Beyond Scenario Planning –
The Role of Models with Deep Uncertainty

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Exploratory Modeling and Analysis in Regional Transportation Planning

Date:
Sunday, May 14, 2017

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U.S. Department of Transportation
Federal Highway Administration

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Agenda

- Presentation Objectives
- Defining an Exploratory Modeling and Analysis (EMA) Approach
- CV/AV Project Example:
  - Variables & Assumptions
  - Methods for Modeling
  - Adaptations
  - Scenarios
- Question & Answer, Discussion

Presentation Objectives

- Define "exploratory modeling and analysis" (EMA), and why it can be valuable in the context of "deep uncertainty"
- Compare different approaches to use under "deep uncertainty", and explain why EMA was chosen for this research.
- Provide an example of how EMA can be used in the context of connected and autonomous vehicles and vehicle-sharing.
- Use the example to provoke discussion on how exploratory approaches can be used in practice in the current long-range planning context.

Defining Exploratory Modeling and Analysis (EMA)

EMA is a systematic approach to perform sensitivity analysis using models when many of the model inputs cannot be asserted with confidence, so that a wide range of different input assumptions can be tested simultaneously, looking for patterns in the results to guide **robust decision-making** (RDM)

A relevant quote:

"Travel demand forecasting as widely practiced today deals inadequately with uncertainty…The current transportation modeling process is demanding in the sense that it employs a great deal of data to a large number of interconnected models having many parameters. The complexity of the modeling process, however, does not extend to the accurate representation of complex economic and social phenomena, and point estimates of many quantities are used that make it difficult to analyze or even to represent the uncertainty that characterizes transportation systems and traveler decision making"

Dewar, James A., and Martin Wachs. "Transportation planning, climate change, and decision-making under uncertainty". Transportation Research Board, 2008.

What is typically allowed to vary in long-term travel demand forecasts?

Yes	No
Spatial allocation of households and employment	Total regional population, employment, demographics
Transportation infrastructure, services, and pricing	Basic types of modes available (especially for auto)
Travel demand management	Model relationships and parameters

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Yes	No
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Transportation infrastructure, services, and pricing	Basic types of modes available (especially for auto)
Travel demand management	Model relationships and parameters

Sometimes socio-demographic growth scenarios allow these to vary, but….

What is typically allowed to vary in long-term travel demand forecasts?

Yes	No
Spatial allocation of households and employment	Total regional population, employment, demographics
Transportation infrastructure, services, and pricing	Basic types of modes available (especially for auto)
Travel demand management	Model relationships and parameters

… to model AV/CV and "sharing economy" scenarios, these have to be varied >>> <u>Many uncertain assumptions</u>

Approaches that Allow for Uncertainty

- Scenario-based planning
- Assumption-based planning.
- Quantitative risk analysis
- Exploratory modeling and analysis / Robust decision-making

Scenario-Based Planning

- Typically involves creation of a small number (4 or 5) of widely divergent scenarios, created via expert judgement/Delphi methods.
- The scenarios may differ along many assumptions and sources of uncertainty, but there are not enough scenarios to systematically analyze the scenario outcomes and implications as a function of those assumptions.

>>>

- This can be a very useful first step toward framing key assumptions, sources of uncertainty, and possible futures, but..
- Can only provide limited guidance as to how different policy options may lead to (or prevent) those possible futures.

Assumption-Based Planning

Dewar, James A. (2002). Assumption-Based Planning: A Tool for Reducing Avoidable Surprises. (Cambridge University Press.)

An approach designed to identify:

- ***Load-bearing assumptions*** – uncertain inputs that are most critical in determining the outcomes;
- ***Signposts*** – explicit signals that may provide early warning of the vulnerability of load-bearing assumptions;
- ***Shaping actions*** – actions that attempt to control the vulnerability of load-bearing assumptions; and
- ***Hedging actions*** – actions that attempt to better prepare the organization for the potential failure of a load-bearing assumption.

The approach is qualitative in nature, so may not accommodate or provide the level of quantitative information that transportation planners are used to using in decision-making.

