Mobility *is* Economic Development

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Mobility:
The movement of people and goods from place to place, job to job, or one social level to another (across bridges – physical or assumed).
Smart Mobility: the movement of people and goods with...

TRIPLE ZERO

0 Accidents & Fatalities

0 Carbon Footprint

0 Stress
A Smart City ...

... uses data and technology to improve metrics that reflect a city’s values.
Transition Away from Personal Vehicles

• Multimodal integrated payment and trip planning
• Shared pick-up and drop-off locations for shared vehicles
• Adoption of electric vehicles
• New options for public transit
Common Payment Systems

Multi-Modal Trip Planning Application

Integrated Common Payment System

Inclusive Mobility
Different Modes for Different Demands

Smart mobility envisions integrated modes, each with its own purpose.
Innovative Mobility Services

Business models

Innovative mobility services are transportation solutions enabled by emerging technologies and wireless connectivity that allow for more convenient, efficient, and flexible travel.
Elimination of the Personal Vehicle “Security Blanket”

Multimodal Integrated Payment & Trip Planning
Shared pick-up and drop-off vehicles
Electric Vehicle Adoption
New Public Transit Options
Personal Vehicle Utilization

Mobility services can better utilize resources

- Personal vehicles are parked 95% of the time on average
- Cruising to find open curb-side parking can contribute substantially to traffic congestion in urban areas
- Parking is among the lowest values of land-use in urban areas
  - Urban parking subsidized through various means
  - What else might be done with urban space now reserved for parked cars?
Shared Mobility Services in North America

600+ cities with ridesourcing

20+ cities with pooled rides

10+ cities with microtransit

400+ cities with carshare (round trip, free floating, P2P)

400+ cities with bikeshare (stationed, dockless) & scooters

Source: Shared Use Mobility Center
Ridesourcing Adoption

Adoption and Utilization of Ridesourcing in Major U.S. Metropolitan Areas

Ridesourcing (Transportation Network Companies) Problem or Solution?

Bad news:
Emerging evidence suggests TNCs tend to increase VMT, increase vehicle ownership rates, and reduce use of public transit.

Good news:
Data varies by city. This suggests that in the right context, with the right policies, TNCs can be part of a strategy to reducing VMT and GHG.

Source: Schaller 2018
U.S. Innovative Mobility Services Projections

- From 2015 to 2030, total miles traveled rise from roughly 3 trillion to almost 5 trillion

- Of those miles, about 4% are shared in 2015 and will grow to 25% in 2030

Source: CAR Research, UC Berkeley
Growth of North American Carsharing Programs

Yearly data represents July numbers, unless otherwise specified. Totals include one-way and round-trip carsharing and exclude P2P programs. Proxies were used for five of the 32 round-trip operators.

Shared Mobility Services in North America

**Ridesourcing**
- Lyft
- Uber
- Via
- Juno
- RideAustin
- SilverRide

**Pooled rides and ridesharing**
- LYFT LINE
- UberPOOL
- Via
- Hyitch
- Waze CARPOOL
- Scoop

**Bikesharing (stationed)**
- Lyft
- Breo
- Bewegen
- P3GM
- Zagster
- Bicycle Transit
- Shift
- Gotcha
- Bixi

**Bikesharing (dockless)**
- Mobike
- Spin
- Ofo
- Uber
- Jump
- Yeoride
- Lime
- Zagster
- Bird
- Spin
- Lime
- Lyft

**Scooter sharing**
- Scoot
- Skip
- Uber
- Jump

**Microtransit**
- Chariot
- Lyft Shuttle
- Via
- Flex

**Carsharing (round trip)**
- Zipcar
- Enterprise CarShare
- EVO
- Communauto
- Capital CarShare
- Maven
- Hourcar
- Hui
- Go
- Modo
- Ithaca Sharedride

**Carsharing (free floating)**
- Car2Go
- ReachNow
- BlueLA
- Blueindy

**Carsharing (P2P)**
- Getaround
- Turo
- Carrot

Source: Shared Use Mobility Center, CAR research
Modifications to Existing infrastructure
Signals and Road Markings

- Traffic signal updates are necessary to enable V2I
- V2I communication may replace some functions of signs and signals
  - Pedestrians, cyclists, or non-connected vehicles still need them
- Clear lane markings are beneficial, but not necessary

Source: Point Grey
Land form sprawl

- Urban-core space could be freed up for redevelopment, thanks to lower parking demand
- Denser, more walkable developments could be created
- Willingness to travel longer distances to and from work could increase
- Household and businesses might locate farther from urban cores

Source: Alloybuild
Transformation of Parking

CAVs will enable more efficient use of existing parking supply.

Opportunities
- Reduced need for new municipal parking
- Smaller parking spots, less on-site and on-street parking
- Parking relocated on the back of lots or outside prime locations

Considerations
- Possible decline of municipal revenues
- Reconversion in drop-off/pick-up areas
- Relocation of CAV parking impacts both VMT and congestion
Travel demand and vehicle miles traveled (VMT)

- Lower car ownership
- Pay-per-use programs discourage unnecessary travel
- Increased vehicle occupancy
- First-and-last-mile solution with transit
- Overall lower number of vehicles
- Less travel related to searching for parking
- Denser land development (less parking)

- Increased travel demand
- Zero occupancy travel
- Reduced trip chaining
- Mode shift away from mass transit
- Greater urban sprawl
- Significant share of privately owned cars
- Increased mobility of non-drivers
- Increased automated freight and delivery
Implications for Mass Transit

**Opportunities**
- Could offer better first- and last-mile connections
- Could be more affordable
- Improves service in low-density areas
- Feeder service to rail or BRT
- Could decrease wait times
- Pilot projects already exist

**Considerations**
- May reduce public transit demand
- Could negate the congestion benefits
- Might exacerbate equity issues and digital divide
- Could lead to job loss among public transit employees

- Private or shared CAVs
- Automated transit
Over 200 cities responded to Amazon’s RFQ to host its HQ2 location. Over half of these offered generous incentives. But few could offer the on-site access to mass transit that Amazon stated as a core preference.

