Understanding the Demand for Uber Air

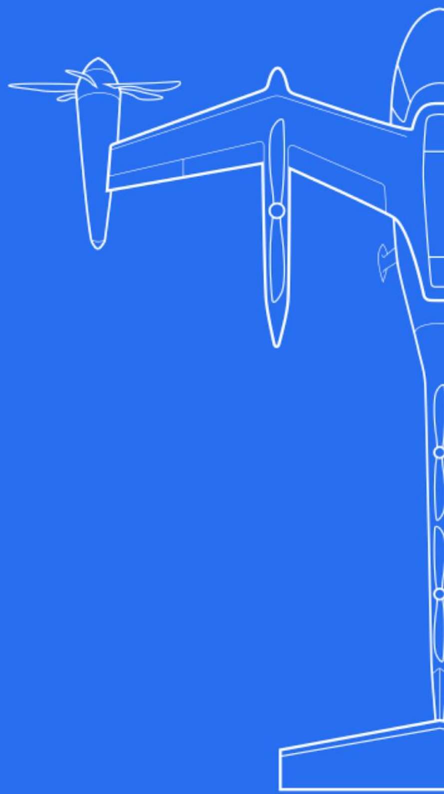
SCAG Modeling Task Force

May 22, 2019

Uber Elevate

Agenda

Urban Aerial Ridesharing



Uber

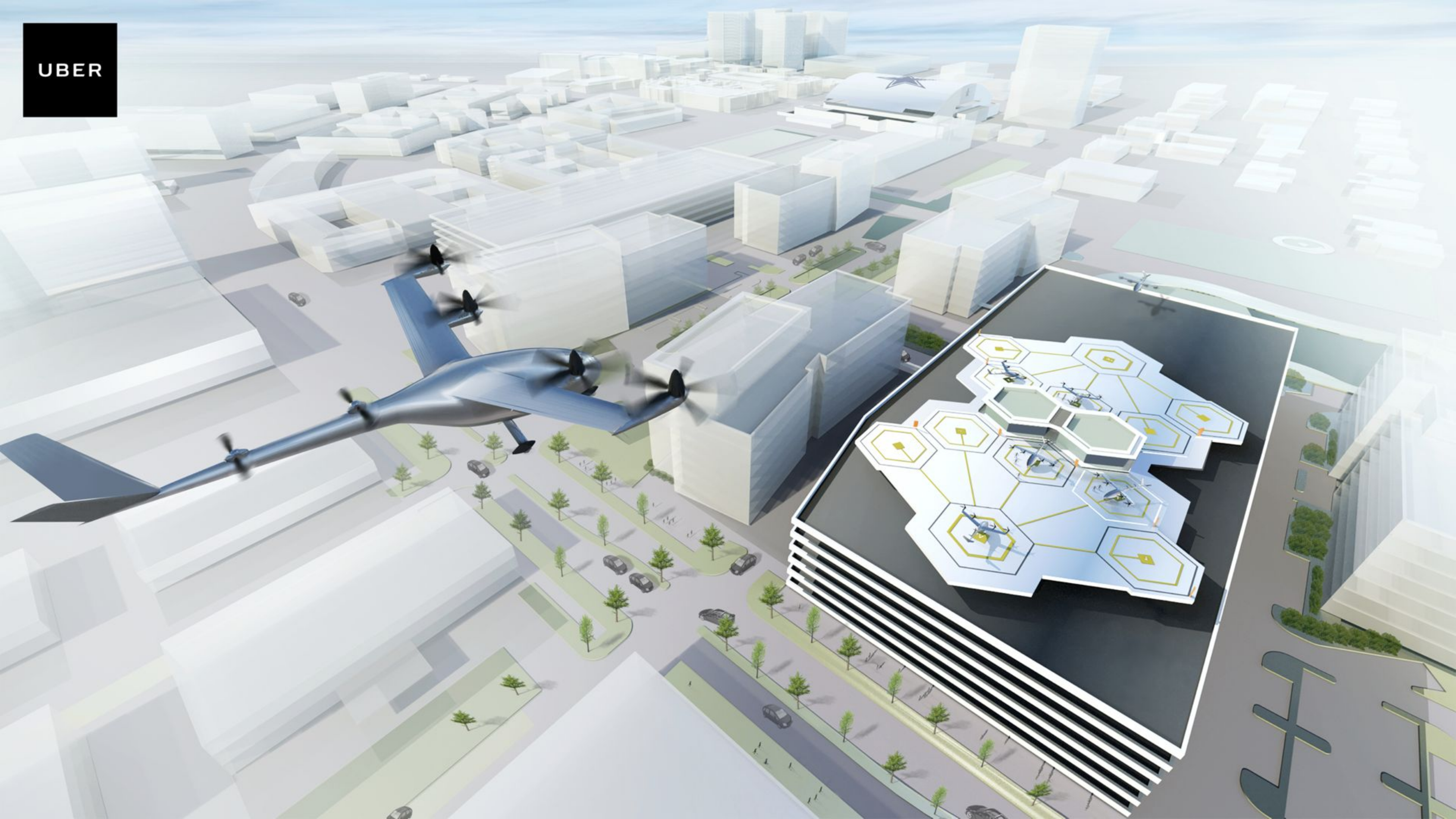

Beijing

Urban aerial ridesharing open up immense mobility bandwidth.

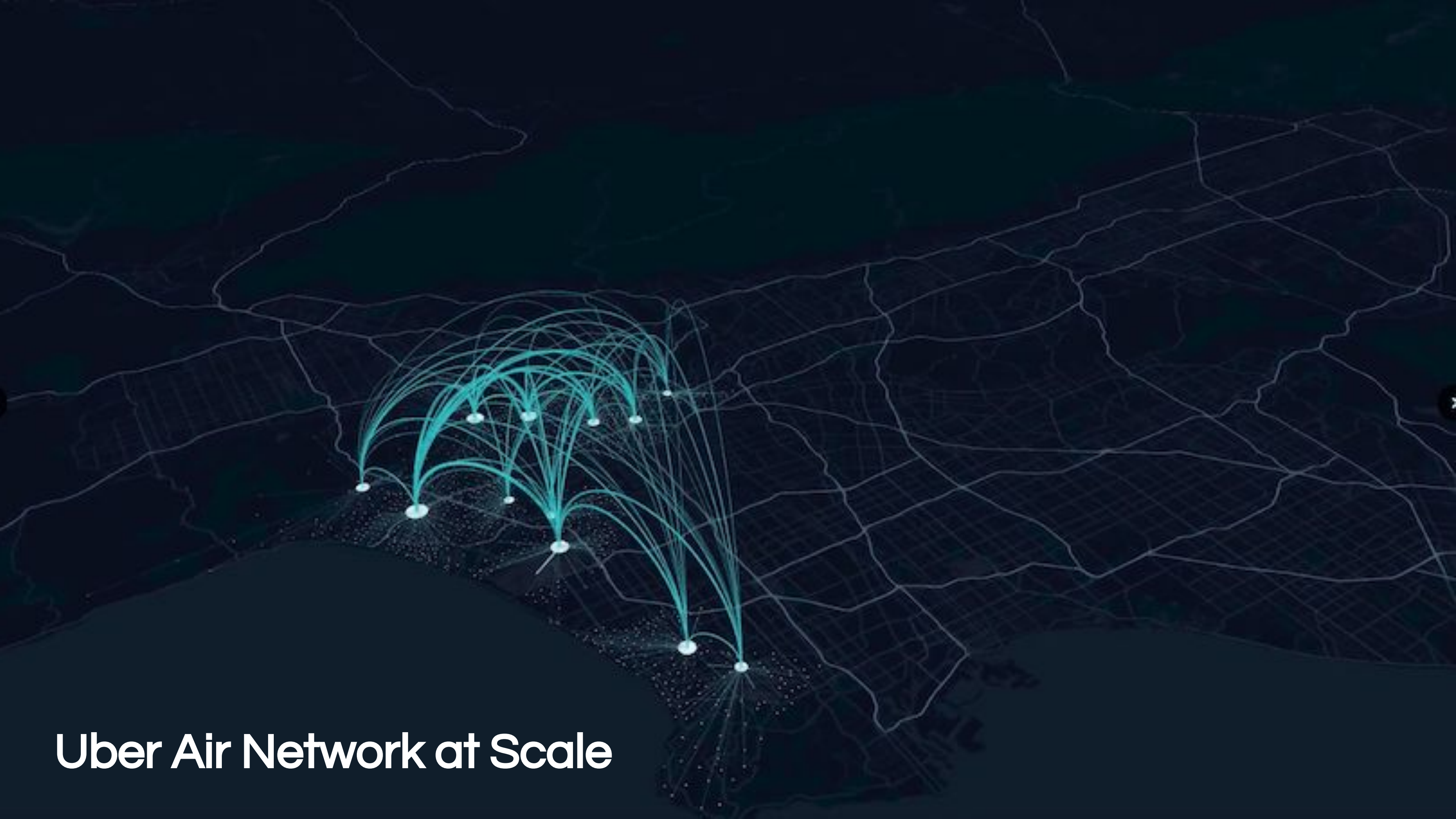
Uber Elevate team envisions a future when people can **push a button** and **get a flight** on demand.