Quantitative Risk Analysis

Adler, T., et al. (2014). "Methods for Quantitative Risk Analysis for Travel Demand Model Forecasts." Transportation Research Record 2429

Select one or two key outputs (e.g. ridership and revenues)
Select a set of key input assumptions to vary, and levels to test. Inputs tend to focus on socio-demographic inputs and a few key model parameters (e.g. toll bias or new mode constants)
Use an experimental design to define a set of model runs to test effects of assumptions. Do the model runs and save the outputs.
Use regression analysis to model the key outputs as a function of the input assumption levels.
Define the joint probability distribution of the input assumption levels.
Apply the regression model to many, many sets of input assumptions, drawing each set randomly from the joint probability distribution, to create a probability distribution of the key model outputs.

The approach is valuable for assessing risk over a wide range of possible future assumptions, but giving the probability distribution of input assumptions is not feasible under "deep uncertainty".

Is there a similar approach that deals with greater uncertainty?

Robust Decision-Making/ Exploratory Modeling & Analysis

Lempert, R.J., S.W. Popper and S.C. Bankes (2003). "Shaping the Next One Hundred Years: New Methods for Quantitative, Long-Term Policy Analysis". RAND Corporation

- Define the scope of the system to be analyzed.
- Define the key system relationships and sources of uncertainty.
- Define a method for modeling the system (interactions and inputs).
- Define a method for simultaneously varying the input assumptions to cover a wide range of future scenarios along the defined dimensions of uncertainty.
- Define the method for investigating and communicating the results of applying the model(s) across the wide range of scenarios.

CV/AV Example
Define the scope of the system to be analyzed.

- The transportation supply and demand in an urban metropolitan region over a 25-30 year time horizon. (The same as for an MPO long-range plan.)

CV/AV Example: Key Variables & Assumptions

CV/AV Variables Network Side:

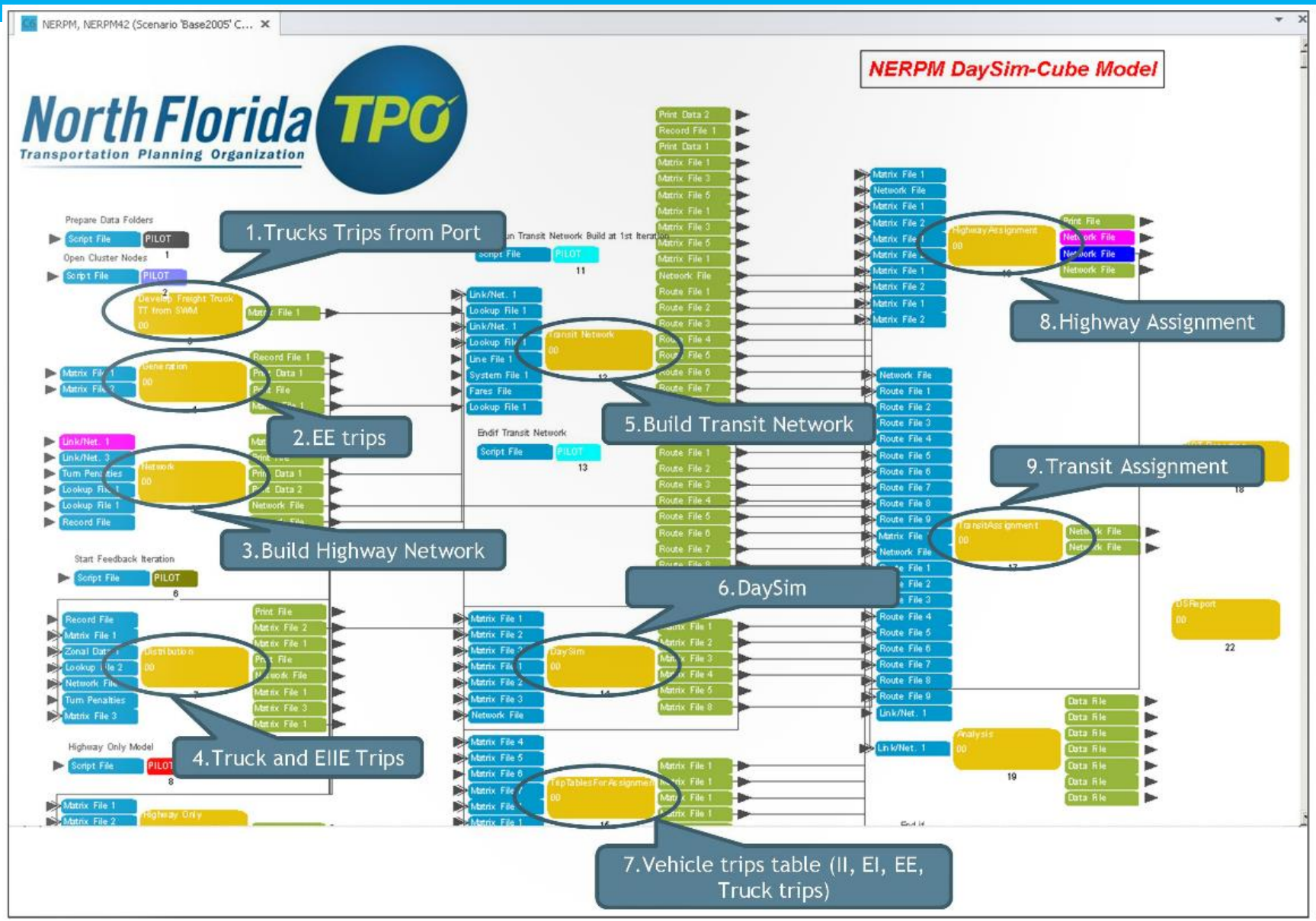
- Dedicated lanes for CV/AV
- Following distance / platooning
- Vehicle operating speeds
- Traffic control systems
- Parking supply and location
- Operating characteristics of paid ride-share/vehicle-share services
- Priority for empty vehicle-trips on the network.
- Frequency/severity of accidents

