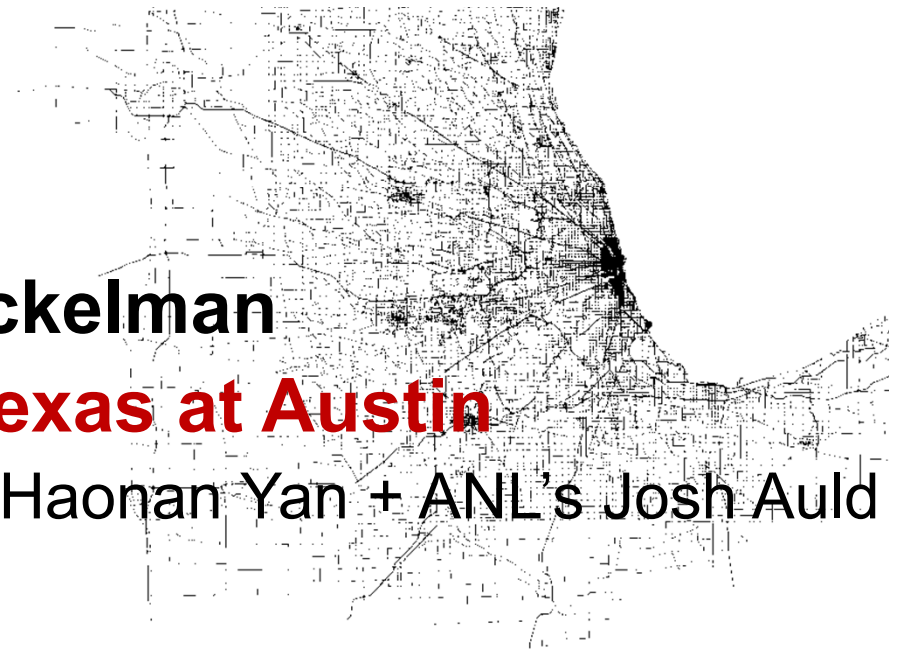




THE UNIVERSITY OF TEXAS AT AUSTIN  
**CENTER FOR TRANSPORTATION RESEARCH**

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



**Kara Kockelman**

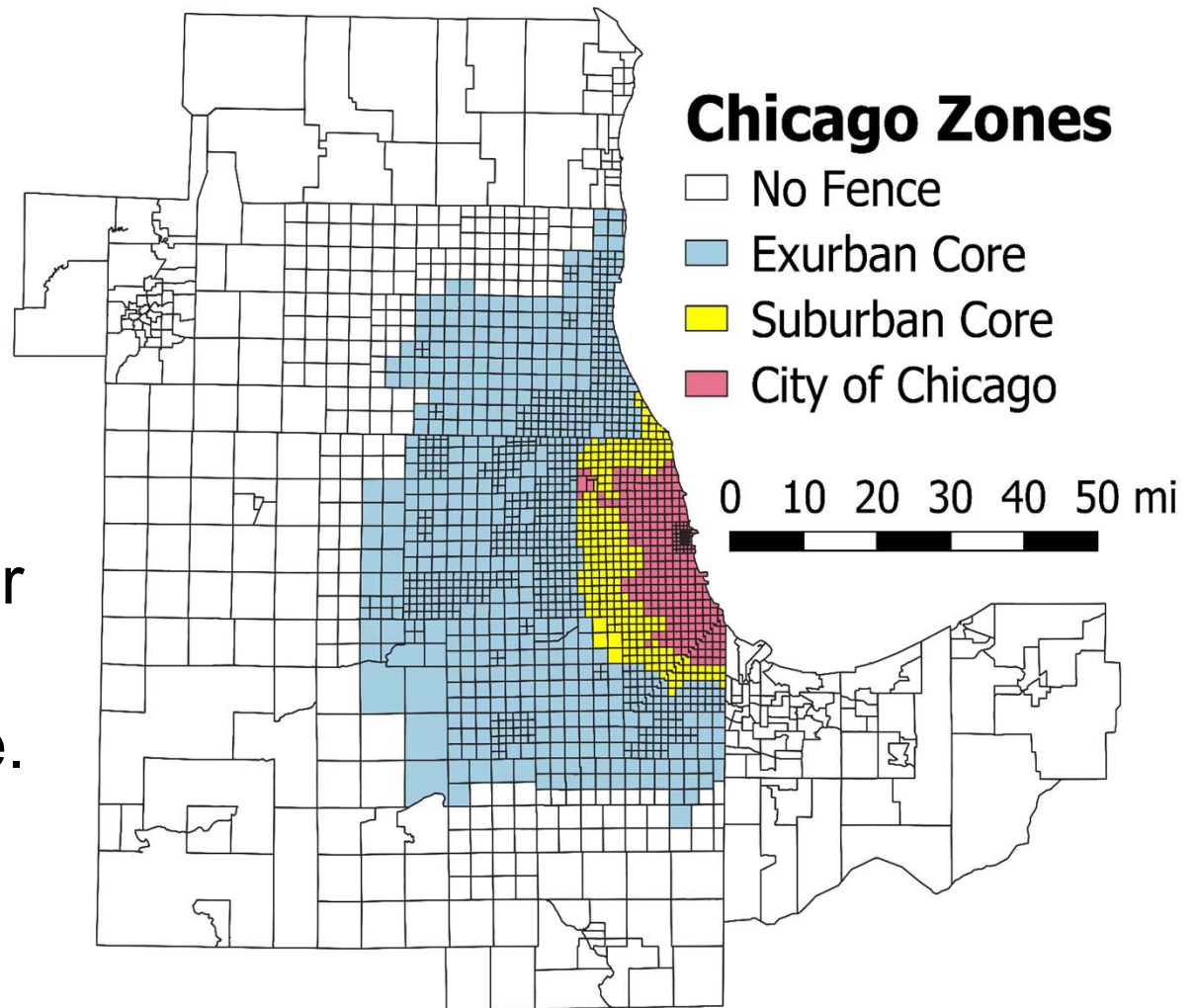
