

SimUAM: A Toolchain to Integrate Ground and Air to Evaluate the Impact of Urban Air Mobility on Travel Behavior

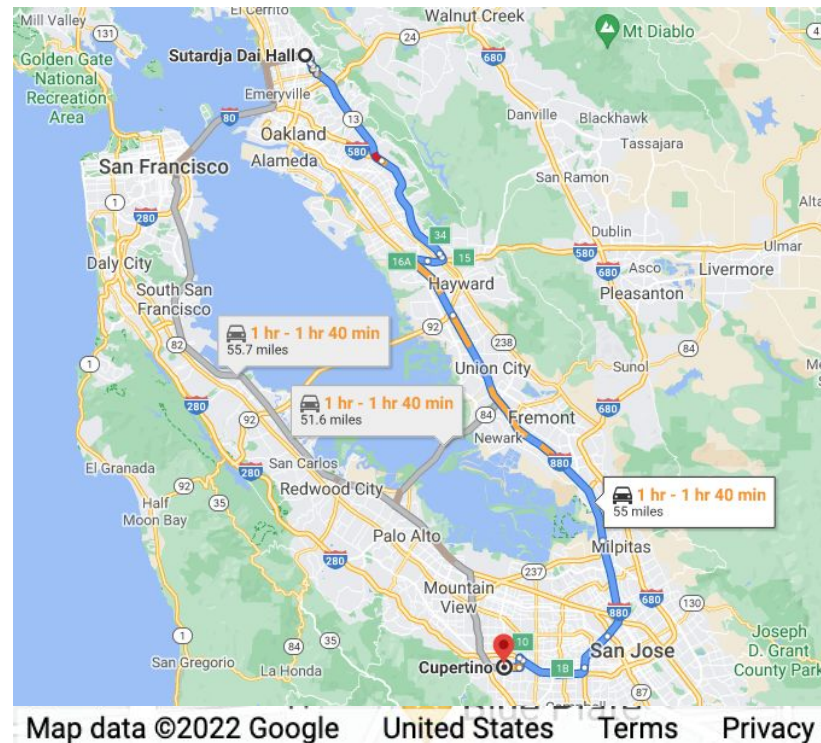
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Vishwanath Bulusu², Min Xue³

What is Urban Air Mobility (UAM)?

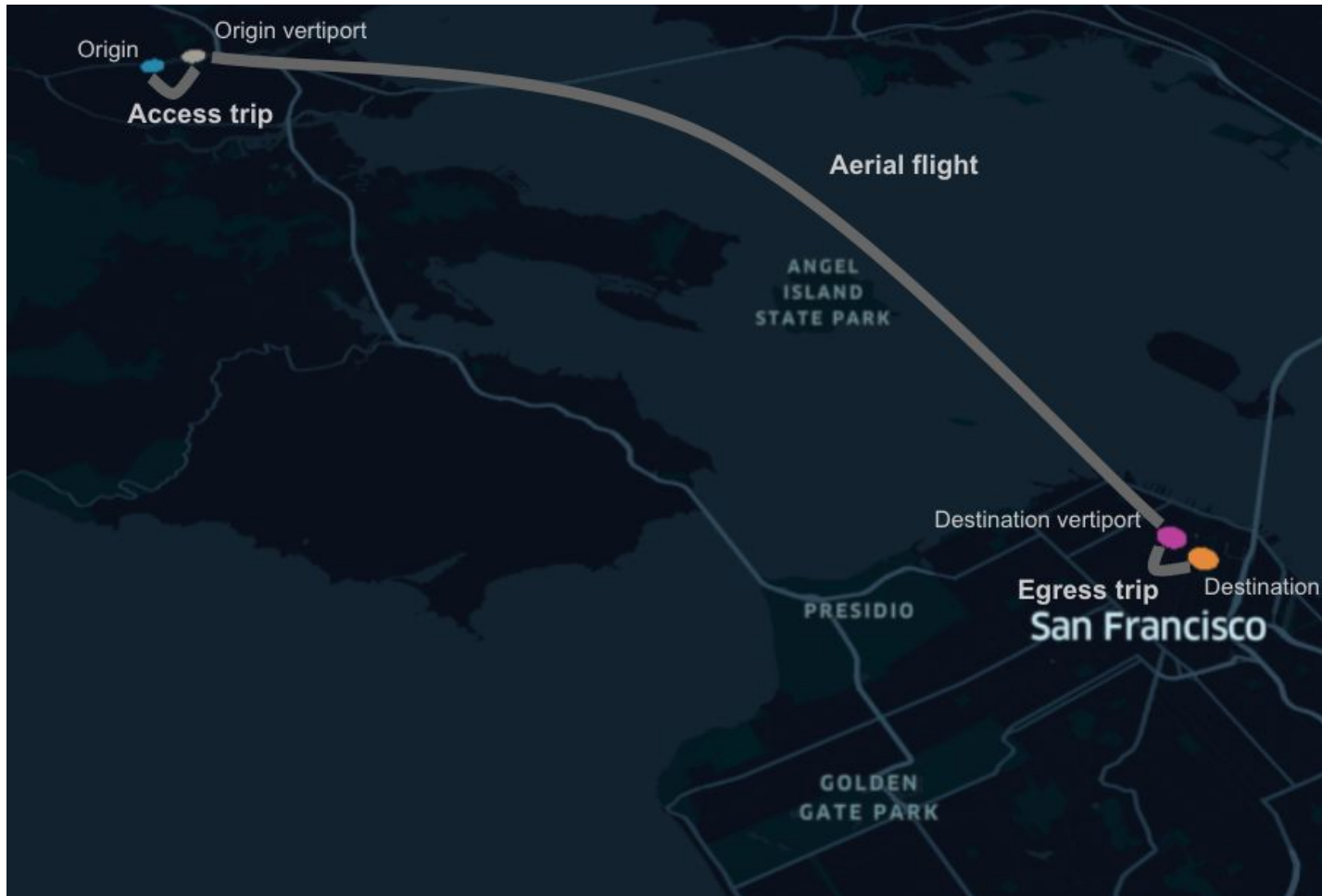
The excitement is in the air!