"Fast-Forwarding to a Future of
On-Demand Urban Air Transportation"
released October 27, 2016

https://www.uber.com/elevate.pdf


UBER

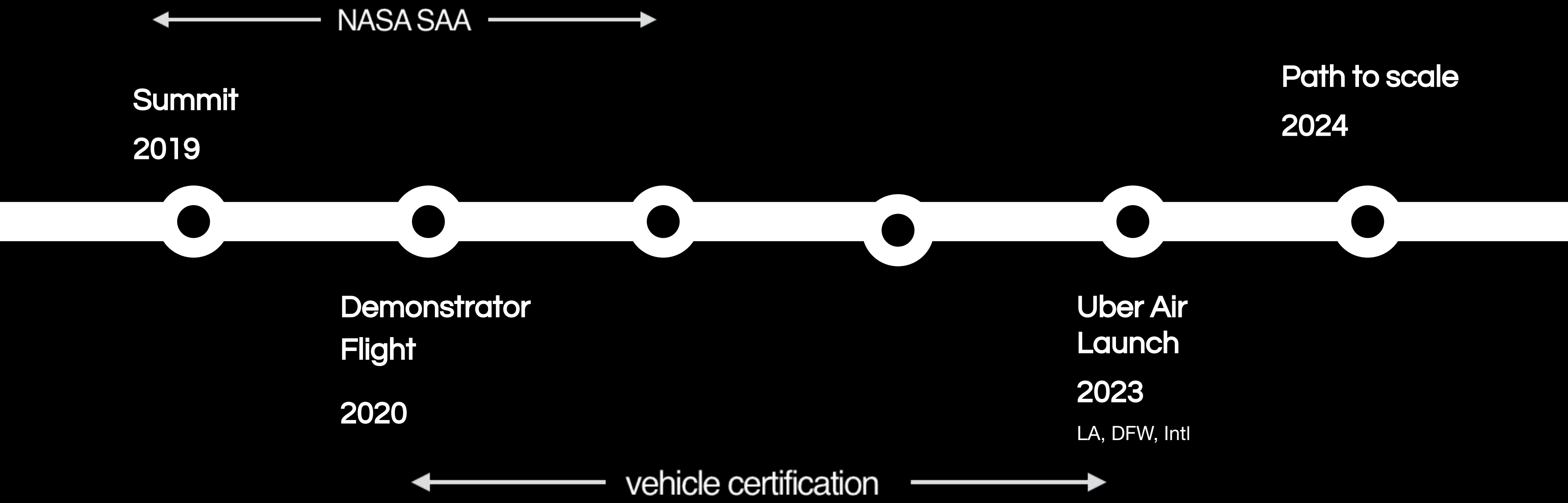

UBER
UBER | PICKARD CHILTON / ARUP



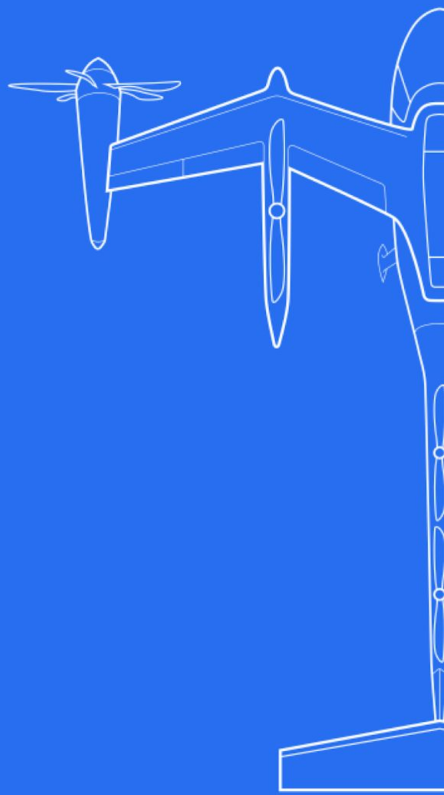
Uber Air Network at Scale


UBER

Timeline


NASA SAA
Summit
2019
Path to scale
2024
Demonstrator
Flight
2020
Uber Air
Launch
2023
LA, DFW, Intl
vehicle certification

Motivations



As we continue to lay the technical, operational, and policy foundations for commercial operations in 2023, we need to understand what the future Uber Air network will demand from us.

How do we predict the future?

Market Size

How many people will want to use an aerial ridesharing service? Can this really be a service for the masses? How do people trade off time, inconvenience, and cost?

Network Design

Where are the optimal locations to build Skyports? How do Skyport networks need to evolve over time? **What levels of throughput do Skyports need to serve?**

Hardware Requirements

How should VTOL and battery hardware be designed? How sensitive are key metrics like throughput and profitability to various design decisions?

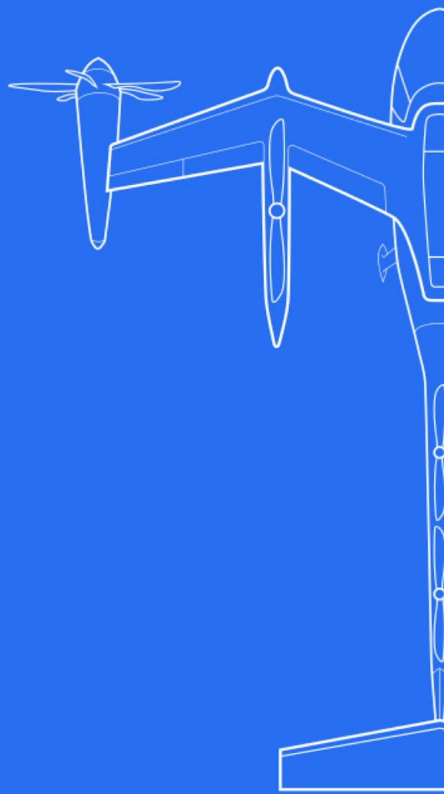
Flux Optimizer is a set of tools and algorithms that enable us to simulate what the Uber Air network could look like.