**University of Texas at Austin**

with UT's Murthy Gurumurthy & Haonan Yan + ANL's Josh Auld

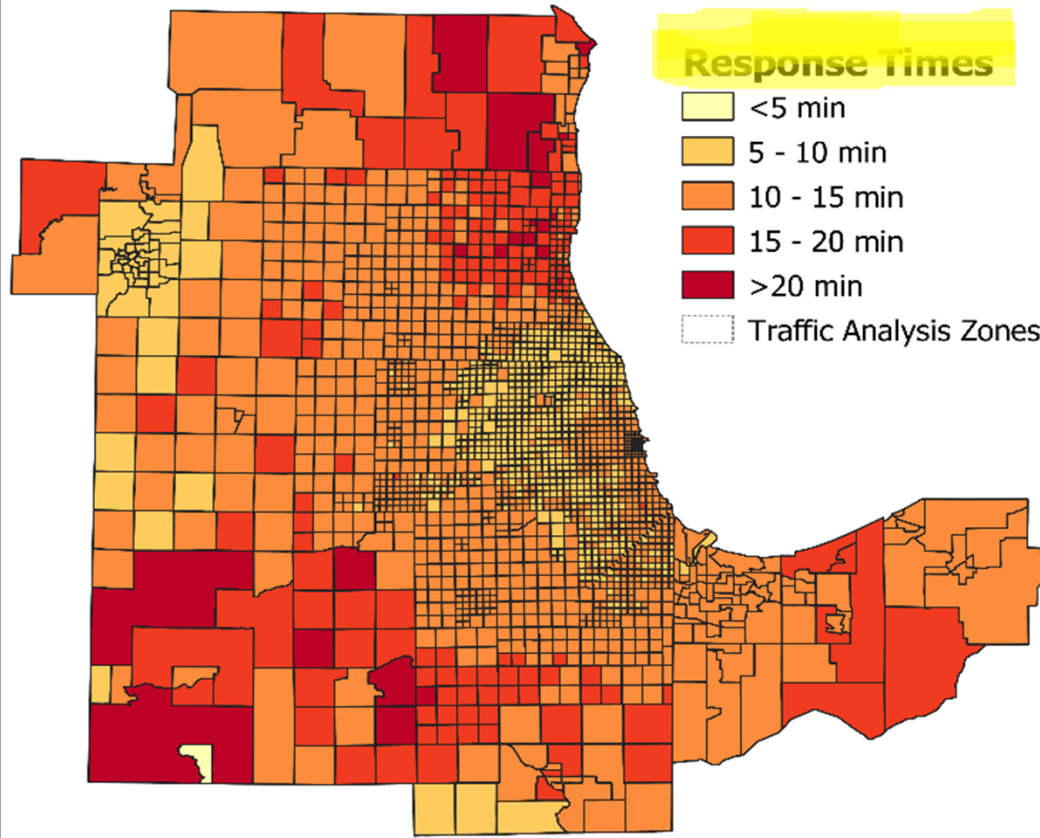


# Case Study #1: 4 Chicago Geofences

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

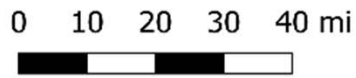


