The Self-Navigating Region
DVRPC

By the Numbers:

- 2 States
- 9 Counties
- 351 municipalities
- 5.7 million people (2015)
- 6.4 million people (2045)
- 3.0 million jobs
- 108 million daily vehicle miles traveled
- 1 million transit trips / day
# Four Industrial Revolutions

<table>
<thead>
<tr>
<th>Era</th>
<th>Period</th>
<th>Technology</th>
<th>Urban Form</th>
<th>Transportation</th>
</tr>
</thead>
<tbody>
<tr>
<td>FIRST (1770s)</td>
<td>1750-1800</td>
<td>Steam Power, Mechanical Production</td>
<td>Factories</td>
<td>Canals, Railroads</td>
</tr>
<tr>
<td>SECOND (1870s)</td>
<td>1800-1850</td>
<td>Electricity, Mass Production</td>
<td>Elevators, Suburbanization</td>
<td>Subways &amp; Trolleys, Cars, Buses, Trucks, Airplanes</td>
</tr>
<tr>
<td>THIRD (1960s)</td>
<td>1850-1900</td>
<td>Electronics &amp; Computers, Automated Production</td>
<td>Globalization, Internet &amp; e-commerce</td>
<td>ITS, Real-Time Transport, Space Travel</td>
</tr>
<tr>
<td>FOURTH (2010s)</td>
<td>1900-2000</td>
<td>Robotics &amp; AI, 3-D Printing, 3-D Printing</td>
<td>Internet of Things, Networked Space</td>
<td>CVs &amp; HAVs, UASs (Drones), ???</td>
</tr>
</tbody>
</table>

Adapted from World Economic Forum

The Digital Revolution
The Digital Economy

Alibaba, the highest sales retailer, has no inventory.

AirBNB, the largest accommodation provider, owns no real estate.

Facebook, the most popular media provider, creates no content.

Instagram, the most valuable photo company, sells no cameras.

Netflix, the fastest growing television network, lays no cables.

Uber, the world’s largest taxi company, owns no fleet.

Source: Tom Goodwin
Networks

A **network** is a group of interconnected people and things.

A **network effect** occurs when a good or service becomes exponentially more valuable as more people & things are a part of it.
Music Industry Digitization

Source: Recording Industry Association of America, 1983 – 2015

1983

- Paid Subscriptions / On-Demand Streaming
- Ringtones and Ringbacks
- Downloads
- SoundExchange/Synchronization
- SACD / DVD Audio
- Music Video
- CDs
- Cassette: 48%
- EP/LP/Vinyl: 52%

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

1984

- Paid Subscriptions / On-Demand Streaming
- Ringtones and Ringbacks
- Downloads
- SoundExchange/Synchronization
- SACD / DVD Audio
- Music Video
- CDs: 2%
- Cassettes: 55%
- EP/LP/Vinyl: 43%

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

1985

- 55% Cassettes
- 36% EP/LP/Vinyl
- 9% CDs
- 0% Other

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

1986

Paid Subscriptions / On-Demand Streaming
Ringtones and Ringbacks
Downloads
SoundExchange/Synchronization
SACD / DVD Audio
Music Video
CDs
Cassettes
EP/LP/Vinyl

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

1987

- Paid Subscriptions / On-Demand Streaming
- Ringtones and Ringbacks
- Downloads
- SoundExchange/Synchronization
- SACD / DVD Audio
- Music Video
- CDs: 29%
- Cassettes: 54%
- EP/LP/Vinyl: 18%

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

1988

Paid Subscriptions / On-Demand Streaming
Ringtones and Ringbacks
Downloads
SoundExchange/Synchronization
SACD / DVD Audio
Music Video
CDs 34%
Cassettes 55%
EP/LP/Vinyl 11%

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

1989

- Paid Subscriptions / On-Demand Streaming
- Ringtones and Ringbacks
- Downloads
- SoundExchange/Synchronization
- SACD / DVD Audio
- Music Video
- CDs: 39%
- Cassettes: 54%
- EP/LP/Vinyl: 5%
- Other: 2%