The long distance transportation problem



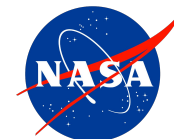
The multi-modal UAM trip



The Car Trip: MANTA

Microsimulation Analysis for Network Traffic Assignment

- Fast, high-fidelity, regional scale
microsim
- 223K nodes, 550K edges in SF Bay
Area
- ~3M trips from Bay Area MTC
 - Trips from 1454 traffic analysis
zones disaggregated into
individual trips
- Vertiport network design
 - k-medians clustering on trips \geq
30 mins



The Car Trip: MANTA

Microsimulation Analysis for Network Traffic Assignment

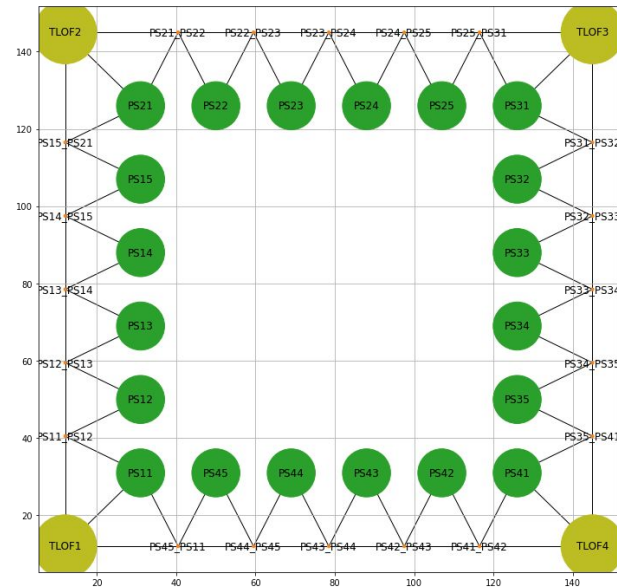
- Microsimulation
 - ~4.6 minute runtime
 - 7 hours with .5 second timesteps
 - Car-following, lane changing, and gap acceptance
 - Parallelized, GPU-based
 - Vehicle checks the traffic atlas to find the position and speed of surrounding cars
- Shortest-path routing
 - Contraction hierarchy scheme using Pandana OSRM
 - Parallelized using OpenMP framework of message passing and shared memory usage
 - 3M routes computed in < 1 minute

$$\dot{v} = a \left[1 - \left(\frac{v}{v_0} \right)^\delta - \left(\frac{s^*(v, \Delta v)}{s} \right)^2 \right]$$

$$m_i = \begin{cases} \exp(-(x_i - x_0)^2) & x_i > x_0 \\ 1 & x_i \leq x_0 \end{cases}$$

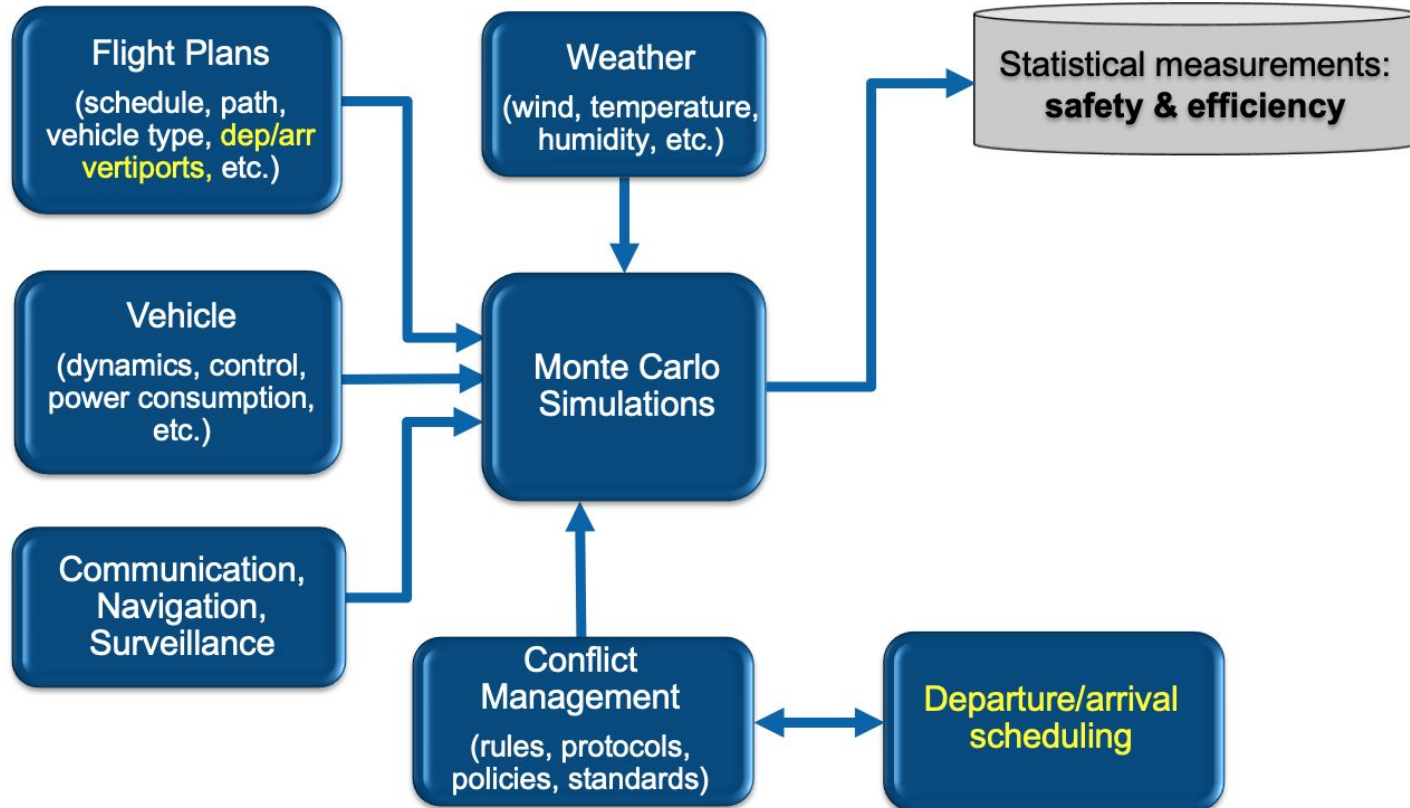
Ground-Air Coordination: VertiSim

- Vertiport design - Vertiport layout
- Aircraft model
- Passenger model
- Vertiport management strategy
- Vertiport network

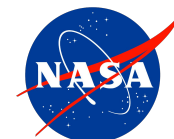


Vertiport layout design (based on Zelinski et al.)

