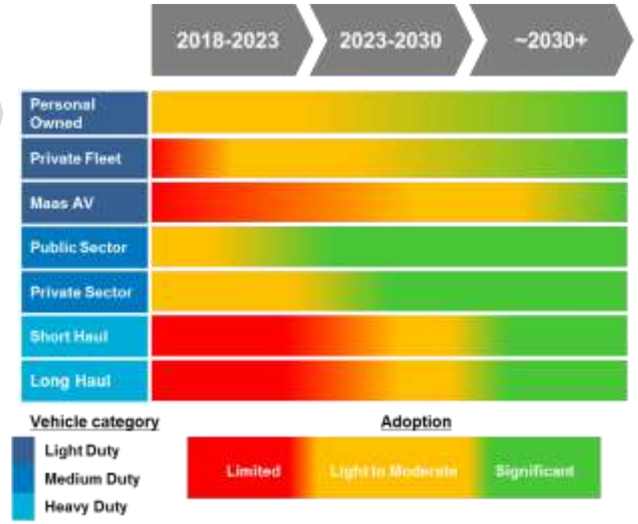
% Distribution of EVs by Density	
Density	% Distribution
Rural	5%
Exurban	10%
Suburban	25%
Urban	30%
Dense Urban	30%

% Distribution of Car Types	
Car	46%
Pickup	18%
SUV	23%
Other	12%

Year	Avg. Car Price	Total New EV Sales	% New Car Sales
2019	46,000	381,685	2.2%
2020	44,000	757,017	4.6%
2025	35,000	2,092,656	13.3%
2030	30,000	4,697,720	30.7%
2040	30,000	12,521,875	78.0%

Density	Mode	Fill Rank
Dense Urban	AV Personal PV	1
Urban	AV Personal PV	2
Dense Urban	Personal PV	3
Urban	Personal PV	4
Suburban	AV Personal PV	1
Exurban	AV Personal PV	2
Suburban	Personal PV	3
Exurban	Personal PV	4
Rural	AV Personal PV	1
Rural	Personal PV	2
Dense Urban	AV MaaS	1
Urban	AV MaaS	2
Suburban	AV MaaS	3
Exurban	AV MaaS	4
Rural	AV MaaS	5

US Electric Vehicle VMT Summary (millions)					
	Mode	2020	2025	2030	2040
	Personal PV	22,092	33,622	32,394	29,291
	AV Personal PV	0	37,905	166,976	904,313
	AV MaaS	21,009	189,721	473,560	1,046,648
	Total	**43,100**	**261,248**	**672,930**	**1,980,251**



What holds true is that an efficient, safe, and well-maintained transportation network is still critical to a region's success

Key insights

- ACEs are expected to significantly reduce travel cost, time and congestion, while increasing safety
- New investment will be needed to allow Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) communications – increased demand for connectivity and reliability / bandwidth
- These technologies could help DOTs/Transit agencies to eliminate potential inefficiencies within transportation systems – i.e., congestion, safety, etc.
- Each market with unique travel patterns require a different solution

Technological disruptions (ACEs, drones, cloud, IoTs, Dedicated Short Range Communication (DSRC), ride sourcing, business analytics, block chain, 3D printing, Artificial Intelligence) can have a major influence on transportation services in terms of:

- Mobility
- Accessibility
- Public safety
- Environment
- Asset management (location, condition, functionality, etc.)
- Transportation planning
- Demographic preferences
- Funding sources

While transportation agencies face funding crises from declining revenues and greater infrastructure investment needs