CV/AV Variables Demand Side:

- Private CV/AV ownership
- Use of paid ride-share/vehicle-share services
- Disutility of in-vehicle time
- Changes in parking behavior
- Changes in intra-household vehicle sharing and coordination
- Generation of empty vehicle-trips
- Latent demand for car travel in currently congested areas
- Supply and service levels for transit
- Location/density of housing and employment

CV/AV Example: Define a Method for Modeling the System

- Adapted existing models for the Jacksonville, Florida region:
  - ***DaySim*** activity-based travel demand simulation
  - ***TransModeler*** dynamic traffic simulation
  - Feedback between the simulation models
- **Assumptions**
  - Detailed simulation models will facilitate a realistic representation of new aspects of AV/CV demand and supply for exploratory analysis
  - Relevant findings from these detailed models can be adapted for use with simpler (trip-based and static) models.


NERPM, NERPM42 (Scenario 'Base2005' C...
NERPM DaySim-Cube Model
North Florida TPO
Transportation Planning Organization
1.Trucks Trips from Port
2.EE trips
3.Build Highway Network
4.Truck and EIIE Trips
5.Build Transit Network
6.DaySim
7.Vehicle trips table (II, EI, EE, Truck trips)
8.Highway Assignment
9.Transit Assignment
Prepare Data Folders
Open Cluster Nodes
Start Feedback Iteration
Highway Only Model
Endif Transit Network

TransModeler: Microscopic DTA

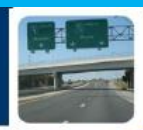
Microscopic in level of detail

- Referenced to ground truth with accurate geometry
- Lane level and intersection area representation
- Temporal dynamics (as low as 0.1-sec)
- 2-d and 3-d dynamic visualization

Microscopic in modeling accuracy

- Microscopic (car following, lane changing)
- Employs realistic route choice models
- Handles complex network infrastructure (Signals, variable message signs, sensors, etc.)
- Simulates multiple modes, user classes, vehicle types

Implementation: Jacksonville, FL



Region-wide, Six-county coverage

NASSAU
HAMILTON
MADISON
BAKER
COLUMBIA
SUWANNEE
FLORIDA
UNION
ST. JOHNS
CLAY
LAFAYETTE
BRADFORD
TAYLOR
GILCHRIST
ALACHUA
PUTNAM
DIXIE
FLAGLER
LEVY
MARION