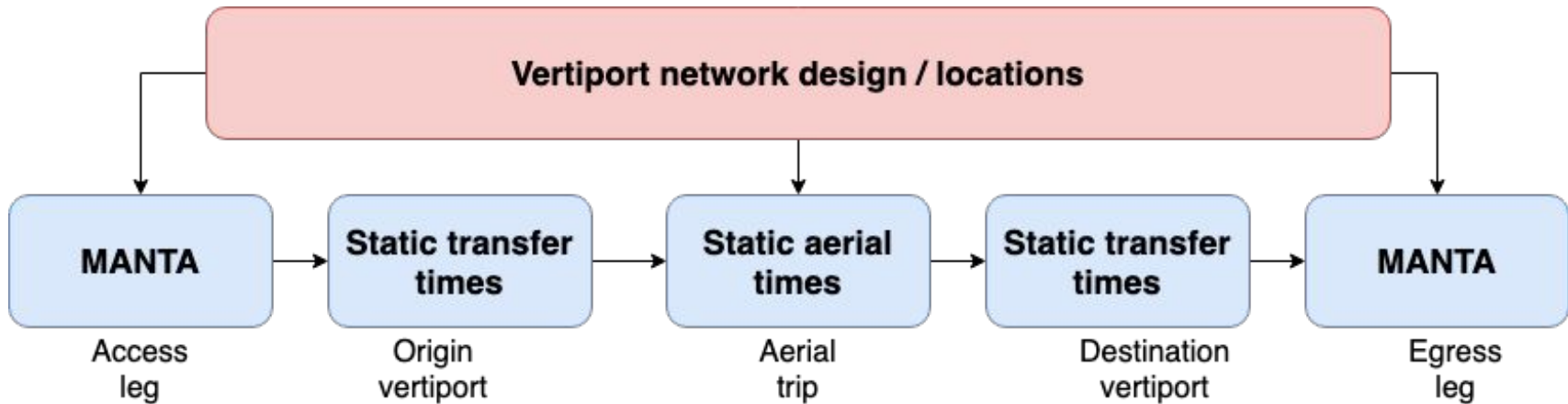
Fe³ system diagram



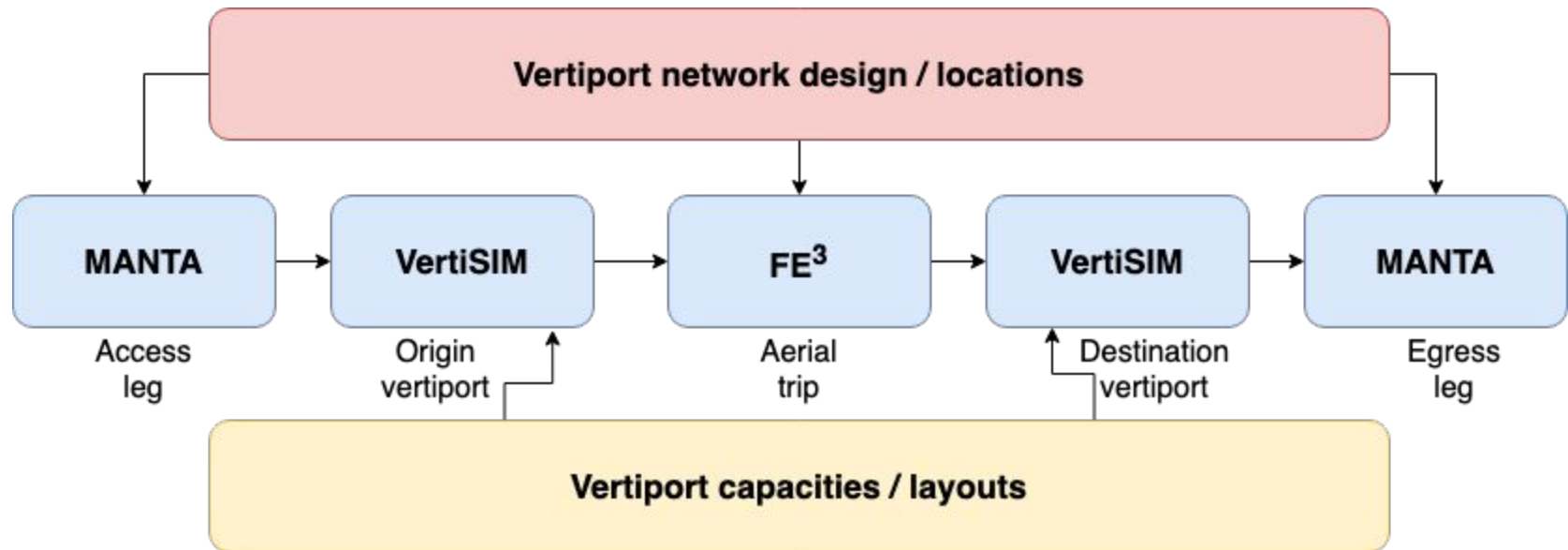
*Fe³ - Flexible engine for Fast-time evaluation of Flight environments



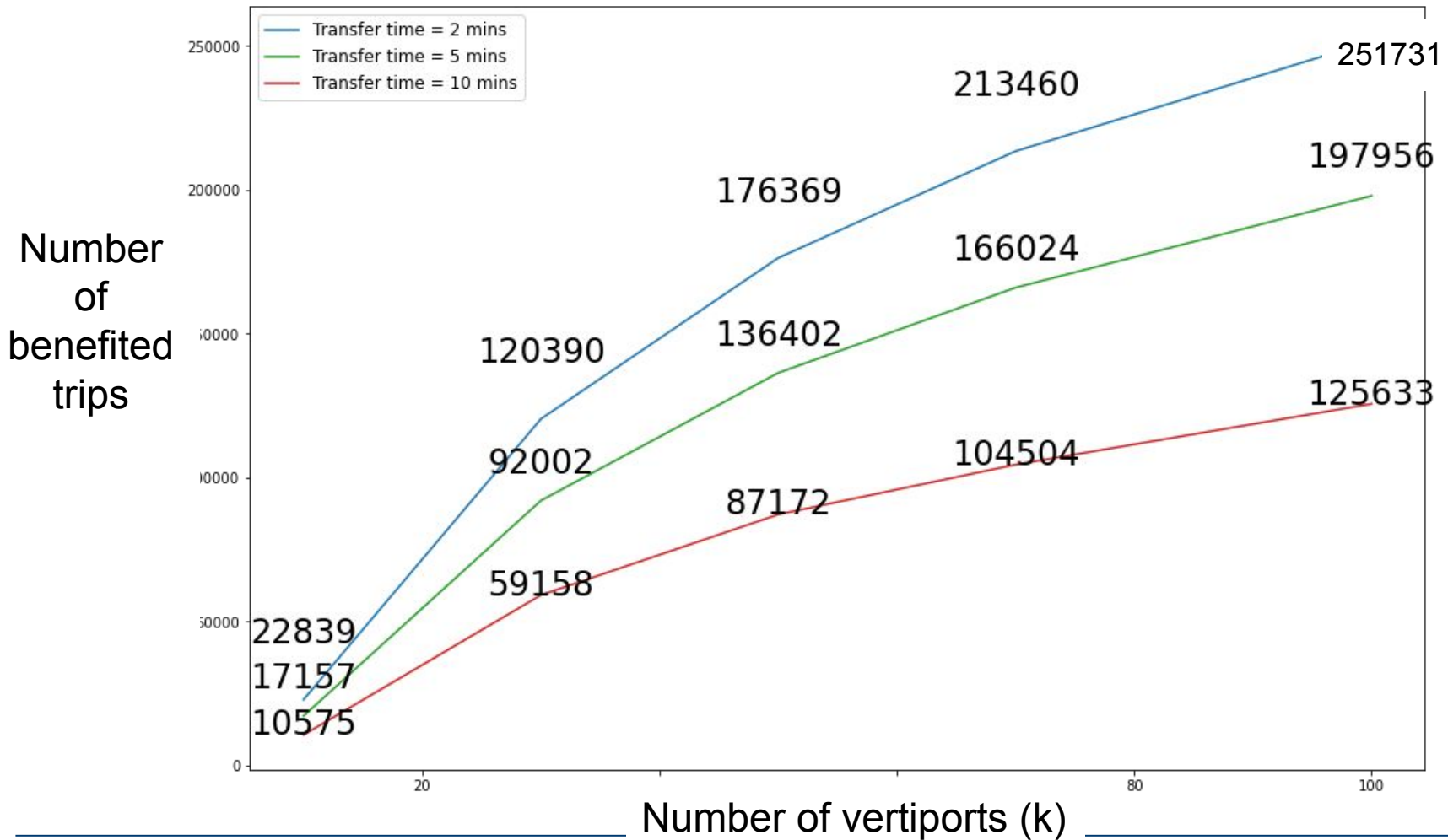
How is static multi-modal UAM modeled?