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

1990

- Paid Subscriptions / On-Demand Streaming
- Ringtones and Ringbacks
- Downloads
- SoundExchange/Synchronization
- SACD / DVD Audio
- Music Video
- CDs: 46%
- Cassettes: 49%
- EP/LP/Vinyl: 2%

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

Source: Recording Industry Association of America, 1983 – 2015

- Paid Subscriptions / On-Demand Streaming
- Ringtones and Ringbacks
- Downloads
- SoundExchange/Synchronization
- SACD / DVD Audio
- Music Video
- CDs: 56%
- Cassettes: 41%
- EP/LP/Vinyl: 1%

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

1992

Paid Subscriptions / On-Demand Streaming
Ringtones and Ringbacks
Downloads
SoundExchange/Synchronization
SACD / DVD Audio
Music Video
CDs
38%
Cassettes
1%
EP/LP/Vinyl

0%  20%  40%  60%  80%  100%

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

1993

Paid Subscriptions / On-Demand Streaming
Ringtones and Ringbacks
Downloads
SoundExchange/Synchronization
SACD / DVD Audio
Music Video
CDs
Cassettes
EP/LP/Vinyl

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

1994

- Paid Subscriptions / On-Demand Streaming
- Ringtones and Ringbacks
- Downloads
- SoundExchange/Synchronization
- SACD / DVD Audio
- Music Video
- CDs: 71%
- Cassettes: 27%
- EP/LP/Vinyl: 1%

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

1995

Paid Subscriptions / On-Demand Streaming
Ringtones and Ringbacks
Downloads
SoundExchange/Synchronization
SACD / DVD Audio
Music Video
CDs
2%  77%
Cassettes
21%
EP/LP/Vinyl
1%  1%

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

1996

- Paid Subscriptions / On-Demand Streaming
- Ringtones and Ringbacks
- Downloads
- SoundExchange/Synchronization
- SACD / DVD Audio
- Music Video: 2%
- CDs: 81%
- Cassettes: 17%
- EP/LP/Vinyl: 1%

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

1997

- Paid Subscriptions / On-Demand Streaming
- Ringtones and Ringbacks
- Downloads
- SoundExchange/Synchronization
- SACD / DVD Audio
- Music Video: 3%
- CDs: 83%
- Cassettes: 14%
- EP/LP/Vinyl: 1%

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

1998

Paid Subscriptions / On-Demand Streaming
Ringtones and Ringbacks
Downloads
SoundExchange/Synchronization
SACD / DVD Audio
Music Video
CDs
Cassettes
EP/LP/Vinyl

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

1999

- Paid Subscriptions / On-Demand Streaming
- Ringtones and Ringbacks
- Downloads
- SoundExchange/Synchronization
- SACD / DVD Audio
- Music Video: 3%
- CDs: 89%
- Cassettes: 9%
- EP/LP/Vinyl: 0%

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

2000

- Paid Subscriptions / On-Demand Streaming: 93%
- Ringtones and Ringbacks: 2%
- Downloads: 4%
- SoundExchange/Synchronization: 0%
- SACD / DVD Audio: 0%
- Music Video: 0%
- CDs: 93%
- Cassettes: 4%
- EP/LP/Vinyl: 0%

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

2001

Paid Subscriptions / On-Demand Streaming
Ringtones and Ringbacks
Downloads
SoundExchange/Synchronization
SACD / DVD Audio
Music Video
CDs
Cassettes
EP/LP/Vinyl

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

Source: Recording Industry Association of America, 1983 – 2015

2002

- CDs: 95%
- Cassettes: 1%
- EP/LP/Vinyl: 0%
- Music Video: 3%
- SoundExchange/Synchronization
- Downloads
- Ringtones and Ringbacks
- SACD / DVD Audio
- Paid Subscriptions / On-Demand Streaming

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

2003

Paid Subscriptions / On-Demand Streaming
Ringtones and Ringbacks
Downloads
SoundExchange/Synchronization
SACD / DVD Audio
Music Video
CDs
Cassettes
EP/LP/Vinyl

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

2004

- Paid Subscriptions / On-Demand Streaming
- Ringtones and Ringbacks
- Downloads
- SoundExchange/Synchronization
- SACD / DVD Audio
- Music Video
- CDs: 93%
- Cassette: 0%
- EP/LP/Vinyl: 0%