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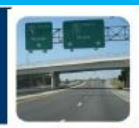
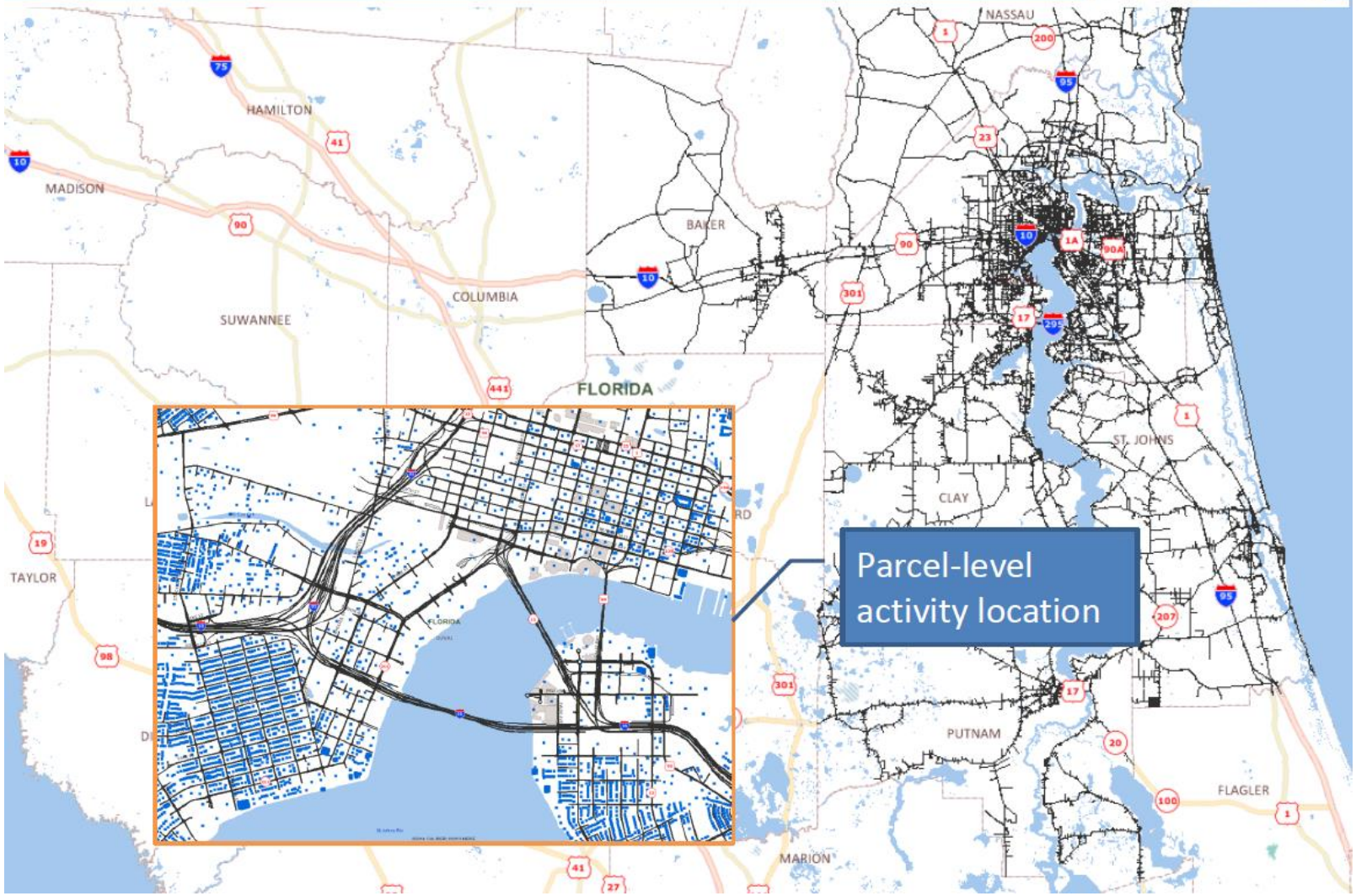
Implementation: Jacksonville, FL





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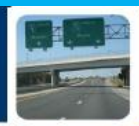