Demand Model

Node Optimization

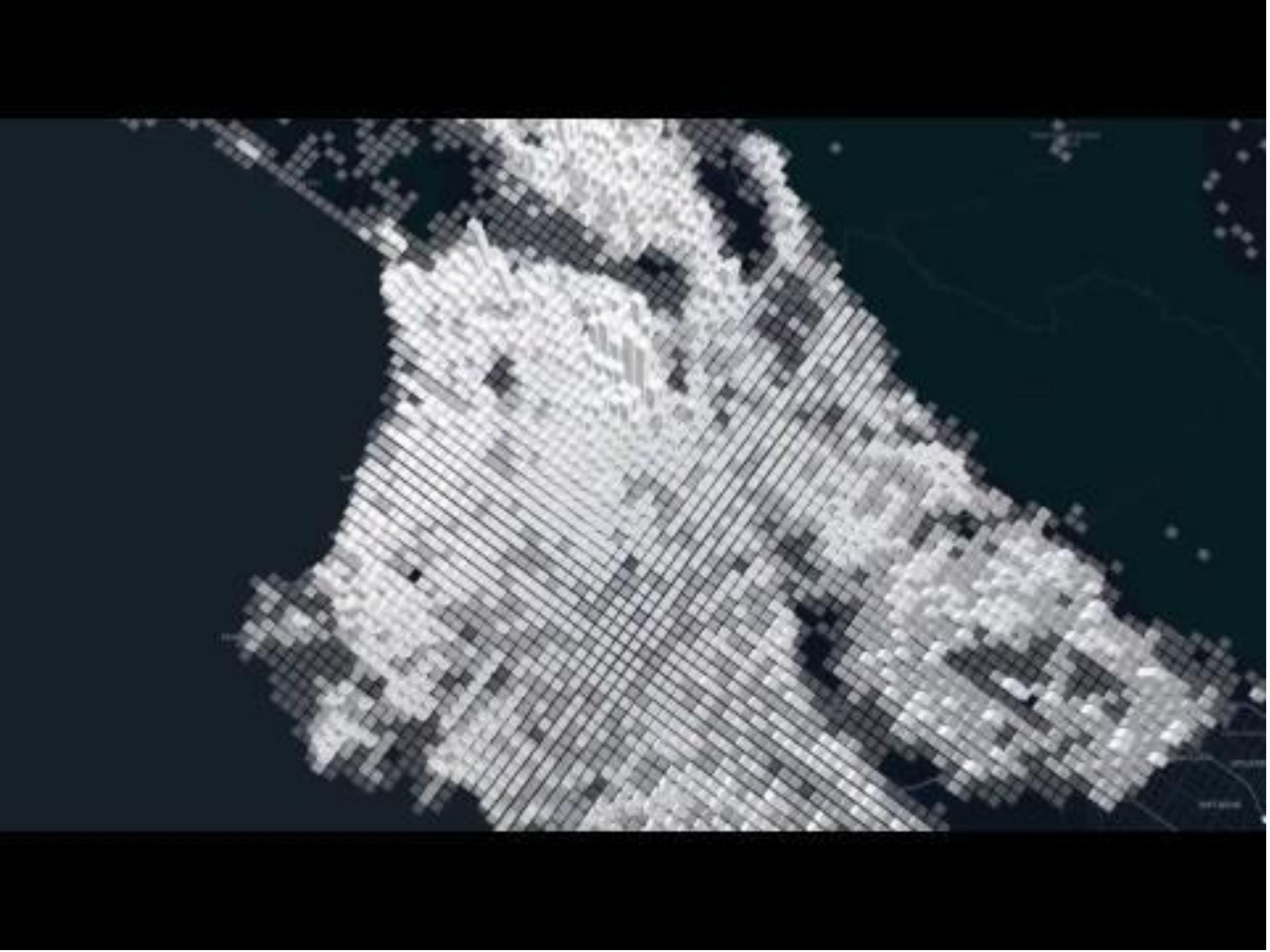
Dynamic Routing

Demand Modeling



Mode Shift

Induced Demand



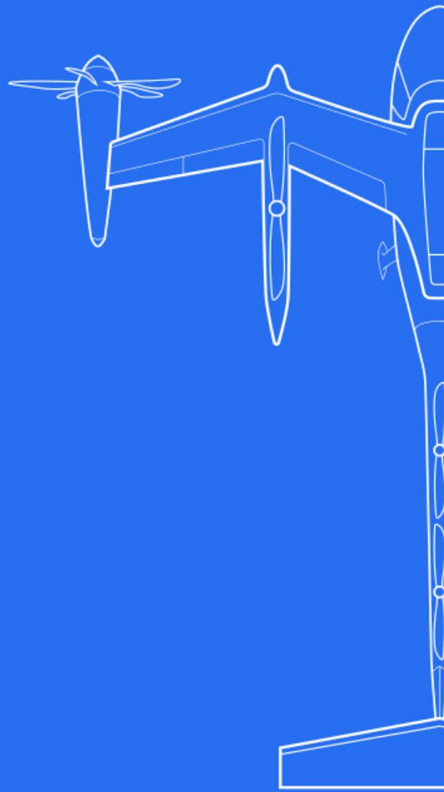
population movement :

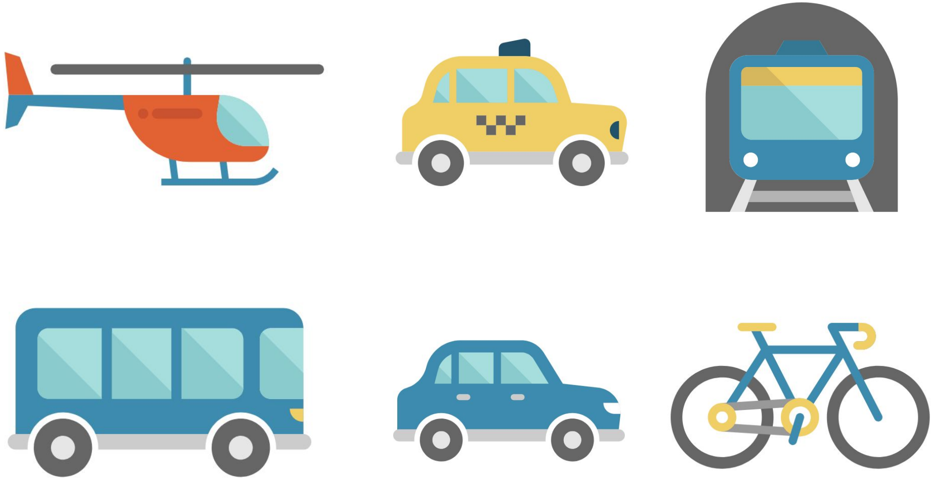
Location based service data + SCAG model

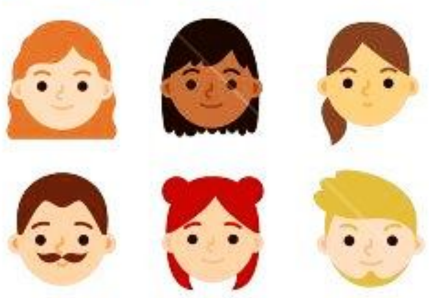
45M

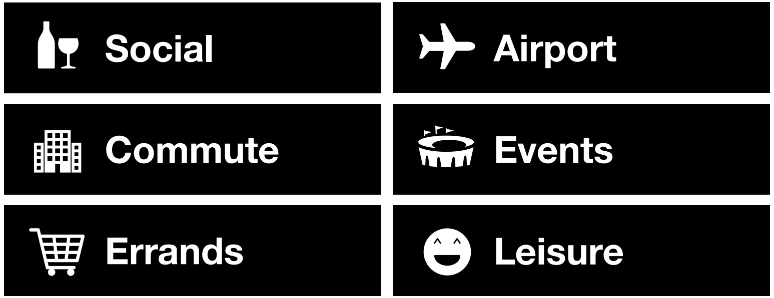
Total Addressable Market

Survey Overview









Which mode are you going to choose?

Stated Preferences Survey Outline

Previous travel behavior

What transportation modes have you used in the last month? What have you taken trips for in the past?

Reference trip information

Think of a recent trip you took. What was it for? When did you take it? How often do you make this trip? How much did you pay for it?

Mode Choice Conjoint

Based on the transportation options and attributes presented, which one would you pick for your reference trip in a future with AVs and Uber AIR?

Vehicle Ownership Conjoint

Given different price points of traditional vehicle, autonomous vehicle and other rideshare services, if you had to replace your up to three of your household vehicles, what would you do?

Sociodemographics

What is your household income? Household structure? How many cars do you own? What's your age? Gender?