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

2005

- Paid Subscriptions / On-Demand Streaming: 1%
- Ringtones and Ringbacks: 3%
- Downloads: 4%
- SoundExchange/Synchronization: 5%
- SACD / DVD Audio
- Music Video
- CDs: 86%
- Cassettes
- EP/LP/Vinyl

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

2006

- Paid Subscriptions / On-Demand Streaming: 2%
- Ringtones and Ringbacks: 7%
- Downloads: 7%
- SoundExchange/Synchronization: 7%
- SACD / DVD Audio: 7%
- Music Video: 4%
- CDs: 80%
- Cassette: 0%
- EP/LP/Vinyl: 0%

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

2007

- Paid Subscriptions / On-Demand Streaming: 2%
- Ringtones and Ringbacks: 10%
- Downloads: 13%
- SoundExchange/Synchronization: 5%
- SACD / DVD Audio
- Music Video
- CDs: 70%
- Cassettes
- EP/LP/Vinyl

Source: Recording Industry Association of America, 1983 – 2015

#ptw17 | #MakingConnections | @dvrpc
Music Industry Digitization

2008

<table>
<thead>
<tr>
<th>Source</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paid Subscriptions / On-Demand Streaming</td>
<td>3%</td>
</tr>
<tr>
<td>Ringtones and Ringbacks</td>
<td>11%</td>
</tr>
<tr>
<td>Downloads</td>
<td>20%</td>
</tr>
<tr>
<td>SoundExchange/Synchronization</td>
<td>1%</td>
</tr>
<tr>
<td>SACD / DVD Audio</td>
<td>1%</td>
</tr>
<tr>
<td>Music Video</td>
<td>3%</td>
</tr>
<tr>
<td>CDs</td>
<td>62%</td>
</tr>
<tr>
<td>Cassettes</td>
<td>1%</td>
</tr>
<tr>
<td>EP/LP/Vinyl</td>
<td>1%</td>
</tr>
</tbody>
</table>

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

2009

- Paid Subscriptions / On-Demand Streaming: 3%
- Ringtones and Ringbacks: 9%
- Downloads: 25%
- SoundExchange/Synchronization: 5%
- SACD / DVD Audio: 3%
- Music Video: 3%
- CDs: 55%
- Cassettes: 1%
- EP/LP/Vinyl: 1%

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

2010

- Paid Subscriptions / On-Demand Streaming: 3%
- Ringtones and Ringbacks: 6%
- Downloads: 32%
- SoundExchange/Synchronization: 6%
- SACD / DVD Audio
- Music Video: 3%
- CDs: 48%
- Cassettes
- EP/LP/Vinyl: 1%

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

2011

- Paid Subscriptions / On-Demand Streaming: 5%
- Ringtones and Ringbacks: 4%
- Downloads: 37%
- SoundExchange/Synchronization: 7%
- SACD / DVD Audio
- Music Video: 2%
- CDs: 44%
- Cassettes
- EP/LP/Vinyl: 2%

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

2012

- Paid Subscriptions / On-Demand Streaming: 8%
- Ringtones and Ringbacks: 2%
- Downloads: 41%
- SoundExchange/Synchronization: 9%
- SACD / DVD Audio
- Music Video: 2%
- CDs: 35%
- Cassettes
- EP/LP/Vinyl: 2%

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

2013

- Paid Subscriptions / On-Demand Streaming: 12%
- Ringtones and Ringbacks: 1%
- Downloads: 40%
- SoundExchange/Synchronization: 11%
- SACD / DVD Audio: 2%
- Music Video: 2%
- CDs: 30%
- Cassette: 3%
- EP/LP/Vinyl: 3%

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

2014

- Paid Subscriptions / On-Demand Streaming: 16%
- Ringtones and Ringbacks: 1%
- Downloads: 37%
- SoundExchange/Synchronization: 14%
- SACD / DVD Audio: 1%
- Music Video: 1%
- CDs: 26%
- Cassettes: 5%
- EP/LP/Vinyl: 5%

Source: Recording Industry Association of America, 1983 – 2015
Music Industry Digitization

2015

- Paid Subscriptions / On-Demand Streaming: 23%
- Ringtones and Ringbacks: 1%
- Downloads: 33%
- SoundExchange/Synchronization: 14%
- SACD / DVD Audio
- Music Video: 1%
- CDs: 22%
- Cassettes
- EP/LP/Vinyl: 6%

Source: Recording Industry Association of America, 1983 – 2015
to the music industry, what year do you think is most significant in terms of digitizing transportation?