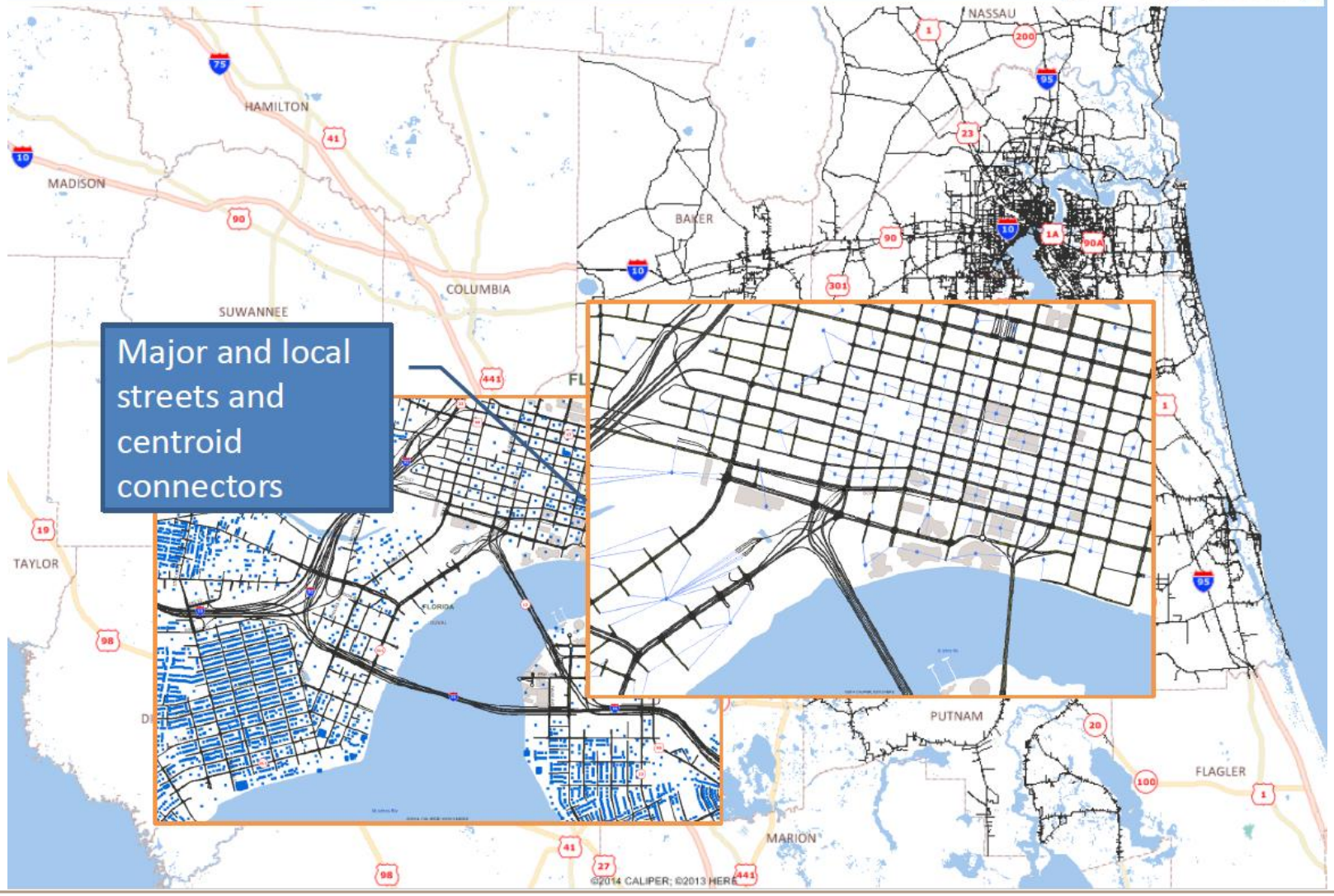

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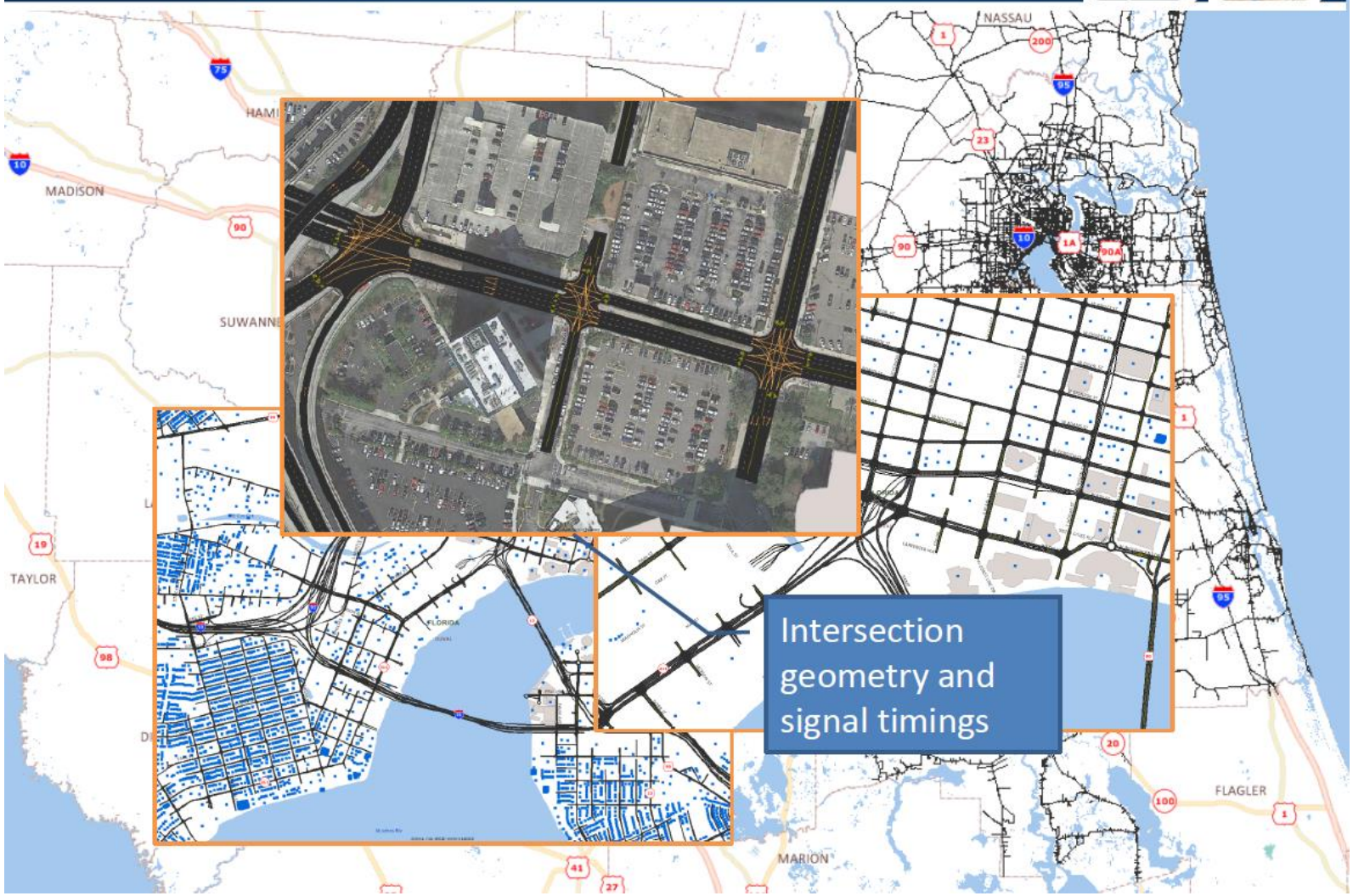

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Information Flows at Model Interfaces

DaySim/NERPM to TransModeler >>>>
A trip list (over 6 million daily trips), parcel-to-parcel, minute-to-minute
Trip matrices for freight, externals, etc. Processed into compatible trip lists with more detailed times and locations

TransModeler to DaySim >>>>
Dynamic travel time skims, TAZ-TAZ, 30 minute periods, by user class (trucks, conventional cars, autonomous cars, etc.)

