The Future of Transportation Technology: What to Expect

Paul Lewis
Eno Center for Transportation
September 11, 2017
Agenda

• Automated Driving
• Ride Hailing
• Technology and Transit
• Sharing Economy
Goals

1. Understand how technology is reshaping transportation across globe
2. Discuss tech’s potential and limitations
3. Create insights into how technology will affect transportation here
About Eno
1. Technology and transportation has limitless opportunities
Presentation Summary

1. Technology and transportation has limitless opportunities
2. Much of it is nacent, untested, unproven
Presentation Summary

1. Technology and transportation has limitless opportunities
2. Much of it is nascent, untested, unproven
3. Concerted effort needed to plan to achieve the optimal outcomes for communities
References

• Reports available on Eno’s website
  – Beyond Speculation
  – Adapting and Adopting
  – Emerging Trends in Transportation Technology
  – Eno Transportation Weekly
AV Summary
AV Summary

• AV has advanced rapidly on the “easy” part of the problem
• Safety (in rural areas) has most to gain in short term
• The future is far from known, but we can begin planning now
What is an automated vehicle?

• Self-driving?
• Driverless?
• Driver assist?
• Automated?
• Autonomous?
• Cars? Trucks? Buses?
# SAE Levels of Automation

<table>
<thead>
<tr>
<th>SAE level</th>
<th>Name</th>
<th>Narrative Definition</th>
<th>Execution of Steering and Acceleration/Deceleration</th>
<th>Monitoring of Driving Environment</th>
<th>Fallback Performance of Dynamic Driving Task</th>
<th>System Capability (Driving Modes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No Automation</td>
<td>the full-time performance by the human driver of all aspects of the dynamic driving task, even when enhanced by warning or intervention systems</td>
<td>Human driver</td>
<td>Human driver</td>
<td>Human driver</td>
<td>n/a</td>
</tr>
<tr>
<td>1</td>
<td>Driver Assistance</td>
<td>the driving mode-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task</td>
<td>Human driver and system</td>
<td>Human driver</td>
<td>Human driver</td>
<td>Some driving modes</td>
</tr>
<tr>
<td>2</td>
<td>Partial Automation</td>
<td>the driving mode-specific execution by one or more driver assistance systems of both steering and acceleration/deceleration using information about the driving environment and with the expectation that the human driver perform all remaining aspects of the dynamic driving task</td>
<td>System</td>
<td>Human driver</td>
<td>Human driver</td>
<td>Some driving modes</td>
</tr>
</tbody>
</table>

### Automated driving system ("system") monitors the driving environment

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<th>Name</th>
<th>Narrative Definition</th>
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<th>System Capability (Driving Modes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Conditional Automation</td>
<td>the driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task with the expectation that the human driver will respond appropriately to a request to intervene</td>
<td>System</td>
<td>System</td>
<td>Human driver</td>
<td>Some driving modes</td>
</tr>
<tr>
<td>4</td>
<td>High Automation</td>
<td>the driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task, even if a human driver does not respond appropriately to a request to intervene</td>
<td>System</td>
<td>System</td>
<td>System</td>
<td>Some driving modes</td>
</tr>
<tr>
<td>5</td>
<td>Full Automation</td>
<td>the full-time performance by an automated driving system of all aspects of the dynamic driving task under all roadway and environmental conditions that can be managed by a human driver</td>
<td>System</td>
<td>System</td>
<td>System</td>
<td>All driving modes</td>
</tr>
</tbody>
</table>

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What will happen?

- Vehicle miles traveled
- Congestion
- Safety
- Liability
- Privacy
- Ethics
Automated Driving
AVs in Arlington

Adam Tuss @AdamTuss · Aug 7
Alert!!! We found the supposed self driving van in Arlington - and there’s a guy hiding behind the seat!!! @nbcwashington
Approach to Automated Tech
Current AV approach
# Expected Commercial Availability

## Table 2: Expected Commercial Availability of Level 3 or Higher Vehicle Automation, by Select Organization

<table>
<thead>
<tr>
<th>Organization</th>
<th>Year</th>
<th>Type of Organization</th>
<th>Automation Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ford Motor Company</td>
<td>2021</td>
<td>Vehicle Manufacturer</td>
<td>Level 4</td>
</tr>
<tr>
<td>Uber</td>
<td>2021</td>
<td>Transportation Network Company</td>
<td>Unspecified</td>
</tr>
<tr>
<td>Volvo</td>
<td>2021</td>
<td>Vehicle Manufacturer</td>
<td>Level 4</td>
</tr>
<tr>
<td>General Motors</td>
<td>2020</td>
<td>Vehicle Manufacturer</td>
<td>Unspecified</td>
</tr>
<tr>
<td>Tesla</td>
<td>2018</td>
<td>Vehicle Manufacturer</td>
<td>Level 3 or 4</td>
</tr>
<tr>
<td>Google</td>
<td>2020</td>
<td>Technology Company</td>
<td>Level 4</td>
</tr>
<tr>
<td>Victoria Transport Institute</td>
<td>2020-2030</td>
<td>Research Organization</td>
<td>Unspecified</td>
</tr>
<tr>
<td>National Association of City Transportation Officials</td>
<td>2020</td>
<td>Association</td>
<td>Level 4</td>
</tr>
<tr>
<td>IHS Markit</td>
<td>2020</td>
<td>Market Research Company</td>
<td>Level 4 and 5</td>
</tr>
<tr>
<td>ABI Research</td>
<td>2021</td>
<td>Market Research Company</td>
<td>Level 4 and 5</td>
</tr>
<tr>
<td>Juniper Research</td>
<td>2025</td>
<td>Market Research Company</td>
<td>Unspecified</td>
</tr>
</tbody>
</table>