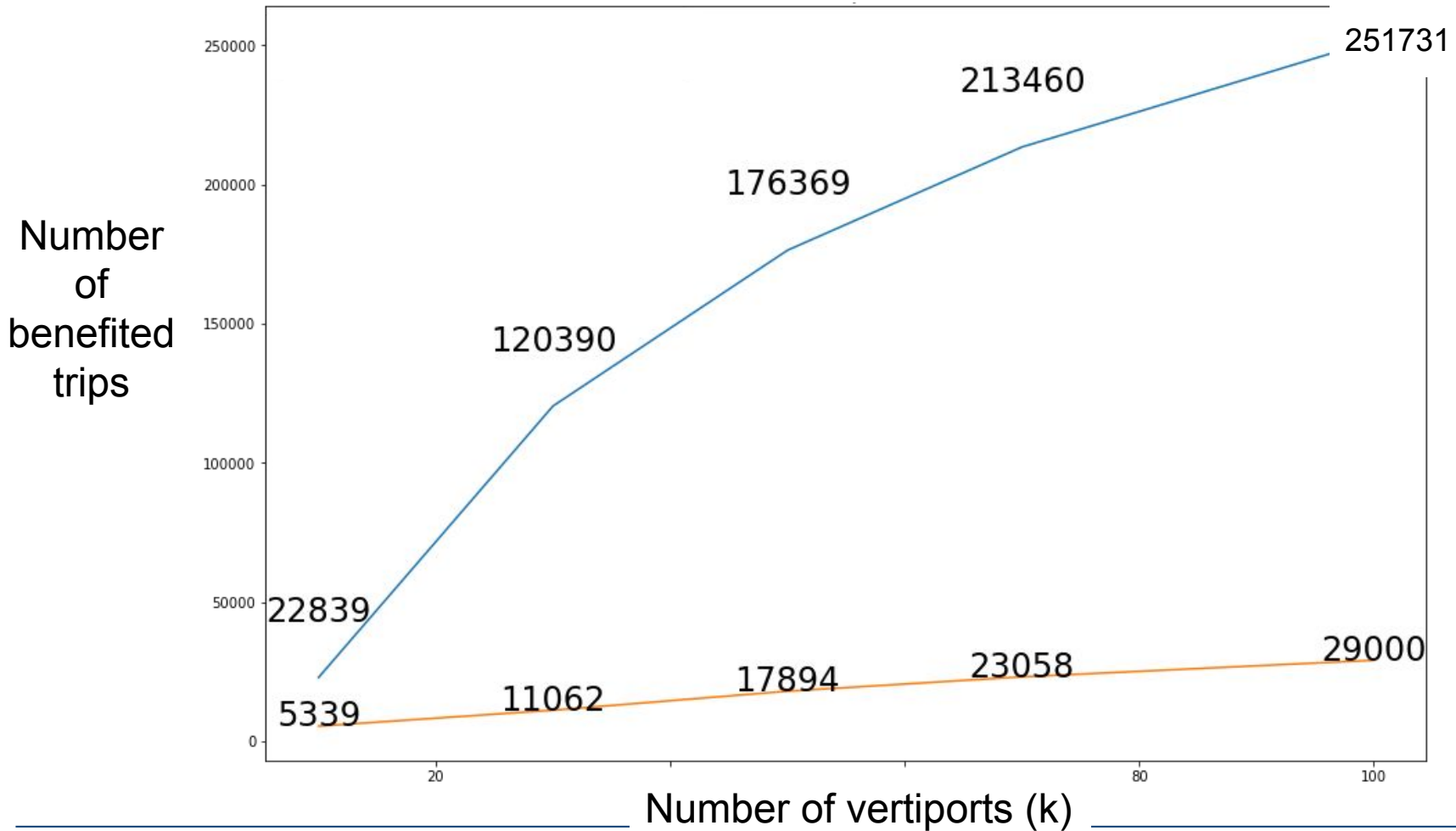
How is dynamic multi-modal UAM modeled?



