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

Driving the Future Mobility in the 21st Century

February 14 2019
A fundamental shift in mobility has been initiated, driven by three major forces:

- Changing consumer, societal, and regulatory demands
  - Moving people
  - Moving goods

- Mobility Value Chain
- Collaboration in the future Mobility Ecosystem
- Electric Vehicles
- Autonomous Vehicles
- Mobility as a Service (MaaS)
Mobility in the 21st Century

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

Historical 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.

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.

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Mobility in the 21st Century

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**

![Graph showing bus ridership in top urban areas from 2011 to 2017.](image)

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

**Bus ridership in select U.S. cities**

![Graph showing bus ridership in select U.S. cities.](image)

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KPMG’s View on Shifting Transportation Demand

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

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

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

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.
KPMG’s View on Shifting Transportation Demand

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

- **On-Demand Mobility**
  - 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**
  - 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**
  - 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).
KPMG’s View on Shifting Transportation Demand

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

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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

#### (PDTs: Personal Distance Traveled)

- **Trip miles (PDT) per capita**
  - Chicago: 8,363
  - Atlanta: 11,030
  - LA-San Diego: 9,115

- **Trip miles (PDT) split by trip environment**
  - City to city: Chicago 17%, Atlanta 4%, LA-San Diego 3%
  - City to suburb: Chicago 13%, Atlanta 11%, LA-San Diego 10%
  - Suburb to city: Chicago 13%, Atlanta 75%, LA-San Diego 71%
  - Suburb to suburb: Chicago 56%, Atlanta 75%, LA-San Diego 71%

- **Trip miles (PDT) split by trip occupancy**
  - 1 to 2: Chicago 76%, Atlanta 81%, LA-San Diego 67%
  - 3 to 4: Chicago 11%, Atlanta 12%, LA-San Diego 7%
  - 5 to 6: Chicago 2%, Atlanta 2%, LA-San Diego 5%
  - 7+: Chicago 11%, Atlanta 2%, LA-San Diego 5%

- **Trip miles (PDT) split by trip duration**
  - <15 min: Chicago 33%, Atlanta 22%, LA-San Diego 19%
  - 15-30 min: Chicago 10%, Atlanta 2%, LA-San Diego 19%
  - >30 min: Chicago 4%, Atlanta 10%, LA-San Diego 21%
KPMG’s View on Shifting Transportation Demand

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

**Levelized cost per mile**

<table>
<thead>
<tr>
<th>Year</th>
<th>POV*/ICE Sedan</th>
<th>MaaS (Uber)</th>
<th>AV/EV MaaS</th>
<th>*Personally owned vehicle (POV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017</td>
<td>$1.97</td>
<td>$1.56</td>
<td>$0.56</td>
<td>$0.58</td>
</tr>
<tr>
<td>2022</td>
<td>$1.97</td>
<td>$1.56</td>
<td>$0.45</td>
<td>$0.58</td>
</tr>
<tr>
<td>2030</td>
<td>$0.61</td>
<td>$0.47</td>
<td>$0.42</td>
<td>$0.40</td>
</tr>
</tbody>
</table>

**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

**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 = 240miles/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

#### % Distribution of EVs by Density

<table>
<thead>
<tr>
<th>Density</th>
<th>% Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>5%</td>
</tr>
<tr>
<td>Exurban</td>
<td>10%</td>
</tr>
<tr>
<td>Suburban</td>
<td>25%</td>
</tr>
<tr>
<td>Urban</td>
<td>30%</td>
</tr>
<tr>
<td>Dense Urban</td>
<td>30%</td>
</tr>
</tbody>
</table>