Business Model

• Personal AVs
• Shared fleets
Figure 1: Status of state policies related to automated driving, as of May 2017

Source: National Conference of State Legislatures and individual state legislation

Created by:
Ann Henebery / Eno Center for Transportation
Implications for Transportation

• Certification, liability and insurance
• Ethics
• Cybersecurity
• Privacy
• Infrastructure/funding
• Vehicle connectivity
• Research
• Workforce
• Freight
• Consumers
Certification, Liability and Insurance
Certification, Liability and Insurance

• Federal role
  – Federal Motor Vehicle Safety Standards

• State/local role
  – liability, licensing, insurance

• Harmonization between states
Ethics
Ethics

• German Ethics Commission
  – Public sector must ensure safety
  – AV developers clearly assign responsibility
  – Trolley dilemma is too complex
Cybersecurity
Cybersecurity

• Industry-led cyber standards
• Prescriptive regulations do not work
• Limited liability for manufacturers?
Privacy and Data

THE COMING FLOOD OF DATA IN AUTONOMOUS VEHICLES

RADAR
~10-100 KB
PER SECOND

SONAR
~10-100 KB
PER SECOND

GPS
~50 KB
PER SECOND

CAMERAS
~20-40 MB
PER SECOND

LIDAR
~10-70 MB
PER SECOND

AUTONOMOUS VEHICLES
4,000 GB
PER DAY... EACH DAY
Privacy and Data

- Data owner = vehicle driver
- Regulations to protect owner privacy
- Cities enact data sharing agreement
Vehicle Connectivity
Vehicle Connectivity

- Maintain existing spectrum
- Create V2X standards
- Test CV technology in pilots
Infrastructure and Funding
Infrastructure and Funding

- ↓↓ parking, traffic violation revenues
- ↓↓ in fuel taxes
- ↑↑ demands for better infrastructure, CV tech
Needed Infrastructure

• State of good repair investments
  – Lane markings, potholes, signage, signals

• Testing of CV
Proposals for Mileage Fee

• Small per-mile fee on Level 3, 4, 5 driving
• Easy administration, significant revenue
• Oregon, Tennessee, Massachusetts
Research and Planning

- AVs in long range plans
- University programs
- Test sites
Workforce

• Truck drivers, taxi drivers, mechanics, bus operators
• “Driver” > 4 million jobs
Workforce

• Large scale workforce replacement unlikely because:
  – Driving is only part of the job
  – Perpetual truck driver shortage
  – Public is skeptical
  – Technology is years, if not decades, away
Freight

• Automated ships
• Automated trains
• Automated trucks
Freight – Truck Platooning
Consumer Acceptance

- Consumers are unsure about tech
- Uncomfortable with truck platooning
- Consumers are price sensitive
AV Summary

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• Ride Hailing
• Technology and Transit
• Sharing Economy
Ride Hailing/TNCs
Ride Hailing Summary

• Public demand is strong and growing
• Recent PR problems are unlikely to derail progress
• Can TNCs function profitably in suburban and rural areas?
• Role of automated technologies
Ride Hailing/TNCs

• “Transportation Network Companies”
• Ride-hailing, ride-sourcing ride-sharing, car-sharing?
• The “modern” taxi industry
# Taxi-like TNCs

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Lyft</th>
<th>Uber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Services</td>
<td>TNC, premium, XL</td>
<td>TNC, premium, XL, Family</td>
</tr>
<tr>
<td>Driver Background Check</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Two-Way Ratings</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Specified Destination</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>TNC Driver Compensation</td>
<td>set fares + tip</td>
<td>set fares + tip</td>
</tr>
<tr>
<td>TNC Commission</td>
<td>25% for new drivers</td>
<td>20-25 %</td>
</tr>
<tr>
<td>U.S Market Share</td>
<td>23 %</td>
<td>75 %</td>
</tr>
<tr>
<td>Value</td>
<td>$7.5 b</td>
<td>$50 b</td>
</tr>
<tr>
<td>Quarterly Loss</td>
<td>$130 m</td>
<td>$645 m</td>
</tr>
</tbody>
</table>
Carpool TNCs

- Via
- UberPOOL
- Lyft Line
- Gett
Basic Business model

• Use app to connect drivers and passengers
• Does not own the vehicles
• Surge pricing to manage supply and demand
• Emailed receipt and payment
• Constant experimentation
Platform for Opportunities

- Uber Family
- Uber WAV
- Uber Eats
- Autoplay Music
- Split fares
- Uber Freight
- ETA Status Update
- Credits at select stores
Driver’s Perspective