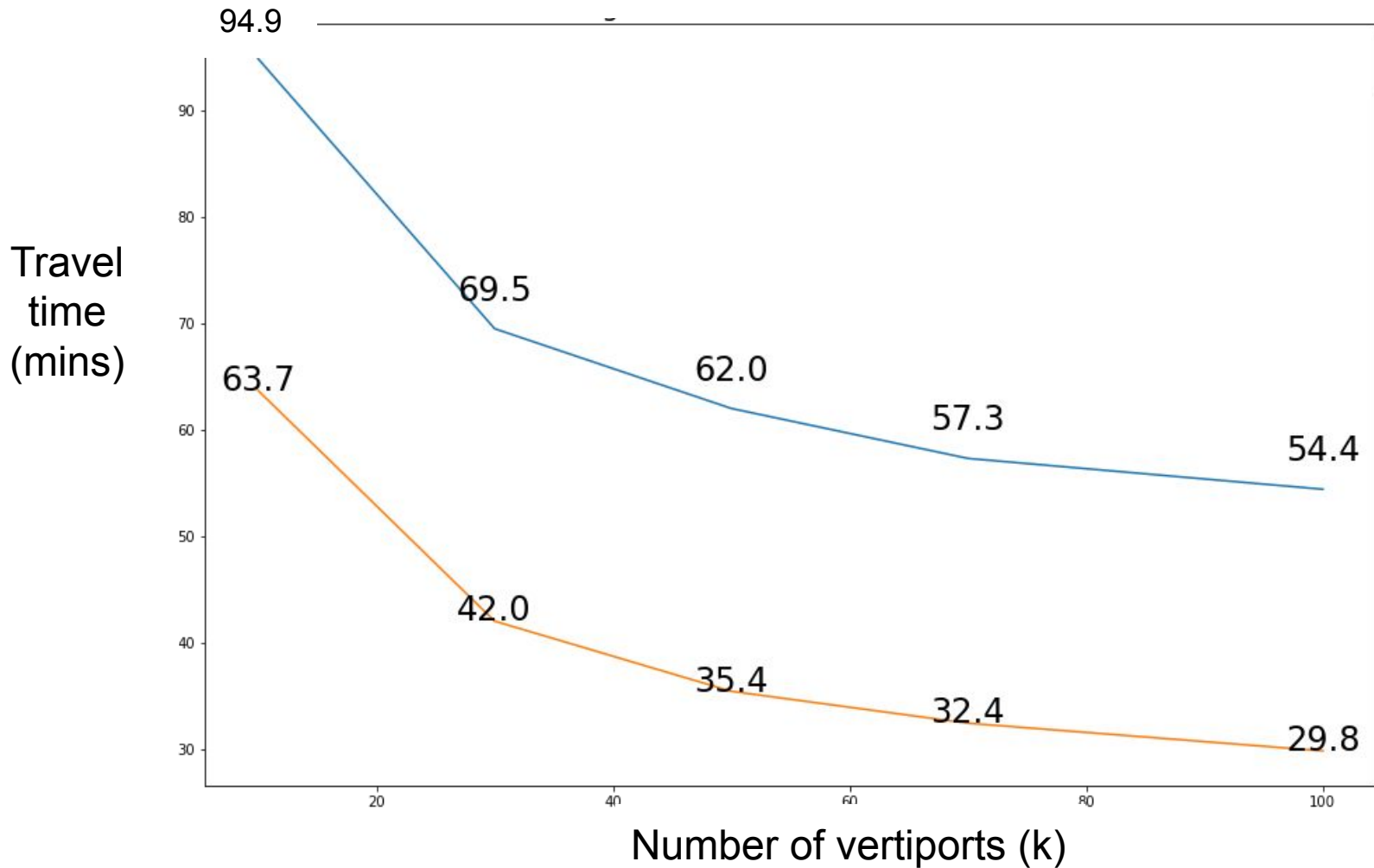
Number of benefited trips across vertiports



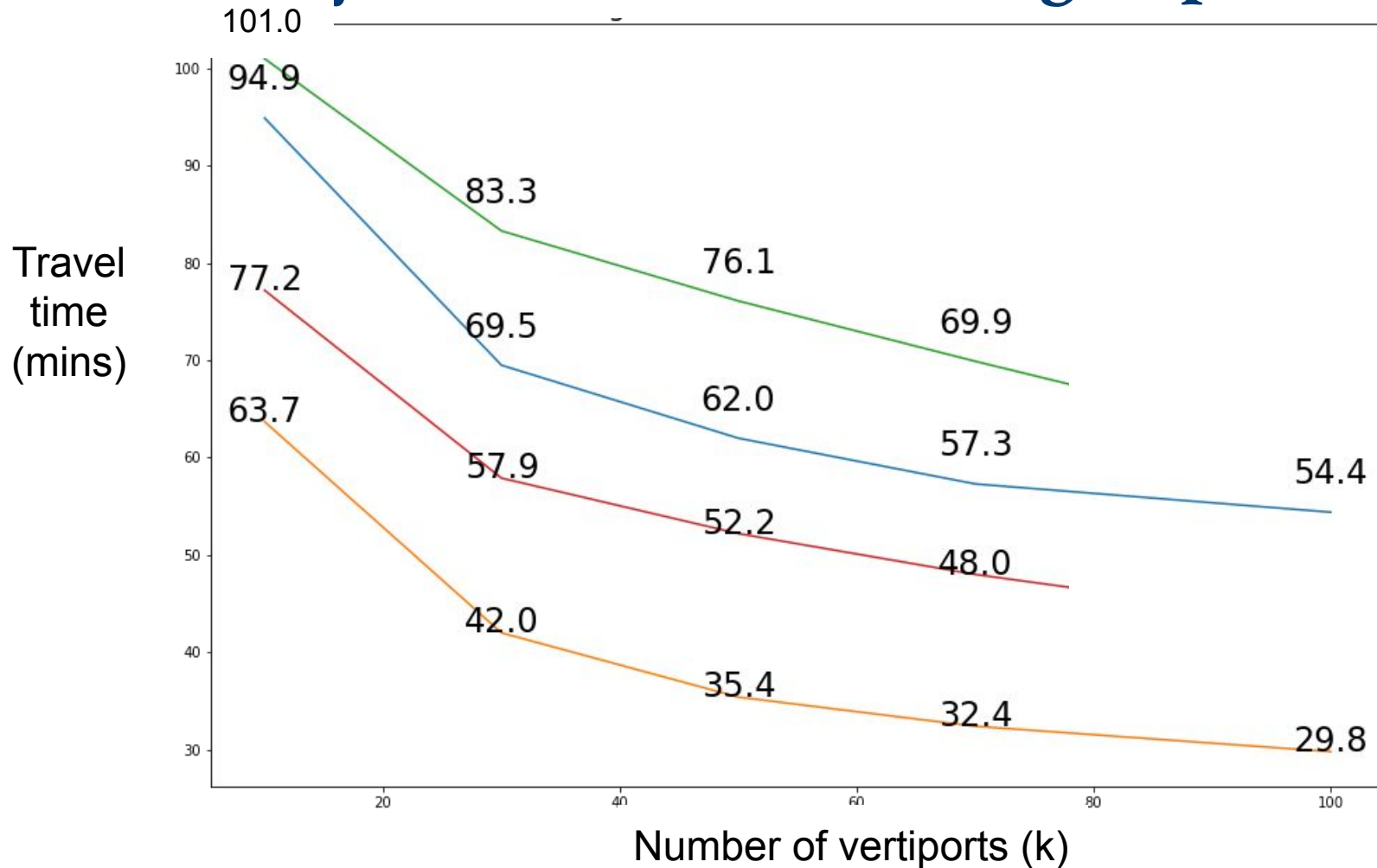
Number of benefited trips (transfer time = 2 mins)