Attitudes and Perceptions

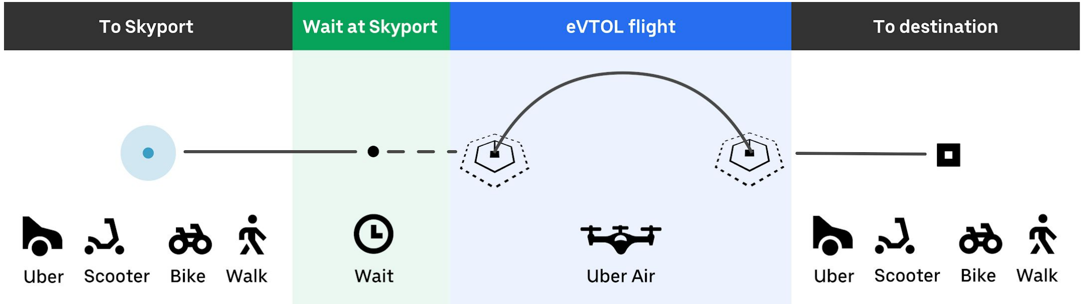
Are you an early adopter? Would you fly in a small plane? Do you think autonomous vehicles will be mainstream in the near future?

Uber Air Intro

In the future, a network of electric vertical take-off and landing (eVTOL) aircraft could make urban air travel a practical alternative to ground transportation. Uber is currently developing an on-demand eVTOL service known as uberAIR, which is aimed at making urban air travel affordable and accessible to everyone.

uberAIR

uberAIR riders will be able to avoid increasingly congested and unreliable roadways cutting existing door to door travel times by an estimated 30% to 60% for longer trips. eVTOL aircraft have zero emissions, are significantly less noisy than helicopters, and may be autonomous. The aircraft will be able to make trips up to 60 to 100 miles, traveling at speeds up to 150mph to 200mph. uberAir flights will likely be shared with other passengers (i.e., pooled).



Respondents Overview

2

Markets (Dallas & LA), Uber cohorts and general population

~50%

Evenly distributed across two markets: 1,499 from LA and 1,532 from DFW

~3K

Total qualified respondents for the mode choice conjoint

22%

Respondents rejected due to geographic screening

68%

Respondents' reference trip over 7 miles haversine distance

29%

882 respondents are Uber cohorts: airport travelers, commuters, venue goers, frequent users

Conjoints Overview

10

Mode choice scenarios for each qualified respondent

8

Mode alternatives include personal vehicle, transit, single rideshare, pooled rideshare, Uber Air, taxi, bike, scooter

~21K

Number of scenarios where Uber Air is present

3

Vehicle ownership choice scenarios for each qualified respondent

2+9

Ownership and other primary mode vehicle replacement alternatives

~4K

Total vehicle ownership survey respondents

Experiment Design Space

(PART)

Mode Options	**Shown** *Logic*	**Operator Types** *Attribute*	**Additional Passengers** *Attribute*	**Price** *Attribute*	**Travel Time** *Attribute*
Single ridesharing *(e.g. uberX)*	Always	- Human Driver - Autonomous	N/A	6 levels	Total travel time (6 levels)
Pooled ridesharing *(e.g. uberPool)*	Always	- Human Driver - Autonomous	- Up to 1 additional pax - Up to 3 additional pax - Up to 5 additional pax	6 levels	Total travel time (6 levels)
Transit *(rail, subway, bus)*	Always	N/A	N/A	6 levels	Total travel time (6 levels)
Personal Vehicle	If available	N/A	N/A	N/A	Total travel time (6 levels)
uberAIR	Long trips	- Human Driver - Autonomous	- No other pax - Up to 1 additional pax - Up to 3 additional pax	6 levels	- Access time (6 levels) - Wait time (6 levels) - Flight time (6 levels) - Egress time (6 levels)

Survey Overview (Scenario Example)

Below are some different travel options for making a school trip similar to the one you made on Sunday, November 25, 2018.

If the options below were the <u>only options available</u> for a similar school trip in the future, which would you most prefer?

	Operator Type	Additional Passengers	Price	Total Travel Time
○ **Single Ridesharing** (like UberX or Lyft)	Autonomous	---	$10.72	23 min
○ **Pooled Ridesharing** (like UberPool or Lyft Line)	Human Driver	Share with up to 1 additional passenger	$5.89	25 min
○ **Uber Air**	Autonomous	No additional passengers	$12.33	12 min (4 min, 3 min, 4 min, 1 min)
○ **Transit**	---	---	$1.75	1 hr 23 min

(1 of 10)

Survey Overview (Scenario Example)

Scenario 1 of 3: Imagine that autonomous vehicles are widely used and available everywhere. Please assume that:

- *Autonomous vehicles can drive and park themselves anywhere*
- *Autonomous vehicles are proven to be safer than traditional cars*
- *Autonomous vehicles have been approved by regulators*
- *Your household situation is the same as it is today (same age, same home, same job, etc.)*

We'd like you to think about what you would do with all the vehicles in your household if the following travel options were available:

Vehicles available for purchase:	Autonomous Single Ridershareing (like UberX or Lyft):	Autonomous Pooled Ridesharing (like UberPool or Lyft Line):	Autonomous Uber Air:
• Autonomous vehicles cost $5,000 more than traditional vehicles • On average, all personal vehicles cost $0.85 per mile (25% more than an average vehicle today)	• Costs $0.90 per mile	• Costs $0.27 per mile	• Costs $1.80 per mile

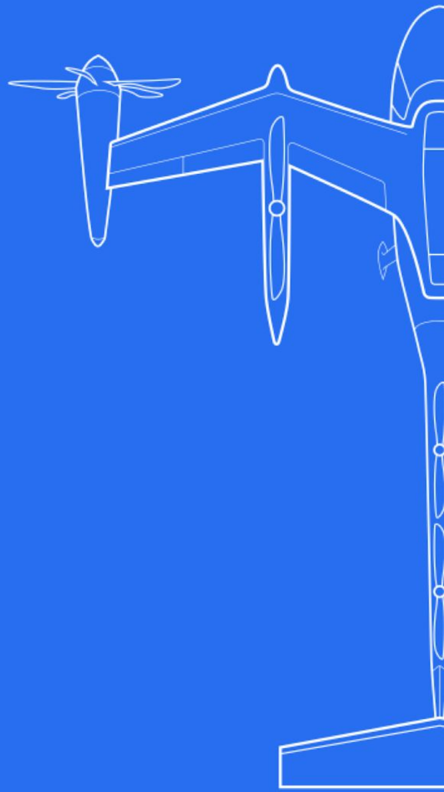
Given the above costs, what would you do for each vehicle in your household when they reach the end of their useful life?

Please assume each vehicle must be replaced or disposed of.

	Purchase NON-Autonomous Vehicle	Purchase Autonomous Vehicle	Not replace it -- I would replace its mileage primarily with...
#2 1996 BMW 7 series	○	○	Please select...
#5 1990 Buick Skylark	○	○	Please select...

(**1** of **3**)