1980: No digitization

1990: Early digitization

2000: On the cusp on transformation

2010: 2nd transformation

Start the presentation to activate live content.

If you see this message in presentation mode, install the add-in or get help at PollEv.com/app.
Real-Time Info & E-Payments

Source: Otto Yamomoto via Wikipedia Commons

Source: PA Turnpike Commission

Source: SEPTA

10:32AM EST Feb 21, 2017

Ticket

To/From Center City Philadelphia

x1
Ticket(s)

One-Way

Ticket Number: MZ23950647

ACTIVE

Please show this screen to the conductor onboard the train.

01:58:56

Source: SEPTA
Smart, Connected Cities

Source: Monnit

Source: Renesys

Source: Nexar
Digital Transportation Sharing

Digital Transportation Services
CAVs & UASs

Source: AIAA

Source: Google

Source: Planning Magazine

Source: FHWA

Source: Planning Magazine

Source: Otto

Source: AIAA

Source: Otto
3-D Printing & Robotics

Source: Z2 / Wikimedia Commons

Source: MX3D

Source: Advanced Paving Technologies

Source: Rutgers CAIT

#ptw17 | #MakingConnections | @dvrpc
Augmented & Virtual Reality

Source: Cisco

Source: Oculus
Competing Transportation Theories

**Auto-Oriented**
- Increase Mobility
- Separation of Uses
- New & Wider Roads

**Cycle of Automobile Dependency**
- Increased Vehicle Ownership
- Automobile-Oriented Transportation Planning
- Reduced Travel Options
- Alternative Modes Stigmatized
- Suburbanization and Degraded Cities
- Generous Parking Supply
- Automobile-Oriented Land Use Planning
- Dispersed Development Patterns

Source: VTPI
Competing Transportation Theories

**Auto-Oriented**
- Increase Mobility
- Separation of Uses
- New & Wider Roads

**Active/Sustainable**
- Increase Accessibility
- Mixed Use, High Density
- Walking, Biking, Transit

**Digital**
- Increase Information
- Live/Work Where You Want
- “Smart” Facilities
Future Shared Mobility Scenarios

Cooperative, Partnerships

A Tale of Two Regions

Moore Growth

Slower Growth

Filling a Niche

TNCs Take Off

Individualistic, Fragmented

Faster Growth
“In lieu of large civil infrastructure projects, transportation systems are increasingly being augmented with a range of information technologies that make them smarter, safer, more efficient, more integrated.”

- Anthony Townsend, PhD

Digital Equity Implications

- New Options Can Improve Access to Jobs & Services
  - Provide Subsidies Based on Need?
- Ensure Digital Providers Serve Low-Income Areas
- Prepaid or Digital Banking Options
- On-Demand Rides by:
  - Concierge / Corner Store / Phone Call / Kiosk
- Use Technology to Enhance Paratransit
AN INTEGRATED, MULTIMODAL TRANSPORTATION NETWORK

Real-time info lets people figure out the best way to get around

Big transportation data is becoming abundant

Digitization reinforces agglomeration economies & the need for walkable communities

Digitization is unleashing creative & entrepreneurial solutions to transportation issues

Cybersecurity is a critical new transportation need

Digital communications can enrich community engagement and services

PHYSICAL AND VIRTUAL WORLDS ARE MERGING
Thank You!