Key insights

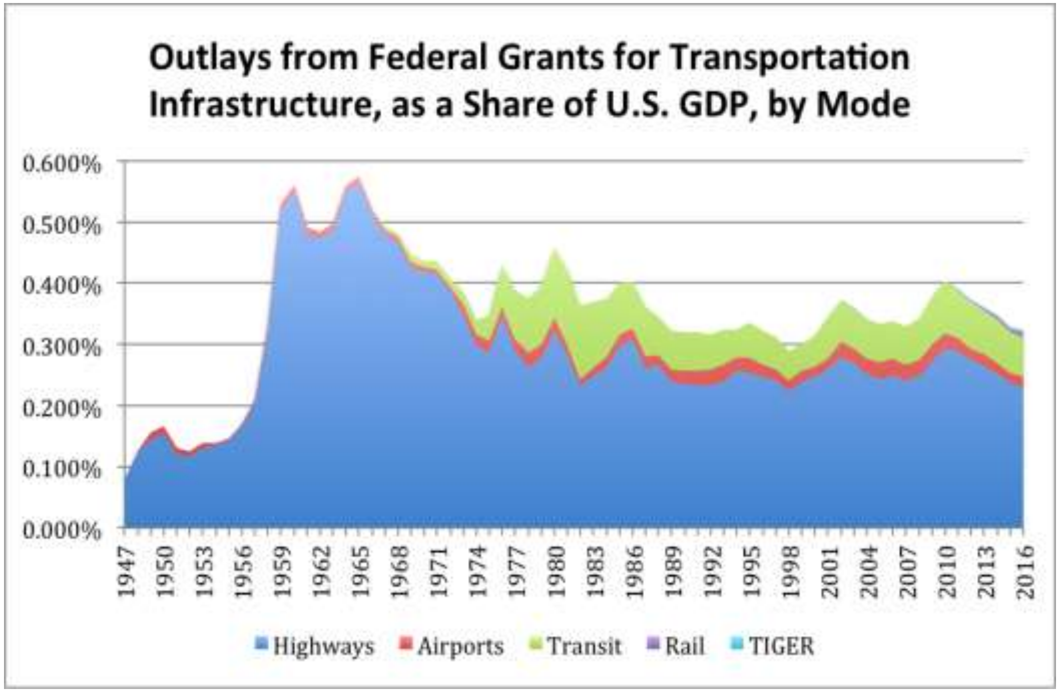
- It is estimated that $163 billion in additional revenue is required to keep the Highway Trust Fund solvent through FY2028 at current spending levels
- Additionally, it is estimated that on average DOTs are spending an estimated one-third to one-half as much as necessary to adequately maintain the transportation system
- At a national level infrastructure spending has remained relatively flat over the past 30 years, resulting in major underinvestment
- Current proposals to rebuild the infrastructure focus on the use of private funds to help finance a significant share of the reconstruction effort

$163 billion

The Congressional Budget Office (CBO) estimates that $163 billion in additional revenue is required to keep the Highway Trust Fund solvent through FY2028

1/3 TO 1/2

It is estimated that on average DOTs are spending only one third to one half of the amount required to adequately maintain and make key improvements to the transportation system