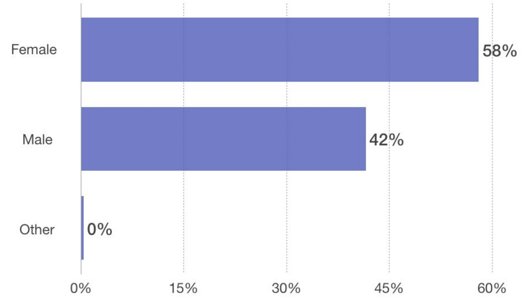
Basic Data Explorations



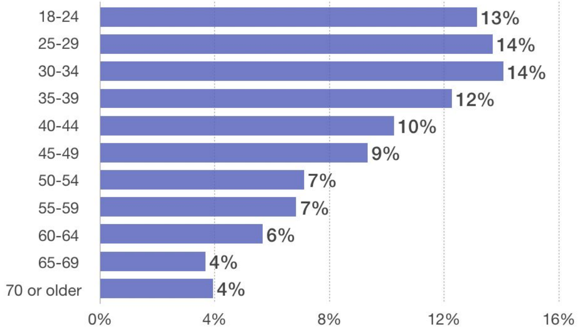
Uber

Survey Overview

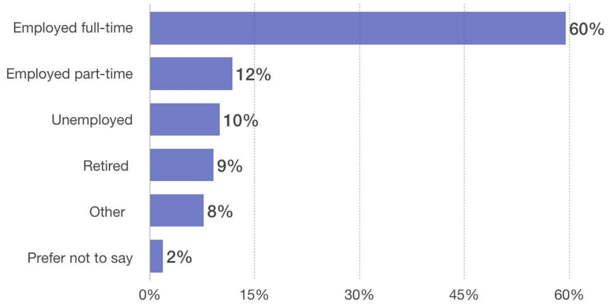
GENDER



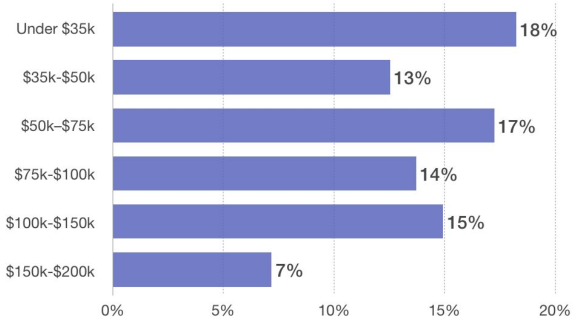
AGE



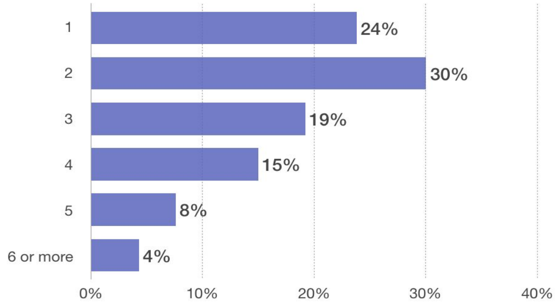
EMPLOYMENT



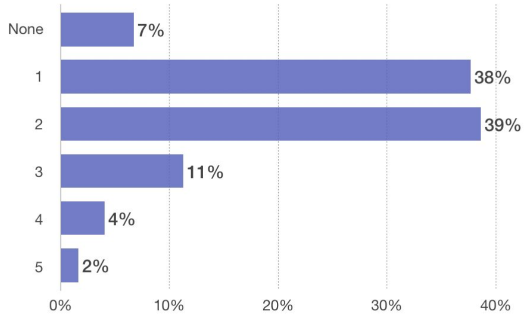
HOUSEHOLD INCOME



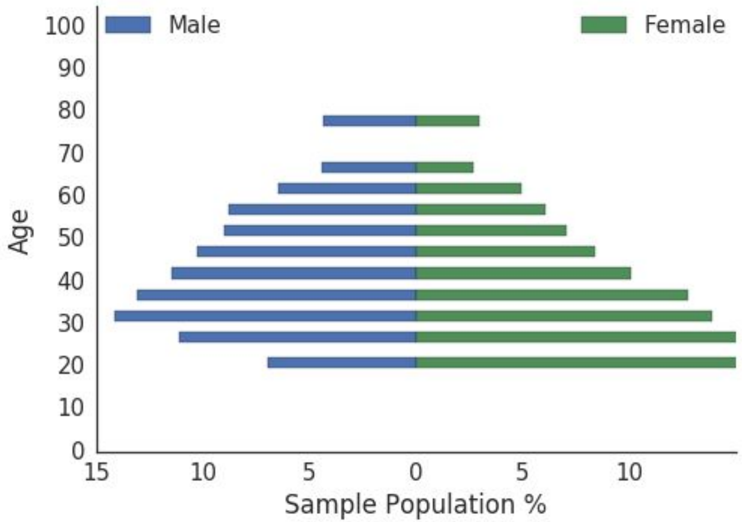
HOUSEHOLD SIZE

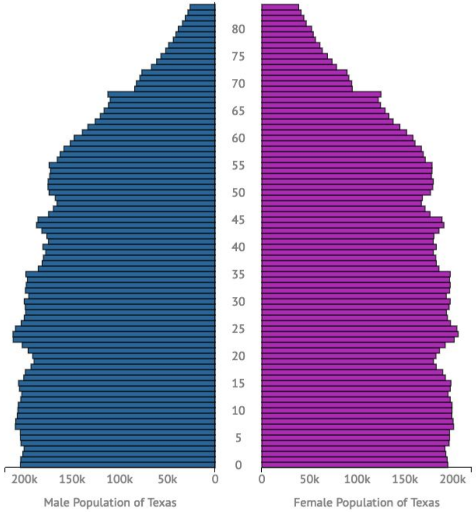


HOUSEHOLD VEHICLES



Survey Overview (Representativeness)





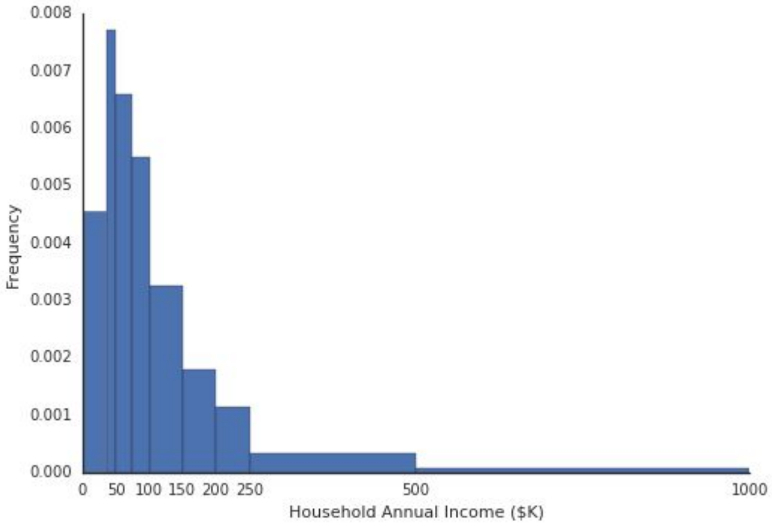
Respondents

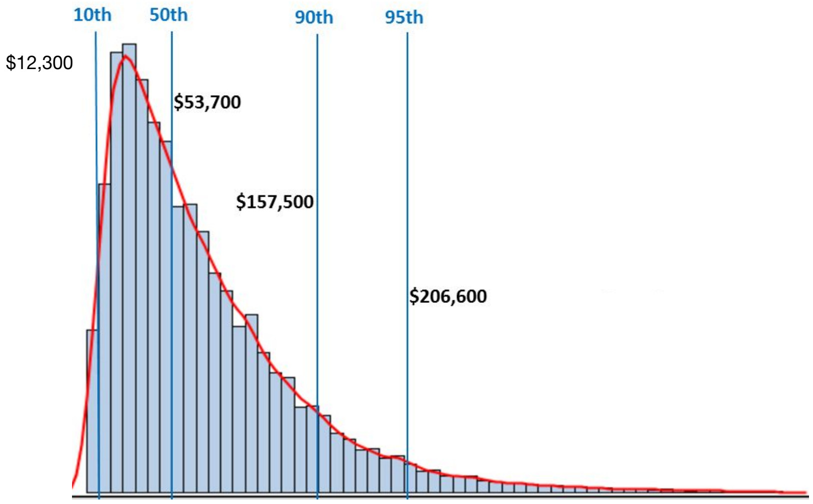
Respondents had to be over 18 years old to participate in the survey and their age was provided in ~5-year bins up to 70 years of age.

Census

This is the Texas age population pyramid based on US Census estimates for 2015, which should be somewhat indicative of the population distribution in Dallas. Note the apparent difference on the younger male subpopulation.