Brett Fusco  
Assistant Manager, Long-range Planning  
Delaware Valley Regional Planning Commission  
bfusco@dvrpc.org

www.dvrpc.org/connections2045
THE SELF-NAVIGATING REGION

PHILLY TECH WEEK

MAY 1, 2017
Technology and Cities

- Wildly changing our experience of city living
- Near unlimited opportunities to make cities better

Tech in concert with what makes cities work
- Agglomeration Economics and Density
- 2nd Densest Downtown
- 5th Largest City by Population
IN CENTER CITY BETWEEN 2010 & 2015:

- New Development **Eliminated 2,426 Public Parking Spaces**
- Employment in Core Center City Grew from 231,873 to 243,450 (+5.0%)
- Population in Core Center City Grew from 58,882 to 63,521 (+7.9%)
- Public Parking Occupancy Rates Actually **Declined** from 75.6% to 73.9% (-1.7%)
- **Not Possible Without Transit**

- **1.33 MILLION RENTABLE SQUARE FEET**
- **REPLACED 360-SPACE PUBLIC PARKING LOT WITH 70-SPACE PRIVATE GARAGE**
- **DIRECT-CONNECT TO SUBURBAN STATION**
- **1,121-FT SKYSCRAPER (9TH TALLEST IN U.S.)**
- **$1.2 BILLION COMMERCIAL INVESTMENT**
WITH SEPTA:

2\textsuperscript{ND} DENSEST DOWNTOWN IN UNITED STATES
WITHOUT SEPTA, 923 ACRES OF ADDITIONAL PARKING NEEDED – 28 COMCAST CENTERS OF SQUARE FOOTAGE JUST FOR CARS
“When we are talking about space, we are talking about geometry, not engineering, and technology never changes geometry. You must solve a problem spatially before you have really solved it.”

– Jarrett Walker, Urbanist and Public Transit Consultant
Source: Jarrett Walker + Associates
Enduring Urbanism Requires Enduring Transit
PHILADELPHIA & SOUTHEAST PA REPRESENT:

- **40%** of PA’s Economic Output
- **32%** of PA’s Population
- **5%** of PA’s Land Mass
RIDERSHIP IS GROWING

ANNUAL INCREASES (1998-2016)

REGIONAL RAIL
+52%

MARKET-FRANKFORD
+41%

BROAD STREET LINE
+29%

FISCAL YEAR

REGIONAL RAIL

MARKET-FRANKFORD

BROAD STREET LINE
NO LONGER A BINARY CHOICE

PRIVATE AUTOMOBILE

PUBLIC TRANSPORTATION
THE INFRASTRUCTURE OF MULTIMODALISM

INFORMATION-DRIVEN TRANSIT EXPERIENCE

- Not Just a Fare Card
- Banking System
- Backend-Based
- Account-Based
- Open Payment Technology
REAL TIME VEHICLE LOCATION
MODEM INSTALL UNDERWAY
• Prerequisite Infrastructure for the Emerging Transportation Era
• Information Infrastructure
• SEPTA as an Information Company
• Transit as the Backbone of A Multimodal Ecosystem
Test New Markets and Test Mobile Payment Methods on Transit

SEPTA Airport Line

April 3 – Sept 30

Purchase Tickets Before You Even Land at PHL

Fully Mobile, Dynamic Tickets

Mozio is the Ground Transport Engine for Booking.com, Kayak.com, and others

Business & Leisure Travelers Unfamiliar with PHL
A CALL TO ACTION

- Big Data as a Civic Resource
  - SEPTA opens data and the Tech community creates tools

- www3.septa.org

- Information as Infrastructure
  - Multimodality will increasingly rely on
    - Information Availability to Customers
    - Information Integration with Providers
  - Travel data will help optimize
    - Transportation and City Planning
    - Investments in Physical Infrastructure
“To be livable, cities must have an efficient and attractive transit system.”

- Vukan Vuchic, Emeritus UPS Foundation Professor of Systems Engineering, School of Engineering, Professor of City and Regional Planning, University of Pennsylvania
Cities, automation, and the self-driving elephant in the room

Philly Tech Week
May, 2017

Erick Guerra
Assistant Professor of City & Regional Planning
A World of Rapid Technological Change
New Technologies and Transportation
The Self-Driving Elephant in the Room
2004: No teams’ autonomous vehicles completed DARPA’s 150-mile challenge

2005: Six teams completed the challenge (including teams from Stanford, CMU, UPenn, and MIT)

Closed course, no lights, no pedestrians, good weather, daytime hours
Existing Prototypes
Market Ready in 2020?
1) How will automated vehicle technologies change cities?