Driving and UAM times of benefited trips with static model

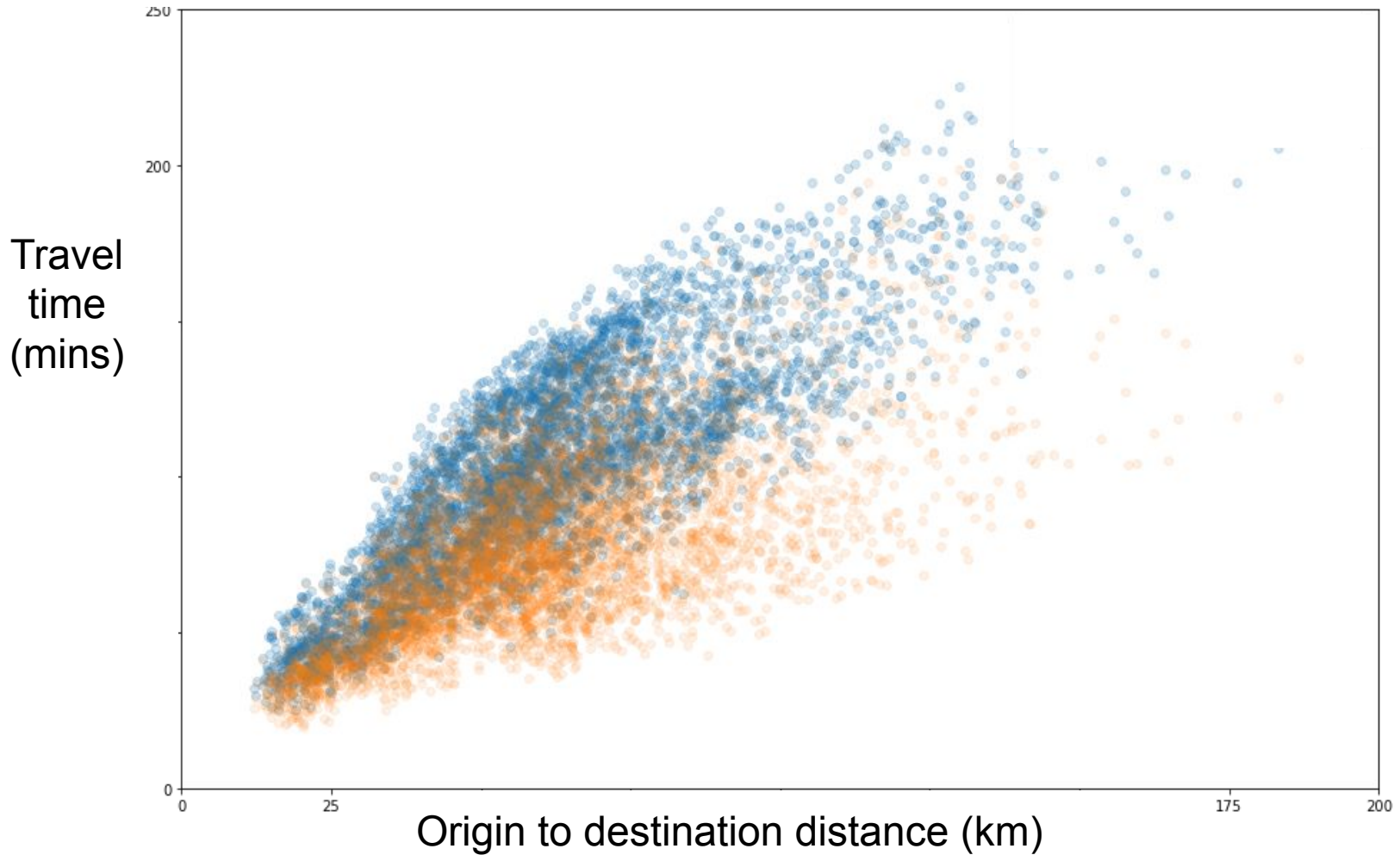


Driving and UAM times of benefited trips with dynamic model - times go up!