#### % Distribution of Car Types

| Car     | 46% |
| Pickup  | 18% |
| SUV     | 23% |
| Other   | 12% |

### Rule Based Allocation to EVs

#### Density Mode Fill Rank

<table>
<thead>
<tr>
<th>Density</th>
<th>Mode</th>
<th>Fill Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dense Urban</td>
<td>AV Personal PV</td>
<td>1</td>
</tr>
<tr>
<td>Urban</td>
<td>AV Personal PV</td>
<td>2</td>
</tr>
<tr>
<td>Dense Urban</td>
<td>Personal PV</td>
<td>3</td>
</tr>
<tr>
<td>Urban</td>
<td>Personal PV</td>
<td>4</td>
</tr>
<tr>
<td>Suburban</td>
<td>AV Personal PV</td>
<td>1</td>
</tr>
<tr>
<td>Exurban</td>
<td>AV Personal PV</td>
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</tr>
<tr>
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<tr>
<td>Exurban</td>
<td>AV MaaS</td>
<td>4</td>
</tr>
<tr>
<td>Rural</td>
<td>AV MaaS</td>
<td>5</td>
</tr>
</tbody>
</table>

### EV Adoption Forecast

(By mode, geography, powertrain, etc....)

#### US Electric Vehicle VMT Summary (millions)

<table>
<thead>
<tr>
<th>Mode</th>
<th>2020</th>
<th>2025</th>
<th>2030</th>
<th>2040</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal PV</td>
<td>22,092</td>
<td>33,622</td>
<td>32,394</td>
<td>29,291</td>
</tr>
<tr>
<td>AV Personal PV</td>
<td>0</td>
<td>37,905</td>
<td>166,976</td>
<td>904,313</td>
</tr>
<tr>
<td>AV MaaS</td>
<td>21,009</td>
<td>189,721</td>
<td>473,560</td>
<td>1,046,648</td>
</tr>
<tr>
<td>Total</td>
<td>43,100</td>
<td>261,248</td>
<td>672,930</td>
<td>1,980,251</td>
</tr>
</tbody>
</table>

#### Year Avg. Car Price Total New EV Sales % New Car Sales

<table>
<thead>
<tr>
<th>Year</th>
<th>Avg. Car Price</th>
<th>Total New EV Sales</th>
<th>% New Car Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>46,000</td>
<td>381,685</td>
<td>2.2%</td>
</tr>
<tr>
<td>2020</td>
<td>44,000</td>
<td>757,017</td>
<td>4.6%</td>
</tr>
<tr>
<td>2025</td>
<td>35,000</td>
<td>2,092,656</td>
<td>13.3%</td>
</tr>
<tr>
<td>2030</td>
<td>30,000</td>
<td>4,697,720</td>
<td>30.7%</td>
</tr>
<tr>
<td>2040</td>
<td>30,000</td>
<td>12,521,875</td>
<td>78.0%</td>
</tr>
</tbody>
</table>
What holds true is that an efficient, safe, and well-maintained transportation network is still critical to a region's success. 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.

**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
Mobility in the 21st Century

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

- 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.

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.

Outlays from Federal Grants for Transportation Infrastructure, as a Share of U.S. GDP, by Mode

Source: Eno Transportation
Mobility in the 21st Century

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.

Mobility in the 21st Century

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$):

![Tax Revenue Implication Graph](image-url)
Mobility in the 21st Century

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

- **Where should I spend my next dollar? How will technological disruption change the way I make decisions about what to build?**
- **How will people interact with infra in the future, when will the changes occur? How will consumer expectations change?**
- **How does IoT change the way I will take care of my infrastructure portfolio and how does it change the way people interact with infrastructure?**
- **How can data and analytics improve the decisions that our clients make and the service they provide?**

**Funding**

- How will governments raise funds for infrastructure with the rise of MaaS, EV, and AV? Who should I build partnerships with?

**Autonomous Vehicles**

- How will autonomous, connected and electric vehicles change the way I look at mobility in the future?
Mobility in the 21st Century

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

**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
Mobility in the 21st Century
Summary Mobility Opportunities and Implications

Opportunities
- Improved logistics
- Safer road networks
- Increased mobility
- Stronger economy
- Connected communities
- Improved equality
- Cleaner air

What is Needed

Implications
- Impacts to revenue sources
- Changes to planning and selection process
- Policy and regulation changes
- Enhanced safety standards
- Decreased reliance on parking
- Increase in vehicle miles traveled

Road maps
- Strategic Planning
- Scenario Analysis
- Internal process impact analysis
- Partnerships

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