2) How should an uncertain but potentially transformative technology influence today’s planning, policy, and investment decisions?
Autonomous Vehicles and the City

- Primary (non-behavioral) impacts
- Two future scenarios and their likelihood
- Planning for automated vehicles
- Parking and parking policy
Road Safety

- 1.25 million fatalities per year (number one killer for 15 – 29 year olds)
- Affects poor countries and poor urban residents disproportionately
• Technology has improved in-vehicle safety thus far
Road Safety

- Autonomous are likely to be conservative, law-abiding, and polite drivers.
- This will likely make walking more pleasant and safer.
- More confident and comfortable pedestrians
Road Capacity
Two Scenarios for Impacts on Travel Behavior and Urban Form

Testing and partial automation (5 to 20 years)

Full automation (no driver needed)

(A) Increased personal mobility

(B) Shared urban mobility
Which scenario do you think is "better"?
Scenario 1: Increased Personal Mobility

- Increased car ownership and VMT,
- Mostly privately owned,
- Zero-occupancy vehicles (picking up, dropping off, parking, etc.),
- Continued trend of increased long-duration commutes.
Summary of MPO estimates (Guerra, 2016)

<table>
<thead>
<tr>
<th>Region</th>
<th>In vehicle time costs</th>
<th>Road Capacity</th>
<th>VMT change</th>
<th>Key assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlanta</td>
<td>Same as car</td>
<td>+50%</td>
<td>+3.6%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>50% of car</td>
<td>+50%</td>
<td>+12.7%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>50% of car</td>
<td>+50%</td>
<td>+23.8%</td>
<td>Reduced operating costs</td>
</tr>
<tr>
<td></td>
<td>50% of car</td>
<td>+50%</td>
<td>+23.9%</td>
<td>Reduced operating costs and free parking</td>
</tr>
<tr>
<td>San Francisco</td>
<td>Same as car</td>
<td>+100%</td>
<td>+2%</td>
<td>All scenarios: driver present, though interventions rare; no intercity travel; same car-ownership levels and urban form</td>
</tr>
<tr>
<td></td>
<td>High quality rail</td>
<td>+10% to +100%</td>
<td>+4% to +5.2%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Half of car</td>
<td>+10% to +100%</td>
<td>+6.7% to +7.9%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Zero</td>
<td>+0% to +100%</td>
<td>+13.2% to +14.5%</td>
<td></td>
</tr>
<tr>
<td>Seattle</td>
<td>Same as car</td>
<td>+30%</td>
<td>+3.6%</td>
<td>Owned by high income households only</td>
</tr>
<tr>
<td></td>
<td>65% of car</td>
<td>+30%</td>
<td>+5.0%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>65% of car</td>
<td>+30%</td>
<td>+19.6%</td>
<td>50% parking cost reduction</td>
</tr>
<tr>
<td></td>
<td>+0%</td>
<td>+0%</td>
<td>-34.5%</td>
<td>No car ownership. Cost is $1.65 per mile.</td>
</tr>
</tbody>
</table>
Extending Personal Mobility

Video link: https://www.youtube.com/watch?v=cdgQpa1pUUE

Nationally 9% of households don’t own cars. And 33% of people do not have licenses.
Scenario 2: Shared Urban Mobility

- Shared point-to-point mobility,
- Limited car ownership,
- Reduced on-street and off-street parking,
- Increased density and urbanity.
Automated Transit

Line 14 in Paris
Private Automated Transit

- Lower operating costs
- Allow for smaller more flexible vehicles
- More frequent service
- If profitable, private reentry
Private Automated Transit

On Bridj you can travel between the connected zones, inbound in the morning and outbound in the evening. When requesting a trip you’ll receive directions to your pick-up and drop-off spots.
Which Scenario is More Likely?

Uncertain but likely a mixture of both and a range of outcomes
Which AV would you choose?