- Independent contractors (1099 employees)
- 20 to 25 percent commission
- New addition of tips on Uber
- Mixed review on satisfaction
- Full or part time

@paulrslewis www.enotrans.org
Local regulations

• Cities and states have struggled to regulate
• Traditional taxi services threatened
• Some cities permissive, some ban.
TNCs are the future Taxi Market

• Taxis are over-regulated
• TNCs are under-priced
• Eventually convergence into the new taxi industry
Ride Hailing Summary

• Public demand is strong and growing
• Recent PR problems are unlikely to derail progress
• Can TNCs function profitably in suburban and rural areas?
• Role of automated technologies
Agenda

- Automated Driving
- Ride Hailing
- Technology and Transit
- Sharing Economy
Technology and Transit

• Subsidized partnerships for transit services:
  – First-mile, last mile
  – Paratransit
  – Guidance applications
  – Replace bus networks?
Tech Transit Summary

• Huge opportunity for partnerships
• Problems with marketing, ridership
• Focus on goals, not technology
• More expensive than expected
• Procurement barriers
• Microtransit/TNCs cannot replace high capacity
First Mile/Last Mile “Microtransit”

• Three case studies
  – Uber/LA Metro discounted rides
  – Bridj/KCATA microtransit pilot
  – Pinellas Sun Coast Transit subsidized Uber
Uber/LA Metro

- Opening of new Expo rail line
- Non financial transaction
- Uber provided discounts
- LA Metro provided advertising
Bridj/KCATA

- New commute routes in underserved areas
- High media visibility, low ridership
- Discontinued after 12 months
Pinellas Sun Coast Pilot

- “Direct Connect” replaced poor bus service
- Uber, Lyft, taxi, WAV options
- $5 discount in geofenced area, recently expanded
Other examples

• MBTA Paratransit
• AC Transit 275 Bus line replacement
• Santa Clara VTA
• Federal Transit Administration MOD Sandbox
Other examples

- Phone apps like moovel and google maps
- Open data for NextBus
- Employer incentive applications
Tech Transit Summary

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Agenda

• Automated Driving
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• Sharing Economy
Sharing Economy
Sharing Economy Summary

- Technology has made sharing easy
- Some revitalization of downtown areas
- Often needs public partnership
- Sharing has to be easy for people to use it
Bikeshare

Public Use Bicycle Programs
by Continent, year end 2016

North America 121
South America 34
Europe 524
Africa 1
Asia 502
Oceania 6

@BikesharingMap
www.bikesharingmap.com
Data collected and maintained by Russell Meddin

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Public Use Bicycle Programs
top ten countries, year end 2016

- China, 430, 37%
- USA, 109, 9%
- Italy, 147, 13%
- Other, 205, 17%
- Germany, 76, 6%
- Spain, 68, 6%
- France, 37, 3%
- Switzerland, 36, 3%
- Austria, 20, 2%
- Japan, 19, 2%
- Greece, 27, 2%

Data collected and maintained by Russell Meddin

@BikesharingMap
www.bikesharingmap.com
Bike Sharing models

Bike share with dock

Dockless

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Bike Share – Governmental Role

• Requires public subsidy
• Requires public space
• Several companies provide technology
Bike Share Challenges
Bike Share Challenges

**Ethnic background of Capital Bikeshare members**

Source: Capital Bikeshare (Luz Lazo/The Washington Post)

**Household income**

Source: Capital Bikeshare  
Fifty percent of Capital Bikeshare users have household incomes of $100,000 or more. (Luz Lazo/The Washington Post)
Car Sharing

• Three models for sharing cars:
  – Cars in designated spaces (ZipCar)
  – One way (Car2Go)
  – Peer to peer (Getaround)

• Insurance, gas, maintenance included

• Internet reservations and payment
Designated-space Car Share

- Zipcar, Maven, Hertz, Enterprise, etc.
- Choice of cars at designated spaces
- Rent by 30 minute segments
- Sometimes requires public parking spaces
One way car share

- Zipcar (in select cities), Car2Go
- Return to any point within the zone
- Charge by the minute
- Requires cooperation by city for street parking
Peer to peer car sharing

- Getaround, Turo (similar to Air BnB)
- Rent out your car to anyone on the internet
- You get paid, company takes a cut
- No city cooperation necessary
Sharing?
Sharing?
Sharing Economy Summary

• Technology has made sharing easy
• Some revitalization of downtown areas
• Often needs public partnership
• Sharing has to be easy for people to use it
Agenda

- Automated Driving
- Ride Hailing
- Technology and Transit
- Sharing Economy
Session wrap up

Future mobility model

Automated

Shared

On-demand
Presentation Summary

1. Technology and transportation has limitless opportunities
2. Much of it is nacent, untested, unproven
3. Concerted effort needed to plan to achieve the optimal outcomes for communities
Ultramodern Transportation

• Drone delivery
• Flying cars
• Hyperloop
Ultramodern Transportation

• Drones
• Flying cars
• Hyperloop

• Streets without potholes?
• Buses that run on time?
Questions/Discussion

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