MODELING A SHARED AUTONOMOUS VEHICLE SYSTEM IN AUSTIN, TEXAS

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A Paradigm Shift for Travelers: Shared Autonomous Vehicles

- Less than 20% of newer (& 15% of all) personal vehicles are in-use at peak times, even with 5-minute pickup & drop-off buffers.
- Car-sharing programs like ZipCar & Car2go, and Transportation Network Companies (TNCs) like Uber & Lyft have expanded exponentially over the past decade.
- Shared Autonomous Vehicles (SAVs) can provide a powerful new service by adding self-driving capabilities to carsharing services, or granting system-level control for TNCs.

Seattle Vehicle Usage by Time of Day
### Expanding Upon Existing Systems

<table>
<thead>
<tr>
<th>Existing System</th>
<th>Examples</th>
<th>Advantages &amp; new capabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Carsharing</strong></td>
<td>Car2Go, Zipcar</td>
<td>Drive themselves, relocate to serve imbalanced demand, provide return-trip certainty.</td>
</tr>
<tr>
<td><strong>Transportation Network Companies</strong></td>
<td>Uber, Lyft</td>
<td>Always available, system-optimal relocation, fewer empty vehicle miles traveled, potential long-term cheaper service.</td>
</tr>
<tr>
<td><strong>Taxis</strong></td>
<td>Yellow Cabs</td>
<td>Same as TNCs, plus allows system-optimally service requests.</td>
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</table>

Even greater advantages with demand-responsive transit systems.
Two Possible SAV Frameworks

- Combining fully self-driving capabilities with on-demand short-term rentals:

  - Audi’s Driverless Car + Car2Go’s Shared Car = Google’s Driverless Car
  
  - GM’s Driverless Car + Small Shuttle/Bus = Robosoft’s Driverless Shuttle for CityMobil2
Case Study Simulation

- **Austin, Texas population** used to generate trip *Origins, Destinations, & Departure Times*.
- **Hourly-varying link speeds** estimated using agent-based DTA simulation software (*MATSim*) serving region’s entire trip table.
- **12 mi x 24 mi geofence (734 TAZs)** serves highest-demand area.
- 100k trips drawn from *regional trip table*, with **56.3k trips** having O&D within geofence (1.3% of total regional trips). These will **use SAVs**.

![Image of Austin Regional Network, Geofence, and Origin-Based Trip Intensity]
SAV Operation

1. New trip finds nearest SAV.

2. Path is planned from SAV to trip Origin & then to trip Destination.

Dynamic ride sharing (DRS)

4. New trip comes online, searches for nearest SAV.

5. If SAV claimed or occupied, check DRS match, testing all pick-up/drop-off order combinations.

6. If success, set the new route & continue moving; Else find the next nearest SAV.

- Unassigned SAVs may relocate to nearby areas with imbalanced SAV supply & travel demand.
Modeling an SAV fleet: One SAV’s 24-hour day

Induct’s Driverless Shuttle
Case Study Results

- **24-hour day simulated** with 56,300 trips served.
- Avg. trip length: **6.1 mi.**
- **Excellent Level of Service**
  - LOS is better w/o DRS, but **LOS is better with DRS** if fleets sized equally.
- **Some extra unoccupied VMT is realized.**
- Replacement rate & reduced VMT gains are large for small amount of shared rides.

<table>
<thead>
<tr>
<th>Measure</th>
<th>With DRS</th>
<th>Without DRS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAV fleet size</td>
<td>1715</td>
<td>1715</td>
</tr>
<tr>
<td>Veh. replacement rate*</td>
<td>10.8</td>
<td>10.8</td>
</tr>
<tr>
<td>Average wait time</td>
<td>1.2 minutes</td>
<td>1.9 minutes</td>
</tr>
<tr>
<td>% Waiting &gt; 10 min.</td>
<td>1.5%</td>
<td>5.7%</td>
</tr>
<tr>
<td>5-6 PM avg. wait</td>
<td>4.5 minutes</td>
<td>9.0 minutes</td>
</tr>
<tr>
<td>Avg. total trip time</td>
<td>14.7 minutes</td>
<td>15.0 minutes</td>
</tr>
<tr>
<td>New VMT introduced</td>
<td>4.5%</td>
<td>4.5%</td>
</tr>
<tr>
<td># rides shared</td>
<td>6151</td>
<td>0</td>
</tr>
<tr>
<td>% VMT shared</td>
<td>4.8%</td>
<td>8.7%</td>
</tr>
</tbody>
</table>

*On a per-trip basis. Replacement rates on a per-VMT basis are less favorable.
Profitability

Assuming:
- $1-per-mile fares vs. $3+ per mile for taxis.
- $70k SAV purchase costs & 250k miles/SAV.
- Operating costs of $0.50/mi. & $0.25/mi.
- Fixed demand + implicit $23/hr. wait costs.

Very favorable ROI:
Thank you for your time!

Questions?