## SAVs Serve the Entire Region (No Fence)

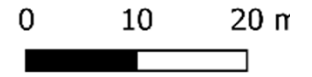
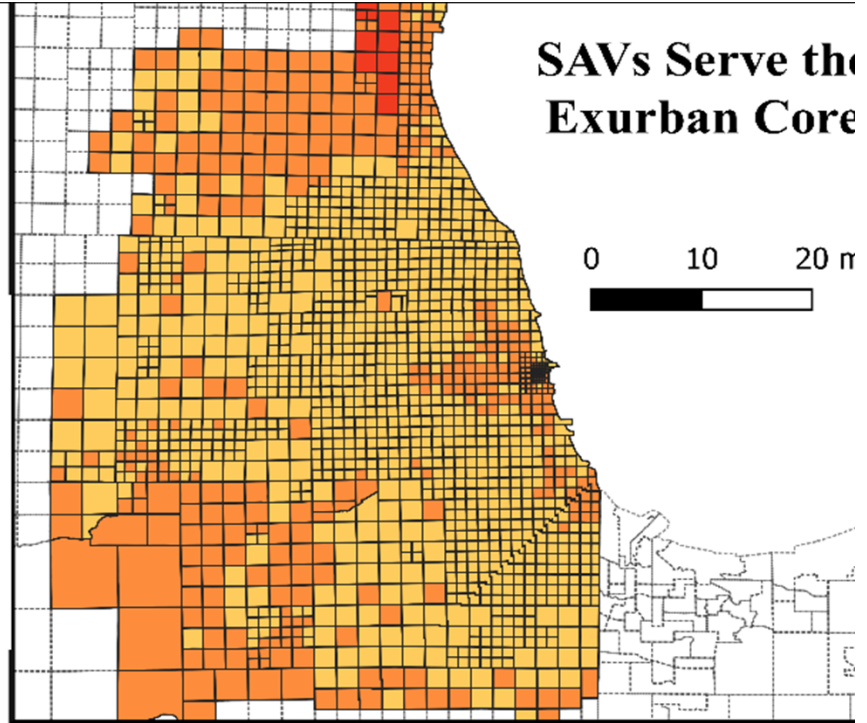


### Response Times

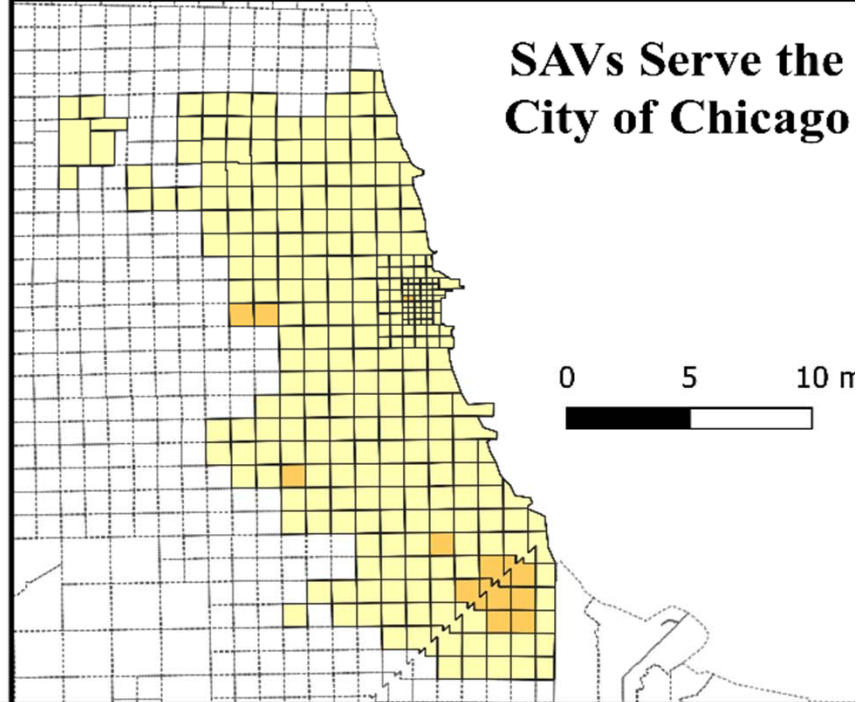
- <5 min
- 5 - 10 min
- 10 - 15 min
- 15 - 20 min
- >20 min
- Traffic Analysis Zones