CV/AV Example:

Define a method for simultaneously varying the input assumptions to cover a wide range of future scenarios along the defined dimensions of uncertainty.

Phase 1.

- Demonstrate the approach, starting with an exploratory analysis of 6-8 demand scenarios in combination with 3-4 supply scenarios

Phase 2

- Eventually use a full experimental design with more dimensions of uncertainty, and more extensive analysis of the outcomes.

Example Experimental Design for 8 Scenario Runs

	AV ownership level	AV travel time disutitility	Paid rideshare usage	AV speed & headway advantage	AV-only lane provision	Smart intersection control
1	Low	Low	Low	Low	Low	Low
2	Low	Low	Low	High	High	High
3	Low	High	High	Low	Low	High
4	Low	High	High	High	High	Low
5	High	Low	High	Low	High	Low
6	High	Low	High	High	Low	High
7	High	High	Low	Low	High	High
8	High	High	Low	High	Low	Low

Example Experimental Design for 27 Scenario Runs

	AV ownership level	AV travel time disutitility	Paid rideshare usage	AV speed & headway advantage	AV-only lane provision	Smart intersection control
1	Low	Low	Low	Low	Low	Low
2	Low	Low	Low	Low	Medium	Medium
3	Low	Low	Low	Low	High	High
4	Low	Medium	Medium	High	Low	Low
	.....	.....	.....	.....	.....	.....
25	High	High	Medium	Low	Low	High
26	High	High	Medium	Low	Medium	Low
27	High	High	Medium	Low	High	Medium

CV/AV Example: Key Variables & Assumptions

CV/AV Variables Network Side:

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- Location/density of housing and employment

Phase 1 Phase 2

CV/AV Example:

Define the method for investigating and communicating the results of applying the models across the wide range of scenarios.

Network Side:

- **Speeds, delays and effective capacities for CV/AV by class:**
  - **Conventional vehicles**
  - **Occupied CV / AV**
  - **Empty CV / AV**
- ***Network maps and/or animations, by time of day***
- ***Comparative graphics for key links under different types of scenarios***

Demand Side:

- **Vehicle ownership levels, trip-level mode shares, average trip distances, VMT and PMT for:**
  - **Conventional vehicles**
  - **Private CV / AV**
  - **Shared CV / AV**
- ***Comparative graphics for different market segments under different types of scenarios***
- ***Regression of outputs on inputs***

Phase 1 – To be completed over the next few months

Objectives:

- To demonstrate the EMA approach for a limited range of scenarios and gain experience with using the approach
- To learn more about what is needed for sound ABM-DTA integration and simulation.

Approach:

- Develop and test integration of the DTA and ABM with the Jacksonville base year inputs
- Adapt the DTA and ABM models to incorporate specific assumptions regarding AV/CV and vehicle-sharing.
- Run combinations of 6-8 demand scenarios with 3-5 supply scenarios (20-40 runs in total).
- Communicate and explain the variation in simulation results across the scenarios, depicting the results in terms of changes in travel behavior on the demand side and changes in vehicle behavior and congestion on the network side.