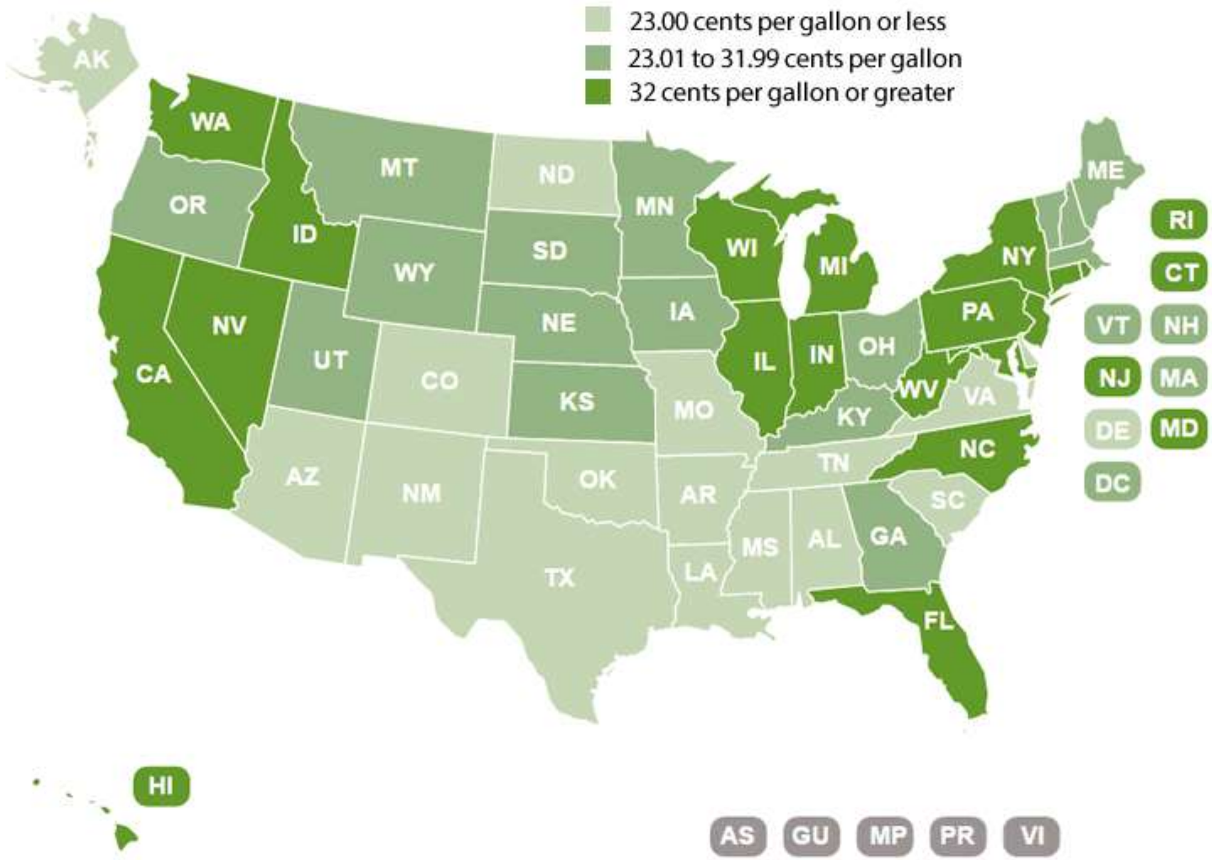


Source: Eno Transportation

The Motor Fuel Tax – which had long satisfied much of this funding – is losing relevance in this new mobility ecosystem

Key insights

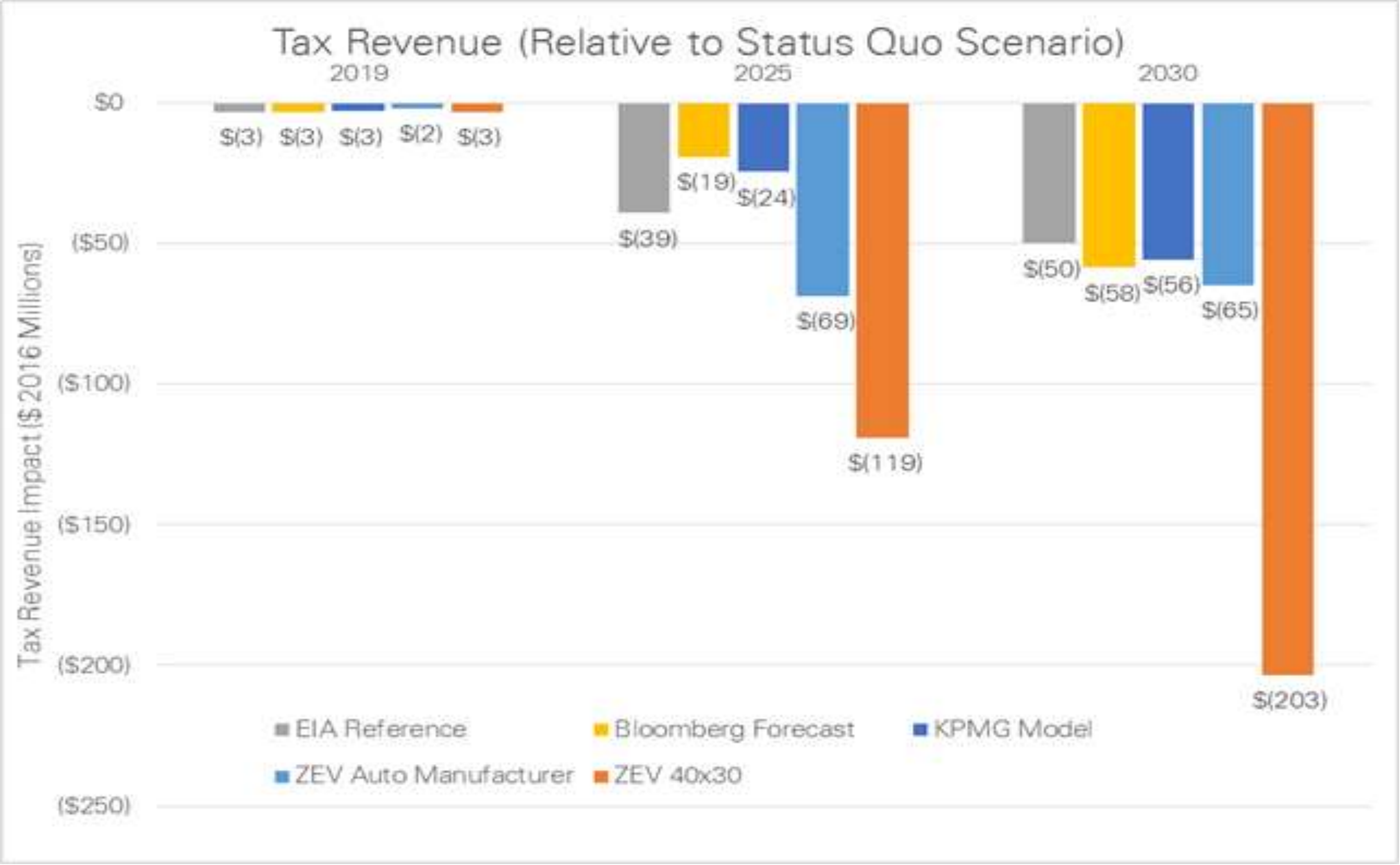
- Adoption of ACE vehicles is expected to result in a significant decrease in fuel consumption
- On average 40 percent of DOT's transportation funding is based on revenues from the motor fuel tax
- Demand for gasoline is expected to decrease 18% by 2030
- Transition to new / innovative revenue sources is key to maintain the current level of service