## SAVs Serve the Exurban Core

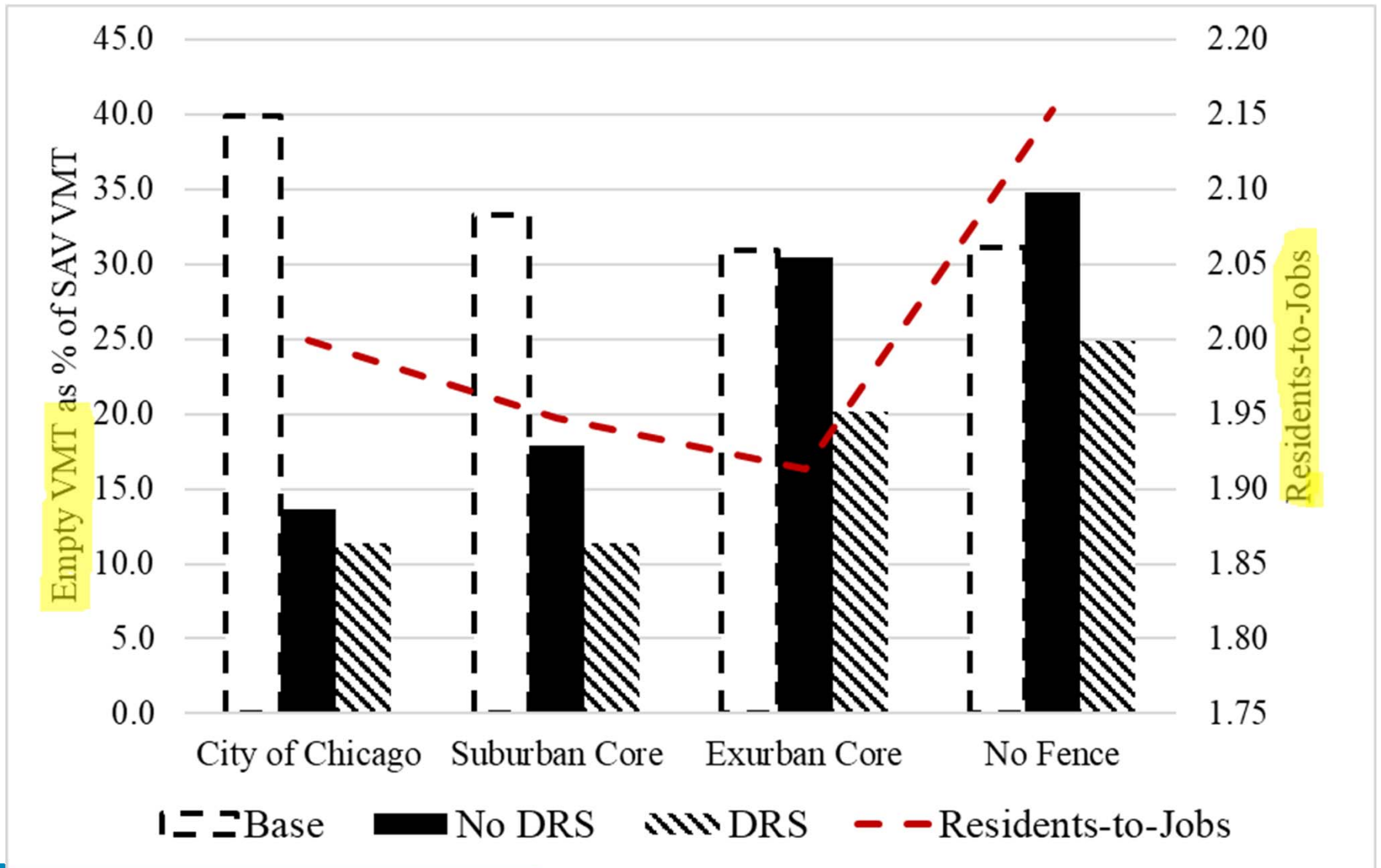


## SAVs Serve the City of Chicago





# %eVMT by Scenario



Note: Base Case = Ridehailing with conventional vehicles



# Fencing Results

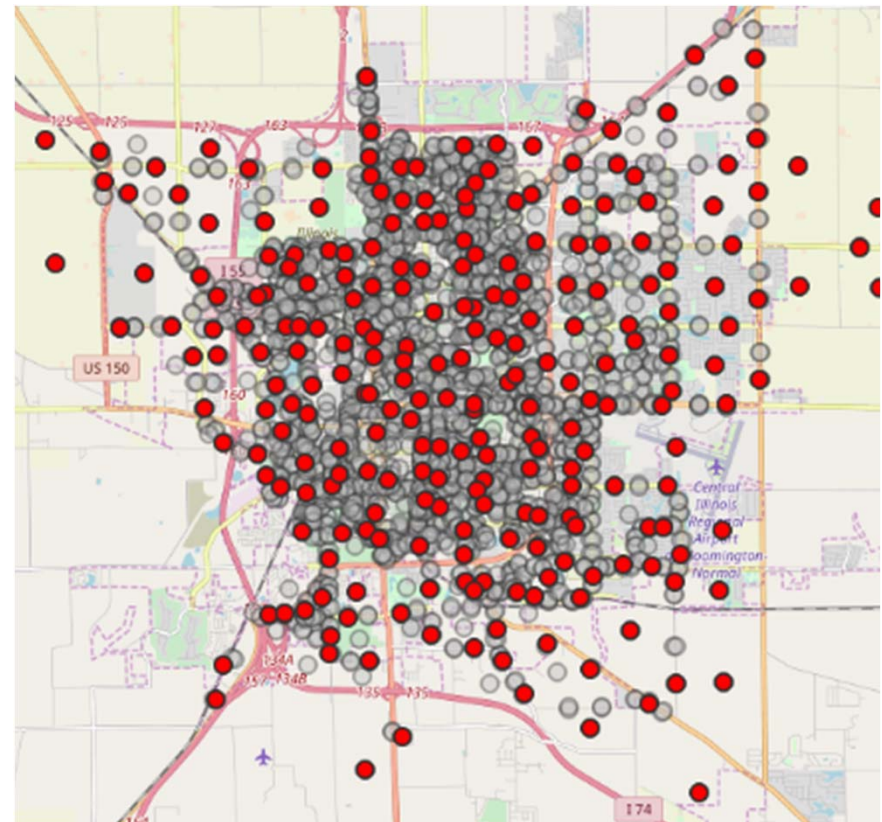
Assuming fewer cars desired per household, **just 1 SAV per 100 residents**, & \$0.50/mile SAV fares:

- **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 (PUDOs) 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,  $d_s$**   
→ **Equi-distant stops**



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



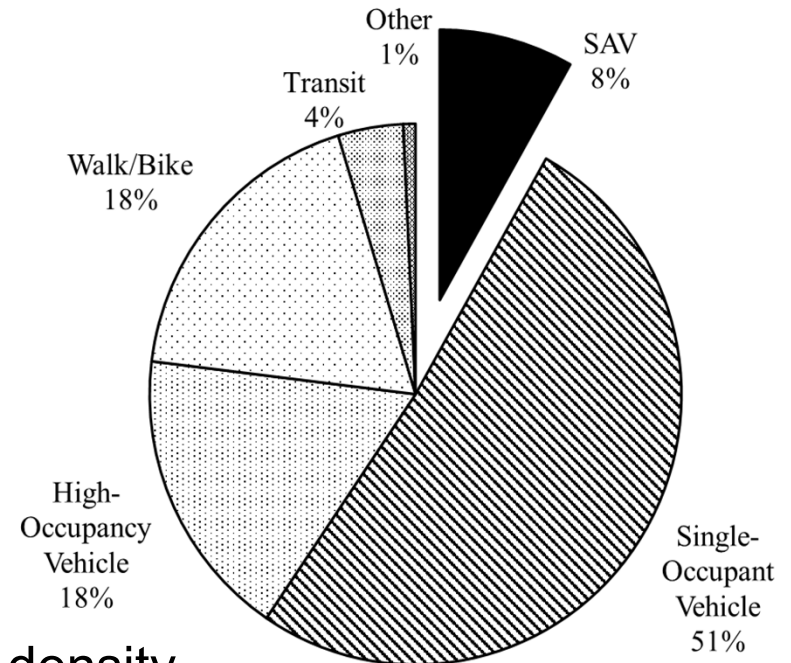
## Scenarios

- **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 PUDOs):**
  - **5 more trips/SAV/day**, **19% eVMT**, & **2% less total SAV VMT**.
  - But **longer response & travel times**.