While overall trends in home-ownership and vehicle use are fairly stable, entry-level knowledge industry workers, on which tech companies rely, highly prefer dense urban settings with reliable frequent transit options.
Vehicle Data Monetization
Many Opportunities, Many Challenges

- Standards and norms around data use and management continue to evolve
- Privacy concerns are emerging (e.g., EU GDPR)
- True value of data unclear
- New types of vehicle data continue to emerge
- Some hints at success, but no one has cracked this code
Mobility as a (Subsidized) Service

Public and private organizations are beginning to partner with mobility service providers to improve the experience of customers, clients, and employees.

Medical patient mobility

Retail and grocery partnerships

Employee Shuttles

Campus Circulators
Automated, Connected and Electric and Shared Mobility
Driving the future

**Shared**
Ride-hailing; Ride-sharing; Car-sharing,

**Automated**
From automated driver assist systems to robo-taxis, technology is leading to a change in who is driving

**Electrified**
The BEV is an enabling technology for shifting how we view mobility

**Connected**
Vehicle to Vehicle; Vehicle to Infrastructure; and Vehicle to Cloud is coming
Intelligent Vehicles & Mobility

- Active safety systems such as ESC, forward collision warning, lane departure
- SAE Level 1-2 available
- 4% of global VMT are shared
- New concepts, services & companies

**TODAY**

- Advanced driver assistance (ADAS) on all new vehicles
- V2V emerging—DSRC and/or 5G
- Wide deployment of Level 2; first Level 4 available in limited release (shuttles, robotaxis)
- 6.5% of global VMT are shared
- New mobility services spread beyond cities

**2020**

- Greater deployment of Level 4 (commercial trucks)
- Wider availability of V2V and V2I communication
- 11.7% of global VMT are shared
- Vehicle sharing becomes a more viable alternative to ownership

**2025**

- Worldwide adoption of Level 4 shuttles, robotaxis, commercial vehicles
- Level 4 available on personal vehicles
- Full availability of V2V; expanded V2I
- 26.2% of global VMT are shared
- New mobility services in rural areas

**2030**

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Interaction with Non-Motorized Traffic

Opportunities

• Automated driving promises increased safety for pedestrians and cyclists.
• AVs can free up space for pedestrian areas and bike lanes (through road diets).

Considerations

• AVs need to learn the implicit and explicit cues of pedestrians and cyclists and vice versa.
• Non-motorized transportation networks could become even more fragmented, especially in urban settings.
Powertrain, Propulsion & Energy Storage

- Mostly ICE
- 6-7 speed transmissions
- Low energy prices

- BEV growth
- Better range & faster charging
- Improved BEV infrastructure
- FCV infrastructure grows
- Improved FE & emissions across fleet

TODAY
- Downsized/boosted ICE
- HCCI and variable compression ratio
- 12V stop/start; 48V growth
- 9-10 speed transmissions (CVTs in NA, dual-clutch & manuals in EU)
- Increased penetration of HEV/BEV (cost challenged)

2020

2025
- ICE still represents >70% of market in North America and globally
- BEV nears cost competitiveness
- Major reductions in battery cost

2030
U.S. Electric Vehicle Charging Infrastructure

Public Charging Needed (2030)
• 27,500 DCFC outlets
• 601,000 non-res L2 outlets

2030 Scenario
• Stock of 15 million EVs
• 88% home charging
• Current daily driving patterns:
  70% driving < 40 mi; 95% < 100 mi

Source: National Plug-in Electric Vehicle Infrastructure Analysis, DoE, September 2017
# Intelligent Mobility Technologies

## Global General Evolution Timeline, 1990 to beyond 2040

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>Development, testing of ADAS features (lane keep assist, pedestrian avoidance)</td>
</tr>
<tr>
<td>1995</td>
<td>Early deployment ADAS features (ABS, ESC)</td>
</tr>
<tr>
<td>2000</td>
<td>Development of ADAS on new luxury vehicle models</td>
</tr>
<tr>
<td>2005</td>
<td>Deployment of ADAS on all new vehicle models</td>
</tr>
<tr>
<td>2010</td>
<td>Level 1 - Driver Assistance</td>
</tr>
<tr>
<td>2015</td>
<td>Level 2 - Partial Driving Automation</td>
</tr>
<tr>
<td>2020</td>
<td>Level 3 - Conditional Driving Automation</td>
</tr>
<tr>
<td>2025</td>
<td>Level 4 - High Driving Automation</td>
</tr>
<tr>
<td>2030</td>
<td>Level 5 - Full Driving Automation</td>
</tr>
<tr>
<td>2035</td>
<td>Worldwide adoption of robust and automated shuttles</td>
</tr>
<tr>
<td>2040</td>
<td>Global deployment of automated vehicles for personal use and of automated commercial trucks</td>
</tr>
<tr>
<td>2045</td>
<td>Road to market saturation of automated vehicles</td>
</tr>
</tbody>
</table>

**Source:** CAR Research
Thank you for your attention.

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