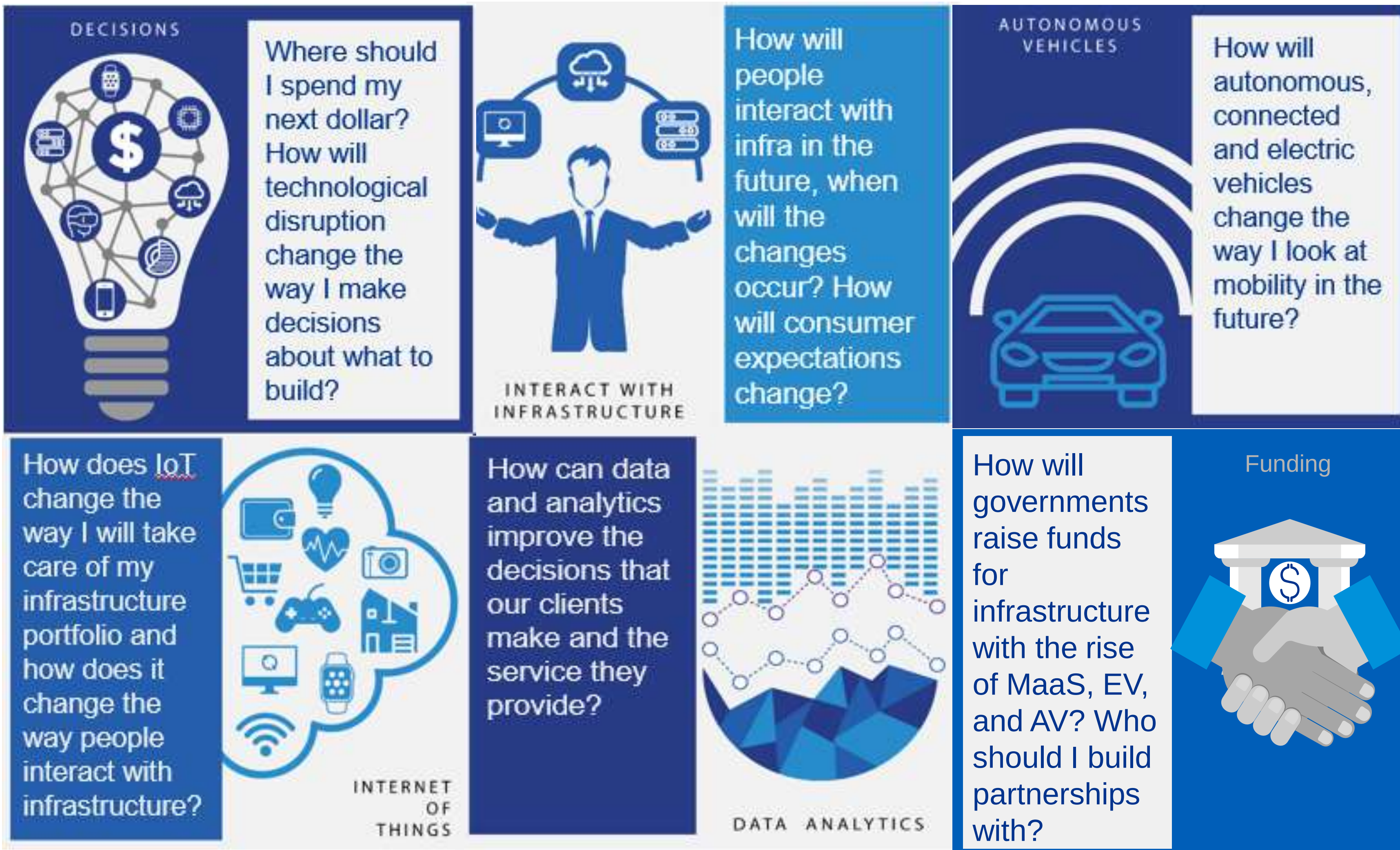
Source: http://www.ncsl.org/bookstore/state-legislatures-magazine/deep-dive-transportation-funding.aspx