Survey Overview (Representativeness)





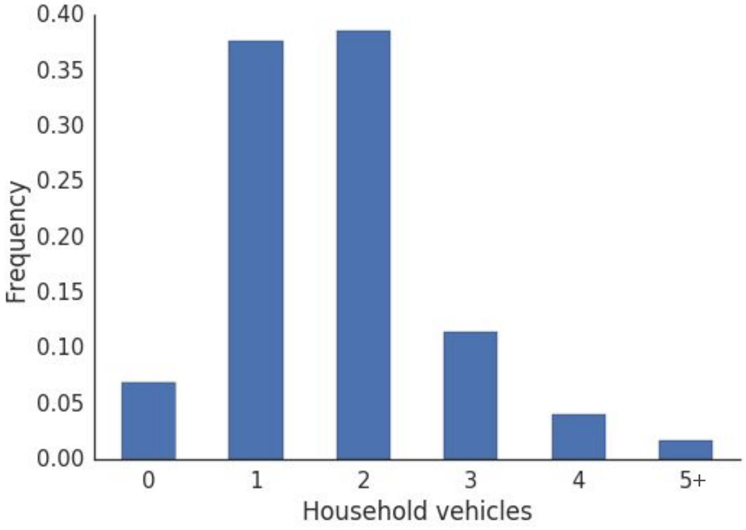
Respondents

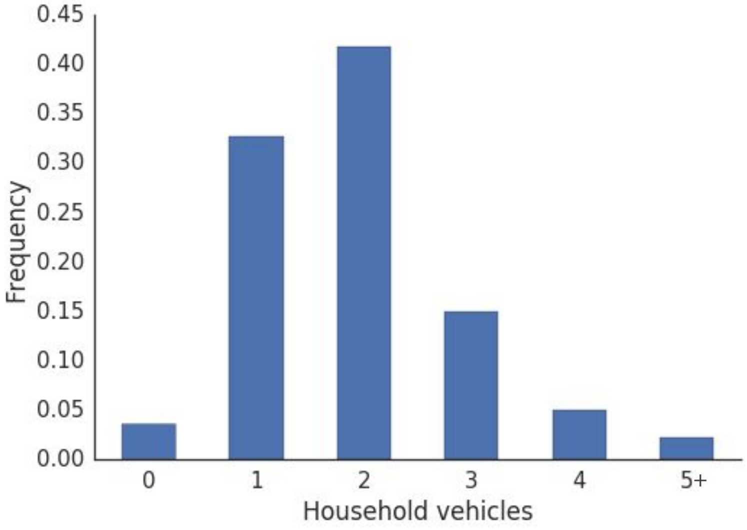
Most respondents provided their annual household income levels (before taxes), which were recorded in bins specified by the following income level thresholds ${0, 35, 50, 75, 100, 150, 200, 250, 500}.

Census

This is the distribution of US household income in 2015, including the {10, 50, 90, 95} quantiles. Note the similarity with the income distribution in our sample.

Survey Overview (Representativeness)





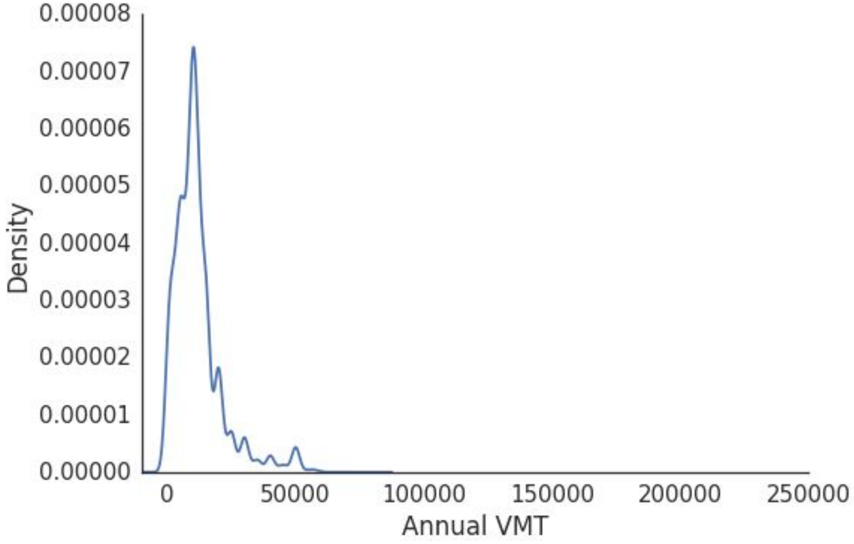
Respondents

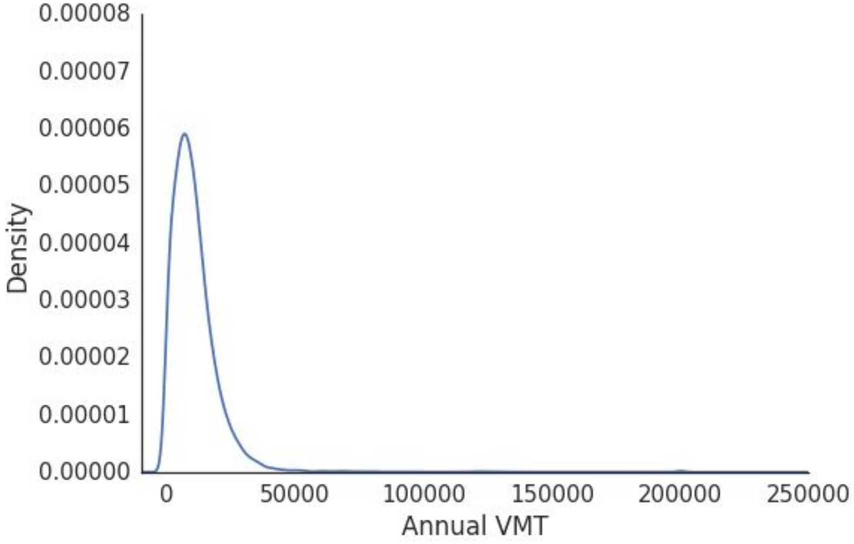
The histogram reveals a higher frequency of lower vehicle households, which could be due to the oversampling of the Uber user cohort.

NHTS

Higher frequency of {2, 3, 4}-vehicle household at the expense of lower vehicle household numbers. Limited to Core Based Statistical Areas for LA & Dallas (31080, 19100).

Survey Overview (Representativeness)





Respondents

Distribution based on the respondents' best guess of their annual VMT.

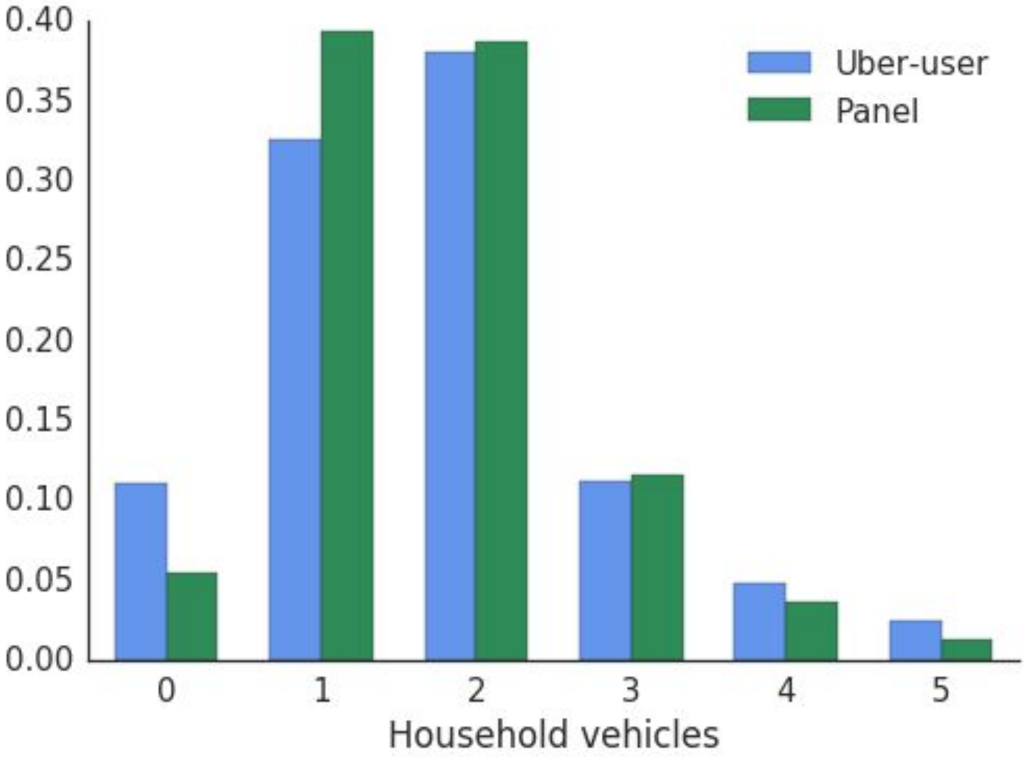
NHTS

Annual VMT distribution based on 23,630 vehicles from the two relevant CBSAs in this study.