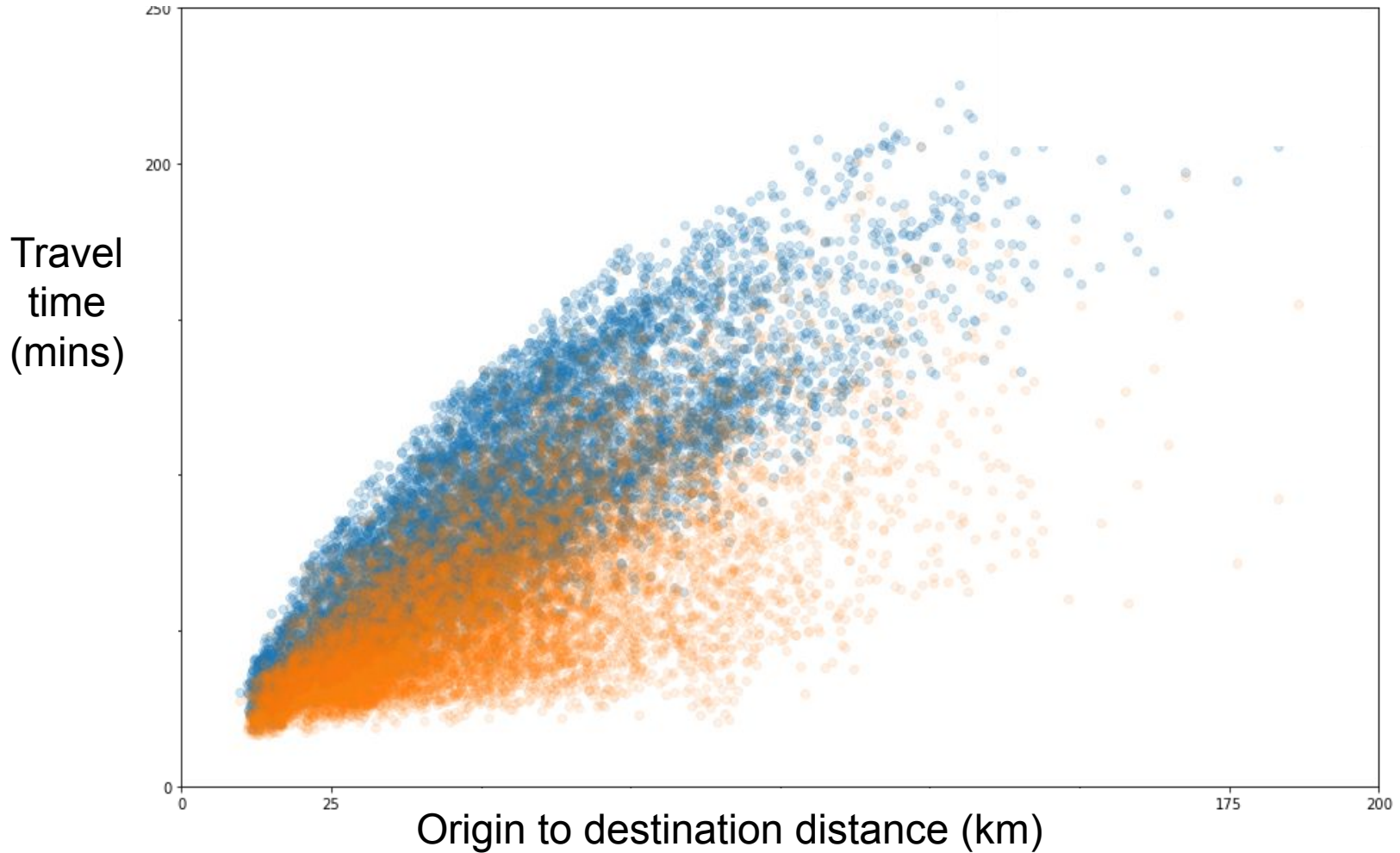
Benefited trips (k=10) scheduling

23K trips assigned to UAM / 5.3K benefit



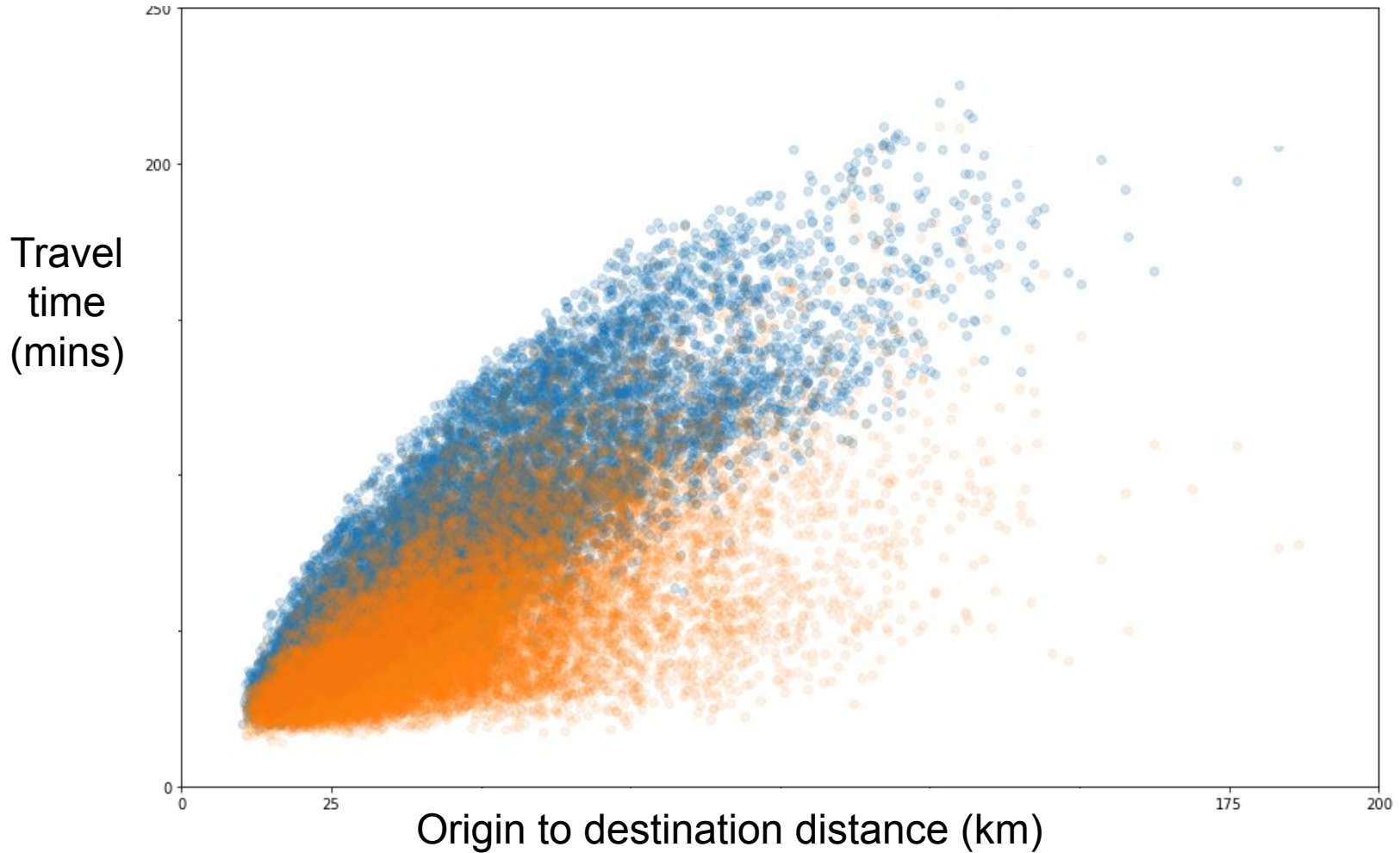
Benefited trips (k=30) scheduling

120K trips assigned to UAM / 11K benefit



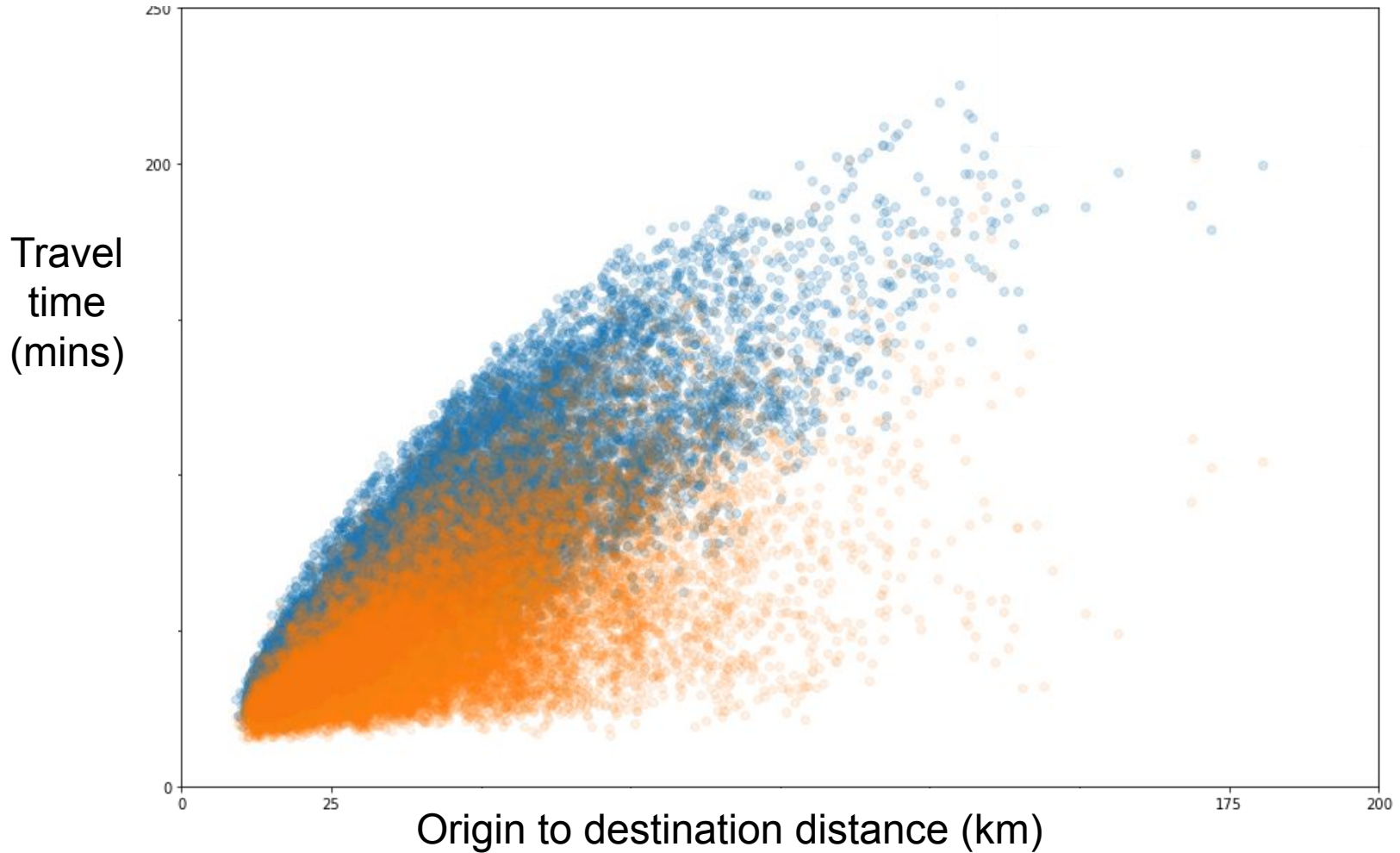
Benefited trips (k=50) scheduling

176K trips assigned to UAM / 18K benefit

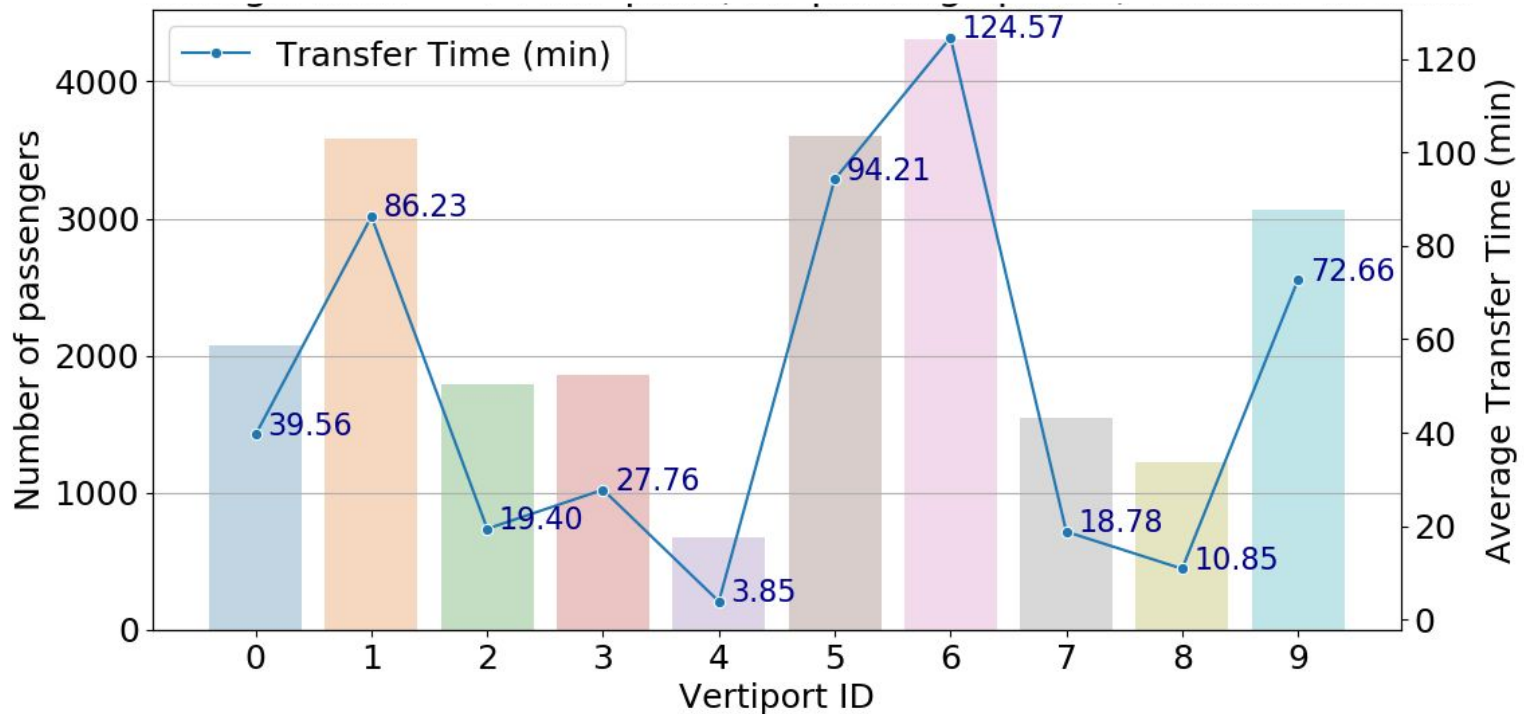


Benefited trips (k=70) scheduling

213K trips assigned to UAM / 23K benefit



Transfer times (avg. = 49.79 mins)



- Passenger consolidation and flight allocation cause delays
- Variable delays across vertiports

Summary and Future Work

- Dynamic of all three legs and vertiports leads to delays previously unseen by static analyses
- Bottlenecks exist predominantly at the vertiport through scheduling
- Aerial conflict resolution not significant cause of delay
- SimUAM toolchain can be foundation for more involved analysis:
 - Efficient vertiport layouts
 - Evenly distributed network designs
 - Optimal scheduling

Thank you!