The negative acceleration of MFT revenues will only increase. States and DOTs have a small window to determine what is next.

Tax Revenue Implication (Relative to Status Quo in Real 2016$):



Government agencies must be prepared to answer the following questions to stay relevant and engaged through the transition



Pulling on a wide variety of available levers will result in a more robust model that better prepares the public sector for the future

Levers

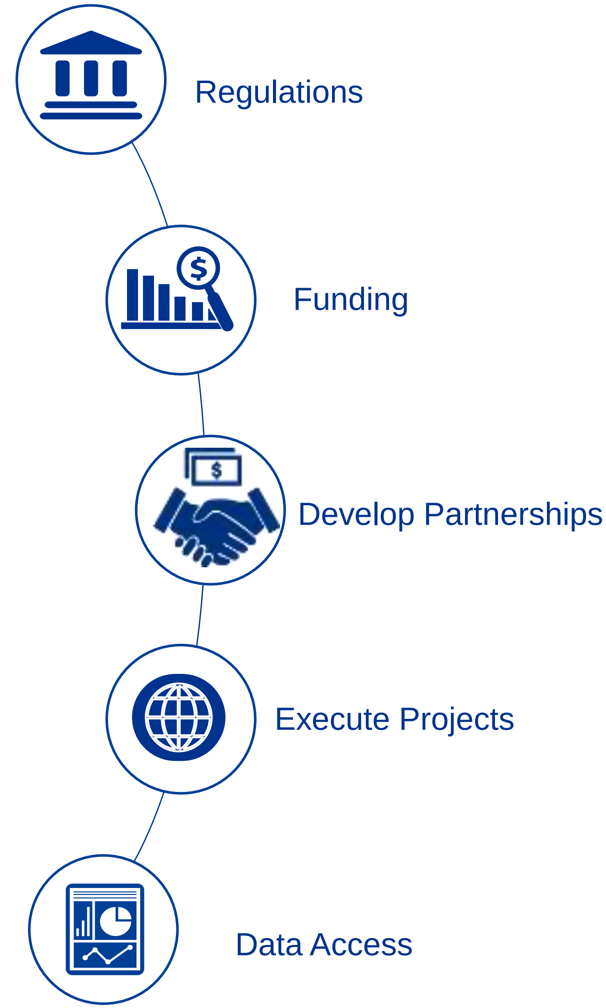
Regulation – Government needs to proactively embrace the autonomous vehicle movement through logical and growth oriented legislation

Funding – How governments raise money for Infrastructure investment and maintenance is a paramount concern. MFT is under accelerating pressure; VMT, tolling, fees will all need to be considered.

Partnerships – Investment focus is changing. Advances in mobility, connectivity, and autonomy are encouraging more dollars toward joint ventures and partnerships to bridge the gap between public and private interest

Execute Projects – Plan, Design, Build, and Maintain infrastructure capable of promoting a connected and autonomous environment

Data Access – Access to data has quickly become one of the most valued resources in the world. Government needs to effectively aggregate, analyze and protect data to drive strategic insights



Summary Mobility Opportunities and Implications