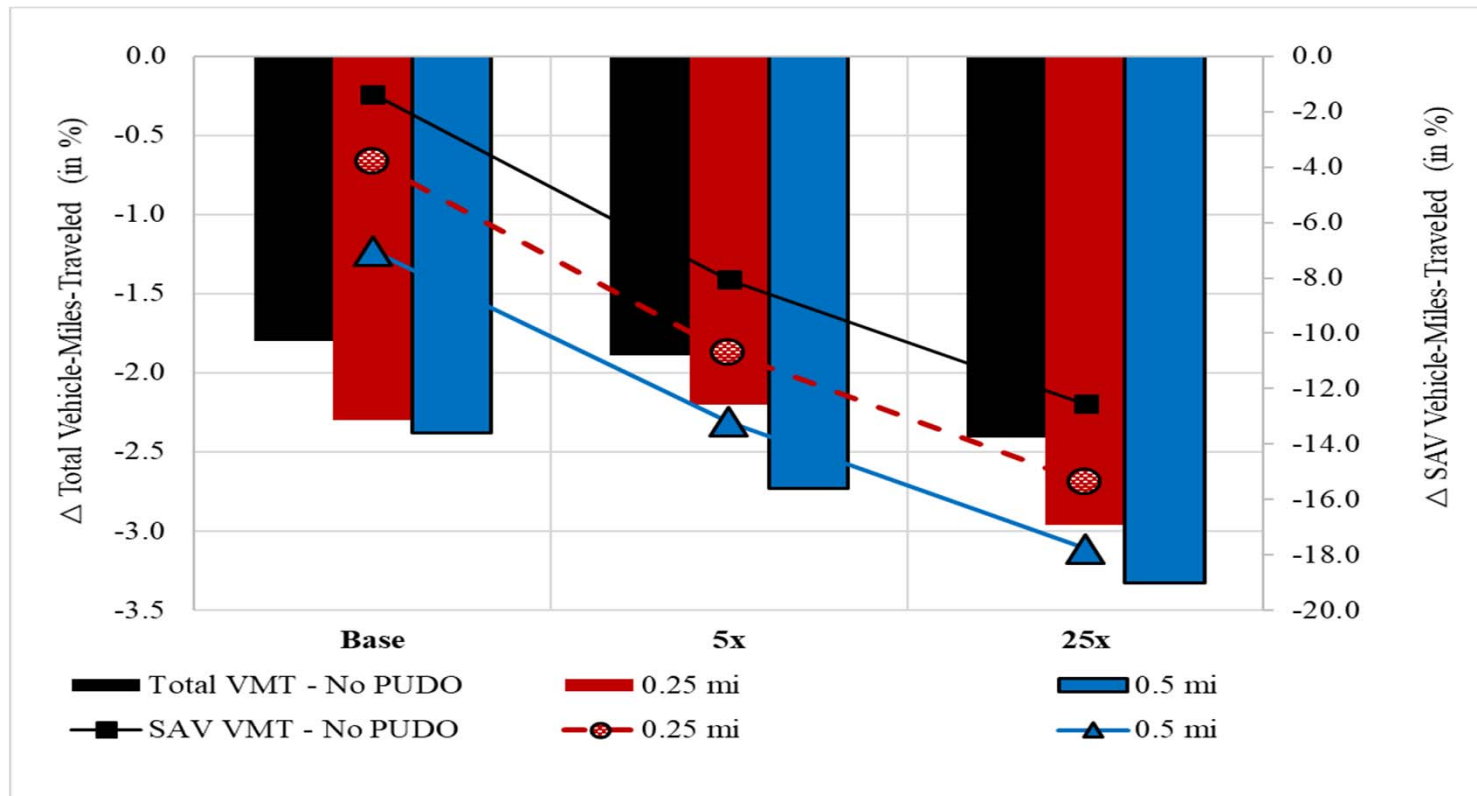






## DRS + Stops

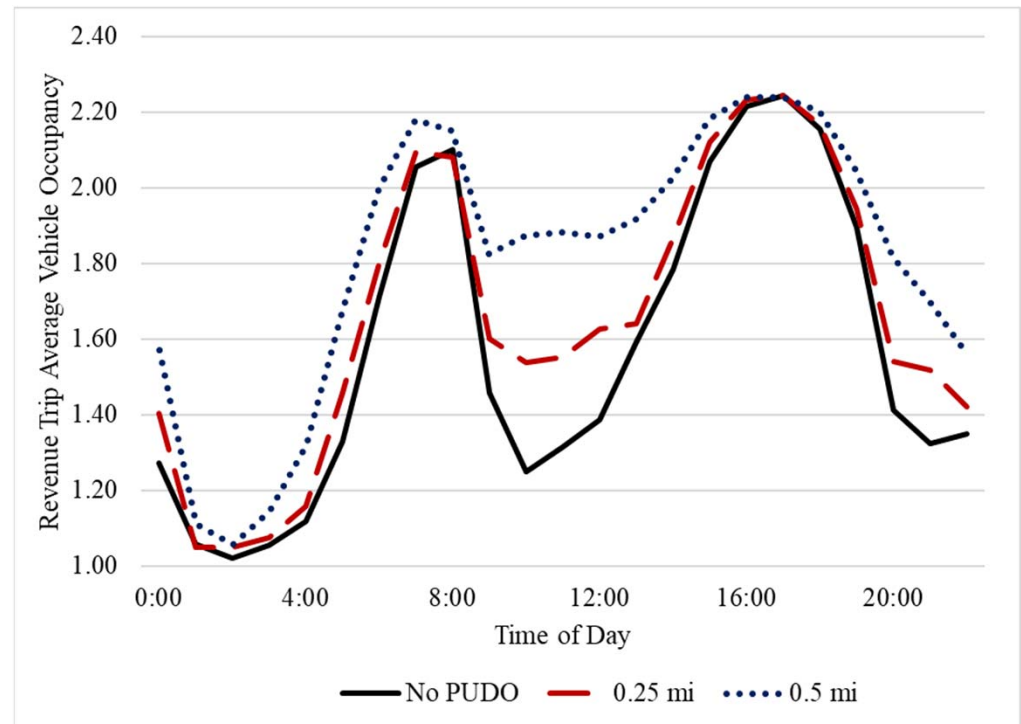
- **Total VMT falls by 1 to 3%.**
- **SAV VMT savings of 10-20% possible**, with more savings from **5x & 25x** trip density **than from stops.**





## Temporal Distribution of Avg Vehicle Occupancy (#passengers)

- **PUDOs 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**.