<table>
<thead>
<tr>
<th></th>
<th>Shared minibus (A)</th>
<th>Taxi (B)</th>
<th>Shared taxi (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>$2.00</td>
<td>$6.00</td>
<td>$4.00</td>
</tr>
<tr>
<td>Total Travel Time</td>
<td>35m</td>
<td>20m</td>
<td>30m</td>
</tr>
<tr>
<td>Walk time</td>
<td>5m</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Wait time (transfer)</td>
<td>5m</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Wait time (home)</td>
<td>-</td>
<td>5m</td>
<td>5m</td>
</tr>
<tr>
<td>Wait time (other passenger)</td>
<td>-</td>
<td>-</td>
<td>5m</td>
</tr>
</tbody>
</table>
Of the three options would you prefer to use this afternoon's event?

- Shared Minibus
- Taxi

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### Features of cities and neighborhoods where each scenario is more likely

<table>
<thead>
<tr>
<th>Feature</th>
<th>Shared Urban Mobility</th>
<th>Increased Personal Mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>Medium to high</td>
<td>Low to medium</td>
</tr>
<tr>
<td>Transit service</td>
<td>Good</td>
<td>Poor</td>
</tr>
<tr>
<td>Land values</td>
<td>High and centralized</td>
<td>Moderate and dispersed</td>
</tr>
<tr>
<td>Rent gradient</td>
<td>Steep</td>
<td>Flat</td>
</tr>
<tr>
<td>Car ownership</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Parking</td>
<td>Priced or permitted</td>
<td>Free and ubiquitous</td>
</tr>
</tbody>
</table>
Services and Pricing Will Matter

VS.

<table>
<thead>
<tr>
<th></th>
<th>uberX</th>
<th>UberBLACK</th>
<th>UberSUV</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIN FARE</td>
<td>$12</td>
<td>$20</td>
<td>$30</td>
</tr>
<tr>
<td>BASE FARE</td>
<td>$5</td>
<td>$10</td>
<td>$15</td>
</tr>
<tr>
<td>PER MIN</td>
<td>$0.30</td>
<td>$0.55</td>
<td>$0.80</td>
</tr>
<tr>
<td>PER MILE</td>
<td>$2.70</td>
<td>$4.70</td>
<td>$6.00</td>
</tr>
<tr>
<td>SEATS UP TO</td>
<td>4</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>CANCELLATION FEE</td>
<td>$10</td>
<td>$10</td>
<td>$10</td>
</tr>
</tbody>
</table>

*A $1 safe ride fee will also be included in your fare. For info on this fee, visit blog.uber.com/safetrade*
How Should We Plan for Tomorrow’s Automated Vehicles?

• Powers are diffuse and agencies have limited mandates

<table>
<thead>
<tr>
<th>Government level</th>
<th>Primary AV roles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Federal</td>
<td>• Set standards</td>
</tr>
<tr>
<td></td>
<td>• Fund research</td>
</tr>
<tr>
<td>State/Regional</td>
<td>• <strong>Allocate large public investments</strong></td>
</tr>
<tr>
<td></td>
<td>• Regulate rules of the road</td>
</tr>
<tr>
<td></td>
<td>• Manage testing</td>
</tr>
<tr>
<td></td>
<td>• Manage highways</td>
</tr>
<tr>
<td>Local</td>
<td>• <strong>Regulate land use</strong></td>
</tr>
<tr>
<td></td>
<td>• Manage local roads</td>
</tr>
</tbody>
</table>
How Should We Plan for Tomorrow’s Automated Vehicles?

• Widespread disagreement on impacts, timing, and desired outcomes

• The technology is being driven by the private sector and technology and car companies have a big stake

• Already starting to have an influence on policy making

“I absolutely believe that technology is going to transform mass transit in a way that very few people can see … It’ll definitely be within 15 or 20 years, which is right when the light rail system for Greenlight Pinellas would be coming online.”

-Florida State Senator Jeff Brandes (R) arguing against St. Petersburg regional transit plan. (Quoted from Fortune article by David Morris, November 2, 2014)
Which scenario do you think is "better"?