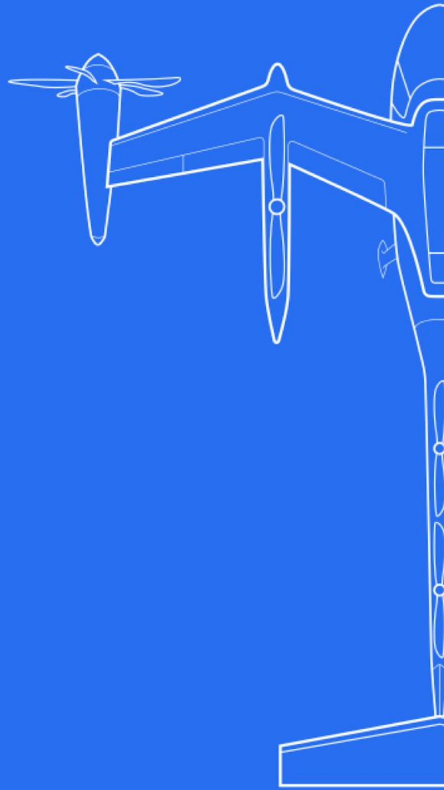
Survey Overview

Sample vs NHTS # veh

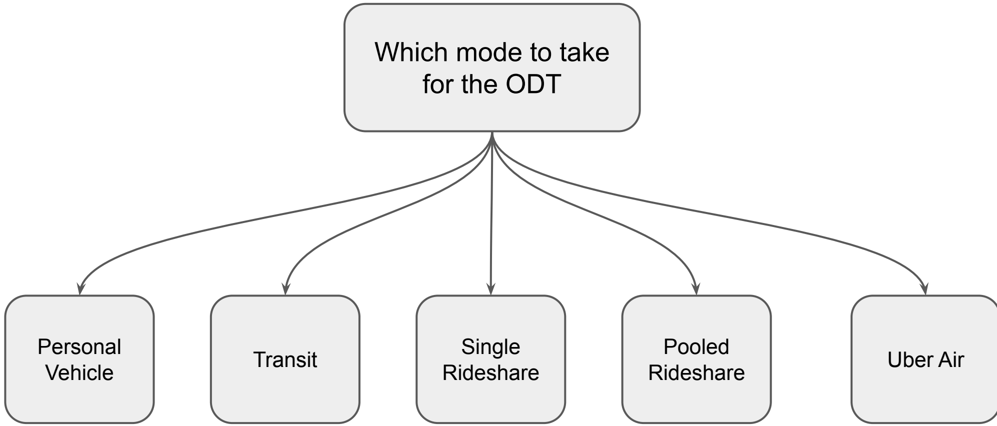
Differences caused by oversampled 0-veh households in Uber cohort and 1-veh households in the respondent population.



Model Estimation and Application



Mode Choice Specification



Main components:

- Total travel time
- Trip fare interacted with trip purpose, income and trip distance
- Trip attributes, e.g. pooling, autonomy, reference mode
- Person characteristics, e.g. age, gender, income

What input data do we need?

Individual demographic information and trip data

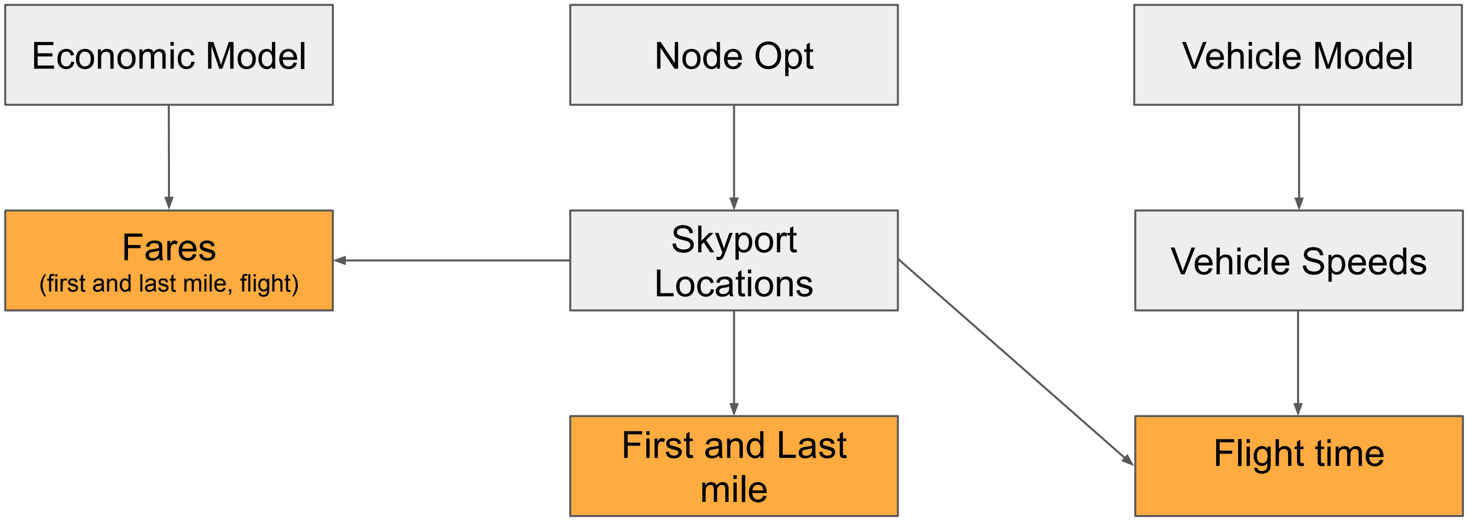
We get this from ODT.

Attributes of different modal choices

We get this from Map Services for existing modes.

But what about the attributes of UberAIR?

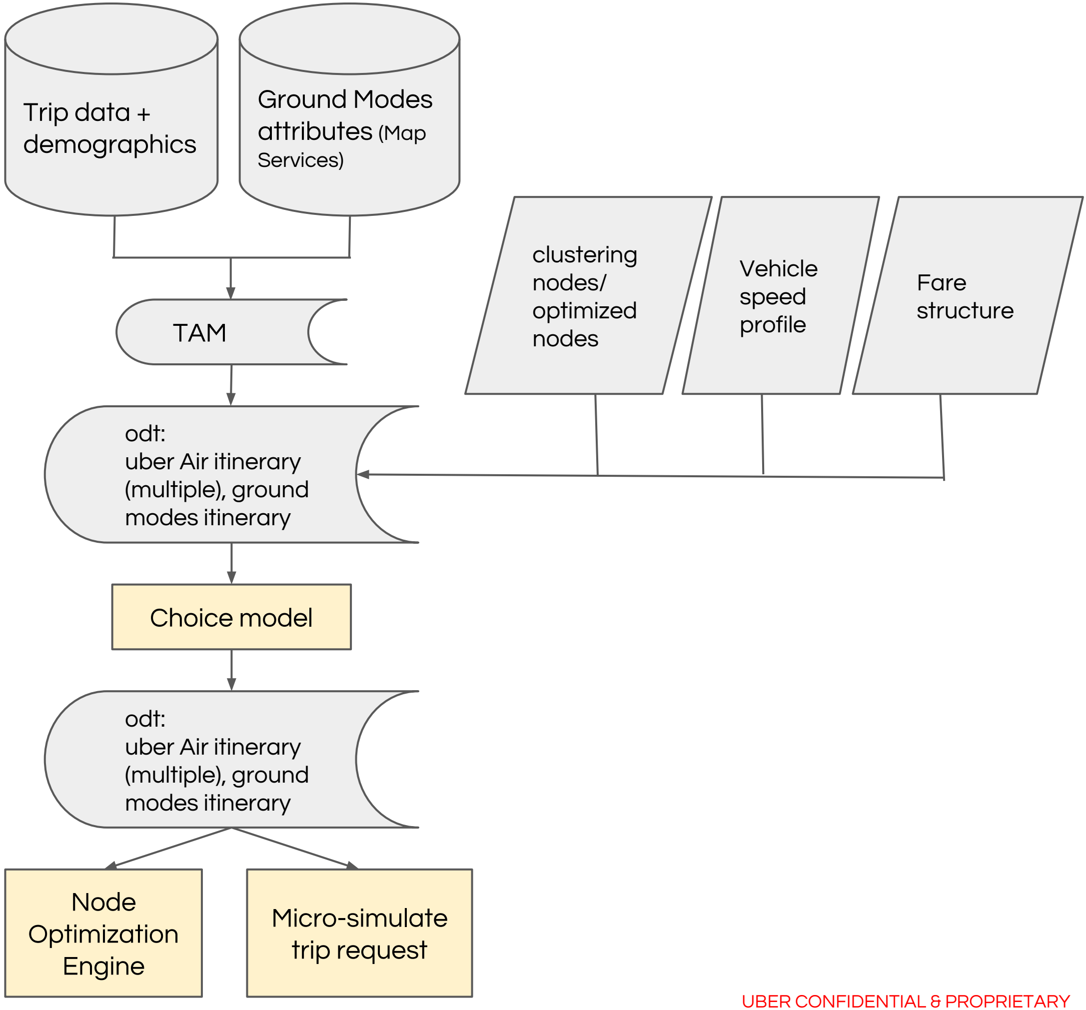
Uber AIR attribute generation using Flux



