Large-Scale Shared AV Simulations with Geofences, Stop Aggregation, & Parking Restrictions

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**Case Study #1: 4 Chicago Geofences**

- **Different population-to-jobs ratios** across geofences.
- **Pop/jobs < 2** for City, Suburban, & Exurban Core.
- **≈ 2.15** for entire region.
%eVMT by Scenario

Note: Base Case = Ridehailing with conventional vehicles
Fencing Results

Assuming fewer cars desired per household, just 1 SAV per 100 residents, & $0.50/mile SAV fares:

• **Unfenced/full-region** service has 11 min avg. response time + 35% (!) eVMT, with SAV mode split of ~6%.

• **Geofencing lowers** response times & eVMT, with greatest reductions within (sub)urban core.

• Avg. response times vary linearly with proximity to CBD.

• **Dynamic ride-sharing** (with strangers) lowers %eVMT by another 2-10%.

• **Net VMT savings** up to 5% (no DRS) & 9% (DRS) thanks to smaller fences.

• **City-wide fence** implies < 1 SAV/100 Residents fleet size for comparable trips served/SAV → non-linear fleet requirement.
Case Study #2: Pickup & Dropoff Stops (PUDO) in Bloomington, Illinois

- **Bloomington**, Illinois
  - Just 74 sq. miles
  - **120,000** residents
  - **4,000** links + **2,500** nodes
  - About **2,800** unique locations

- **POLARIS moves** travelers between all **O’s & D’s**.

- **PUDO stop clustering** using pre-defined **stop spacing,** $d_s$
  $\rightarrow$ **Equi-distant stops**

$$d_s = 0.25 \text{ mi} = 400 \text{ m}$$
Scenarios

- **Trip intensities**: 100%, 500%, & 2500% to approximate a major city.
  - 25x provides about 15M trips/day or **8,500 person-trips per hour per sq. mile**.
  - Travel times rise too, so mode splits need to be unchanged for ideal comparison.
- Fleet sizes scaled up, so **each SAV serves 70 person-trips per day**, on average.
- SAVs considered for match if < 10 min away.
- All travelers assumed willing to use **DRS** (ridesharing).
- **DRS** matching ends if > 5 min or 5% delay (vs. direct travel time).
- PUDO stop spacings of $d_s = 0, 0.25, & 0.5$ mile tested.
Results

• **7-8% of trip-makers** choose SAVs.
  – Between **48k (1x)** to **1.2M (25x)** trips served each day.

• **Without DRS & PUDO Stops:**
  – Average SAV serves **65 trips/day**.
  – Travels approx. **430 mi/day (!)**
  – % eVMT about **34% (!)**
  – **2-5% lower eVMT** with 5x & 25x trip density.

• **With DRS (but no PUDO)**s:
  – **5 more trips/SAV/day**, **19% eVMT**, & **2% less total SAV VMT**.
  – But **longer response & travel times**.
DRS + Stops

- **Total VMT falls by 1 to 3%.**
- **SAV VMT** savings of 10-20% possible, with more savings from 5x & 25x trip density than from stops.
Temporal Distribution of Avg Vehicle Occupancy (#passengers)

- **PUDO**s increase AVO & lower total VMT by aggregating low-density trips at off-peaks.

- Aggregating trips at any time of day or day of week lowers user costs, empty VMT, & overall VMT.
Stop Aggregation Takeaways

- **DRS** does help lower congestion – but really depends on travelers’ willingness to be delayed.
- Higher trip density settings *can* lower total VMT.
- **High parking prices** can shift mode shares to SAVs & transit → boosting savings!
- **Stops** help marginally increase AVO & lower VMT – assuming no disutility from walking.
- **Dedicated infrastructure** may be needed to accommodate SAVs at stops.
- **Link characteristics** (larger capacity & walkability) may be important for stop placement.
Case Study #3: SAV Parking Restrictions in the Twin Cities

- **9.5M person-trips/day** across 7 MPO counties.
- **MATSim** used across 325k links & 131 nodes, ignoring external + trucks trips.
Restricting Curb Idling

- **134 parking lots with 500-vehicle capacity** along links with > 400 trip stops (O’s & D’s) per curb per day.
- **SAVs** dropping off pax at those curbs, seek **closest parking lot**. If no spaces are available at closest 2 lots, SAVs will idle at the curb.
MSP Parking Results

• Curb parking restrictions across 7 counties generated 8% more SAV VMT & 7% more eVMT on average.

• SAV work durations (run times per day) rose 15%.

• # DRS trips fell 5%.

• Curb parking restrictions lowered DRS trips by 0.5%, while increasing wait times by 11% & 19% in the 7-county & Twin Cities scenarios, respectively.
More Twin Cities Results

- Using **1:5 SAV-to-traveler fleet**, eVMT averaged **7.2% to 14%** of total VMT, with each SAV **working 4.0 to 8.9 hours per day**.
- **Smaller fleets of 1:15** has higher eVMT (**17 to 23%**) & run times ranging from **7.2 to 18 hr/day**.
- When **DRS** is enabled, **average response times fall 10%**.
- Relative to the **7-county service area**, Twin Cities simulations averaged **25% more DRS trips & 19% shorter wait times**.
- eVMT occurred **mostly** in **neighborhoods** with **lower trip-end density & dispersed directions**.
- Most SAV VMT & eVMT occur on **freeways & highways** across MSP region.
- As with Chicago, MSP **response times are similar across the region**!
Thank you!
Questions & Suggestions?

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