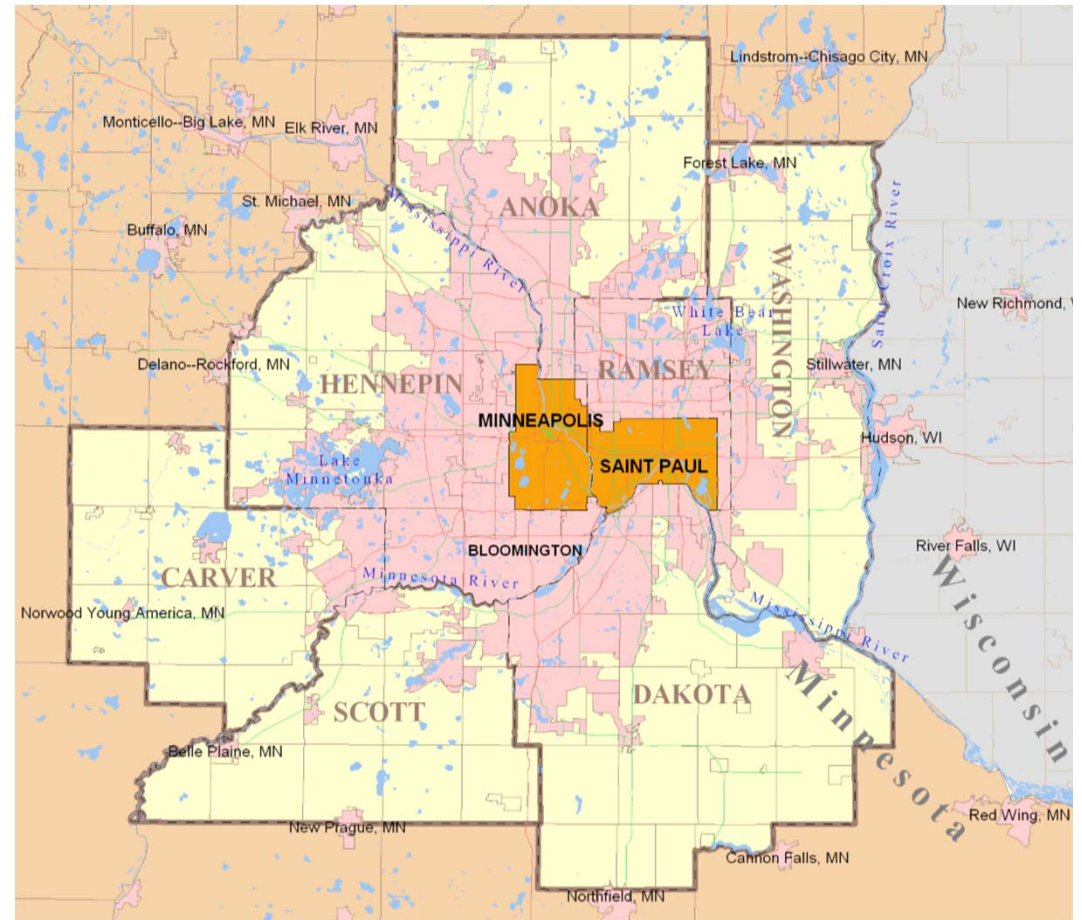
# Stop Aggregation Takeaways

- **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

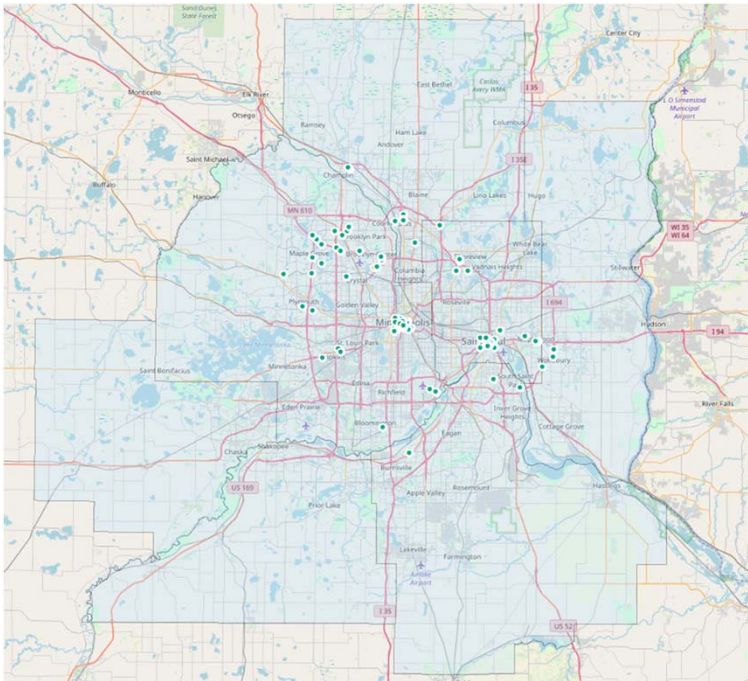
- **9.5M person-trips/day** across 7 MPO counties.
- **MATSim** used across 325k links & 131 nodes, ignoring external + trucks trips.