Increased personal mobility

Shared urban mobility

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### Assertion 1. One scenario is Better than the Other

<table>
<thead>
<tr>
<th></th>
<th>Shared mobility</th>
<th>Personal mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Benefits</strong></td>
<td>• Increased mobility</td>
<td>• Increased mobility</td>
</tr>
<tr>
<td></td>
<td>• Increased safety</td>
<td>• Increased safety</td>
</tr>
<tr>
<td></td>
<td>• Increased road capacity</td>
<td>• Increased road capacity</td>
</tr>
<tr>
<td></td>
<td>• More valuable in-vehicle time</td>
<td>• More valuable in-vehicle time</td>
</tr>
<tr>
<td></td>
<td>• Improved transit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Reduced land consumption</td>
<td>• Increased land consumption</td>
</tr>
<tr>
<td><strong>Costs</strong></td>
<td></td>
<td>• Increased VMT</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Increased land consumption</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Increased pollution</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Increased segregation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Increased roadway required</td>
</tr>
</tbody>
</table>
Assertion 2. There Will Be Time to Adjust Policy

Despite rapid advances, changes will not happen over night (as with smart phones).
- Impacts uncertain
- Technological and regulatory hurdles remain
- Vehicle fleet takes years to turn over (average personal vehicle is 11 years old)

Likely first movers:
- Taxi, freight, and transit industries
- The mobile office crowd
- Regions building new highway capacity (like HOV or HOT lanes, but for AVs)
- Closed facilities like retirement communities, tech campuses, and airports
Assertion 3: Beware the Rosy Future

A short sample of questionable assumptions:

- Shared mobility is inevitable
- Pollution and GHG will decrease
- Congestion will decrease
Assertion 4: Consider Both Scenarios

Low shared mobility <------------------> high shared mobility

Policy Benefits

Removal of traffic lane

Low shared mobility <------------------> high shared mobility
Assertion 5: Focus on WhatAlready Makes Sense

Example: Widen suburban freeway
AV argument:
• AVs likely to increase road capacity, especially on freeways.

Other arguments:
• Expensive and unlikely to reduce congestion.
• Locally desired, but regionally unwanted.
• Induced demand.
The Self-Parking Elephant in the Room
Parking Policy Matters

Total cost of all parking in the United States is higher than the total value of the private car fleet (Shoup 2005)

Increases lifecycle emissions by 25% to 90% for many local pollutants and greenhouse gases (Chester et al. 2010)

Consumes between 8,000 and 17,000 square miles of land nationally (Chester et al. 2010). All of New Jersey is 7,500 square miles.

“[P]arking influences the way cities look, and how people travel around them, more powerfully than almost anything else.”
- The Economist
Parking Policy Matters
Parking will change under either scenario

Redevelopment / expansions of properties where parking is a regulatory or market constraint
Parking will change under either scenario

Commercial on-street
Parking will change under either scenario

Commercial on-street
Parking will change under either scenario

Residential on-street
Parking will change under either scenario

Residential off-street
Local planners control parking

A sample of local off-street requirements

<table>
<thead>
<tr>
<th>Location</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barber shop</td>
<td>2 spaces per barber</td>
</tr>
<tr>
<td>Beauty shop</td>
<td>3 spaces per beautician</td>
</tr>
<tr>
<td>Nunnery</td>
<td>1 space per 10 nuns</td>
</tr>
<tr>
<td>Rectory</td>
<td>3 spaces per 4 clergymen</td>
</tr>
<tr>
<td>Sex novelty shop</td>
<td>3 spaces per 1,000 square feet</td>
</tr>
<tr>
<td>Gas station</td>
<td>1.5 spaces per fuel nozzle</td>
</tr>
<tr>
<td>Swimming pool</td>
<td>1 space per 2,500 gallons</td>
</tr>
<tr>
<td>Mausoleum</td>
<td>10 spaces per maximum number of interments in a one-hour period</td>
</tr>
</tbody>
</table>
Strong Argument to Reform Now

Two parking policy mistakes
1. Require lots of off-street parking spaces
2. Keep curb parking free or cheap

Result in “Great Planning Disaster”
• Distorted urban form
• Degraded urban design
• Higher housing costs
• Limits on homeownership
• Difficulty in reusing buildings
• Damage to the urban economy
• Harm to the central business district
• More driving and pollution
• Higher prices of goods and services
• Lower wages