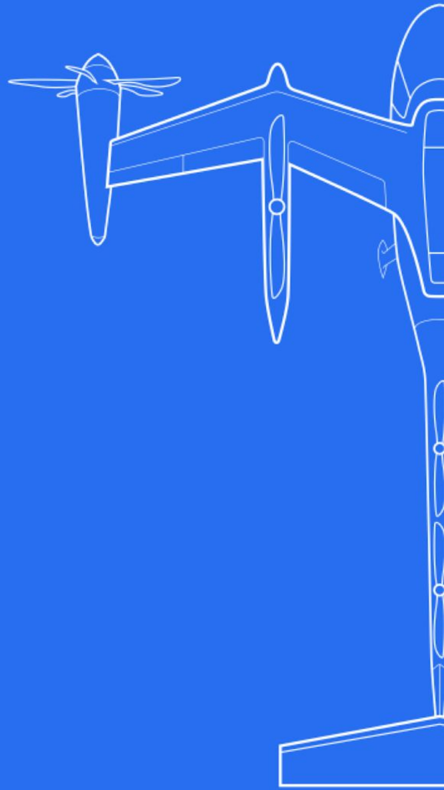
Application

Input:

- City ground movements
    - Trips + inferred demographics
    - Map services
- Choice model coefficients
    - Estimated from stated preference survey
- TAM criteria
    - Distance criteria
    - Time saving criteria
- Candidate nodes / optimized nodes
- Uber Air fare structure
- Observed preferences for calibration (SCAG data)



Model Calibration



Why should we calibrate?

We previously assumed that the error term is independent and identically distributed.

alternative-specific constant (ASC) in the utility equation captures average error of unobserved attributes for that alternative

$$U_{in} = V_{in} + \varepsilon_{in}$$

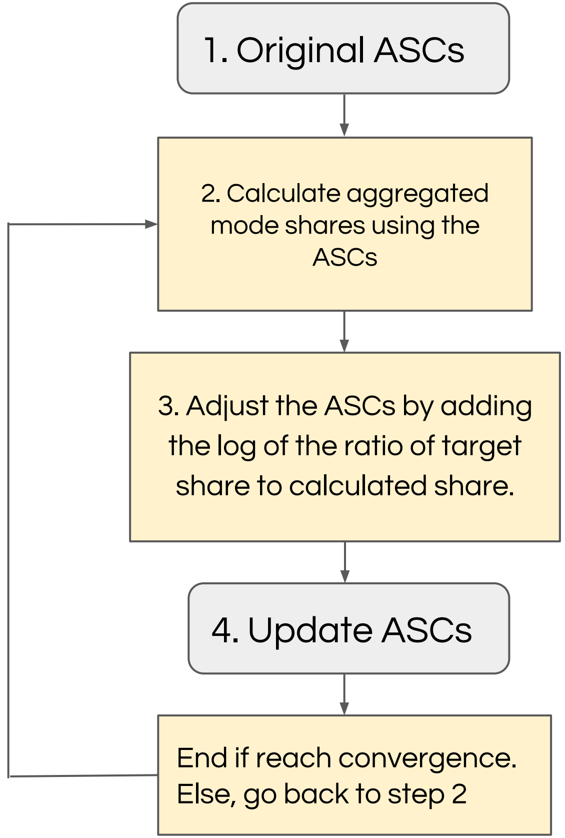
where the deterministic part of the formulation is

$$V_{in} = \beta' X_{in} + \boldsymbol{C} = \sum_{k=1}^{K} \beta_k X_{in_i} + \boldsymbol{C}$$

This ASC term might not be the same as that of the population.

We will adjust the constant such that mode choice percentages generated by the model match that of actual mode choice selections. Of course, we remove UberAIR from the model in order to compare it with actual data. Where do we get the data?

Calibration procedure



Reference:
Discrete Choice Methods with Simulation, Kenneth Train.

Data Inputs for Calibration

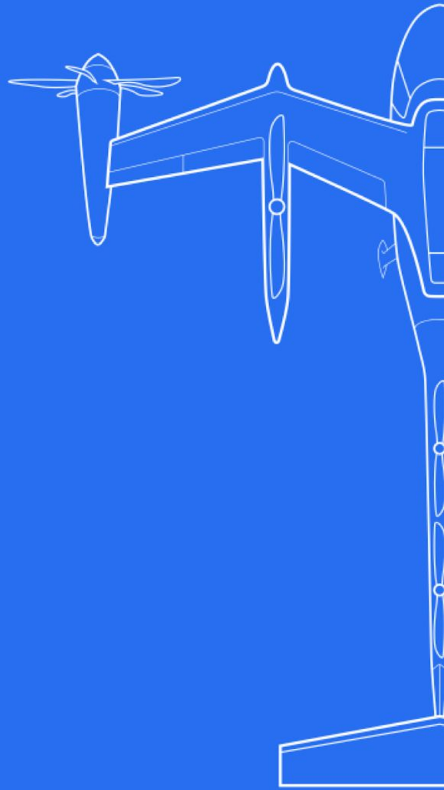
We need to combine city data with our internal rideshare data to generate the most accurate view of current mode choices.

Southern California Association of Governments Regional Demand Model Output Matrix

Have build a complex regional travel model for their constituent counties.

Number of Trips beyond seven miles by mode and trip purpose in SCAG used as target market share.

Conclusion and Next Steps



Uber

Assumptions to keep in mind

ODT input data is not 100% of the population

Trip flow derived from mobile services is a sample collector and aggregator. It covers about 20-30% of the trips made in a given area. The remaining is extrapolated from the initial.

SCAG model results are not actual.

SCAG modeling is a complex series of processes that attempts to build out the regional transportation model from scratch. We treat it as a source of truth, but the actual ground truth is probably different.

The Stated Preferences survey is a sample of stated behaviors.

There can be inconsistencies between respondents' stated behavior and their actual behavior. Moreover, the respondents are only a sample of the general population.

Conclusions & Future Work

Uber Air product insights

Males with higher income, millennials, for airport trips. As a multimodal journey, people are looking forward to a seamless trip experience. People at this moment still express disutility toward autonomy.

Model framework to understand future mobility

We have built out a model framework and detailed steps to solve these subproblems, that can be shared with autonomous vehicles or new mobility teams.

More complex specs

The results in this presentation use relatively simple choice model specifications. Other specifications like LCCM could lead to more detailed market segmentations. The survey also includes attitude & preference questions that could be used to improve our market segmentations.

Model calibration and validation

We have reached out to South California Association of Governments to request their regional model result to calibrate the choice model. Same procedures are being done for Dallas.

THANK YOU!