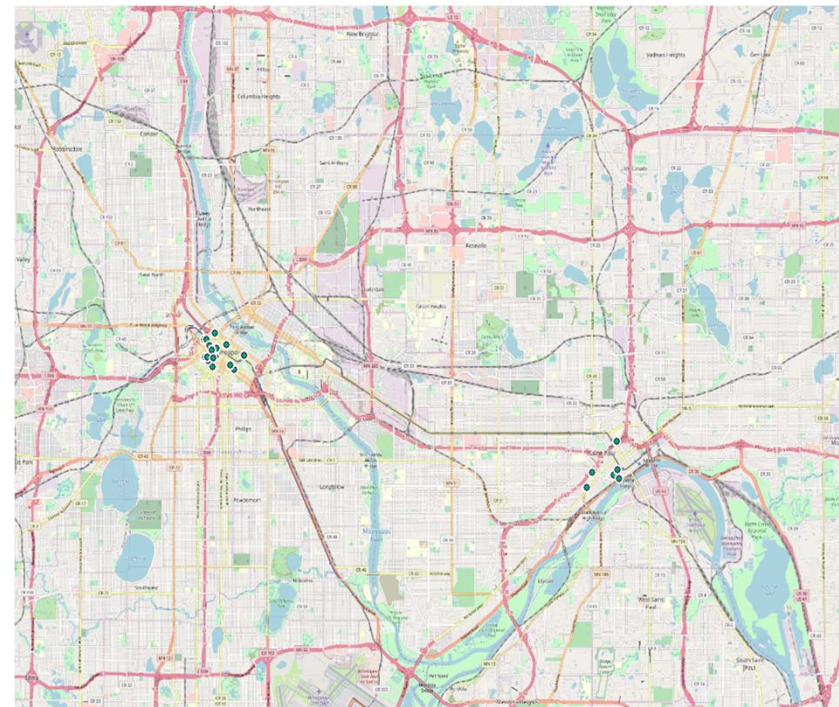


# Restricting Curb Idling

- **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.



SAV Parking Lot Sites across **7 Counties**



SAV Parking Lot Sites in **Twin Cities**



# 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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