Example Demand Scenario Characteristics

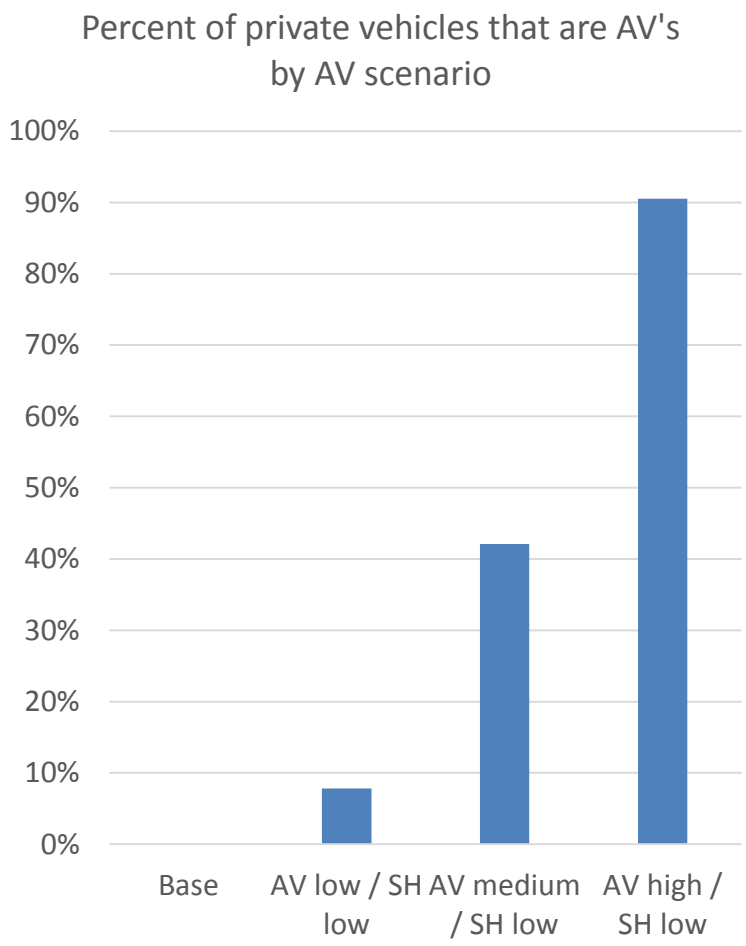
- These are assumed demand scenarios, <u>not</u> forecasts

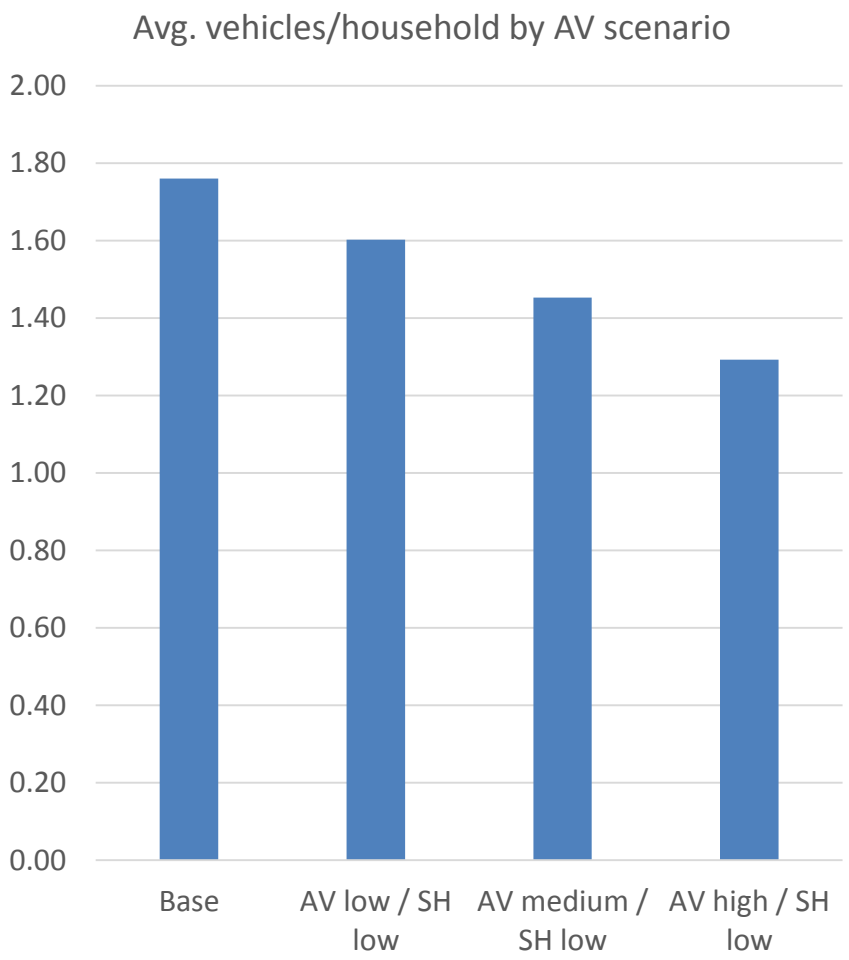
- These initial characteristics are illustrative, from running one iteration of the AB model with base year travel times and no feedback from DTA

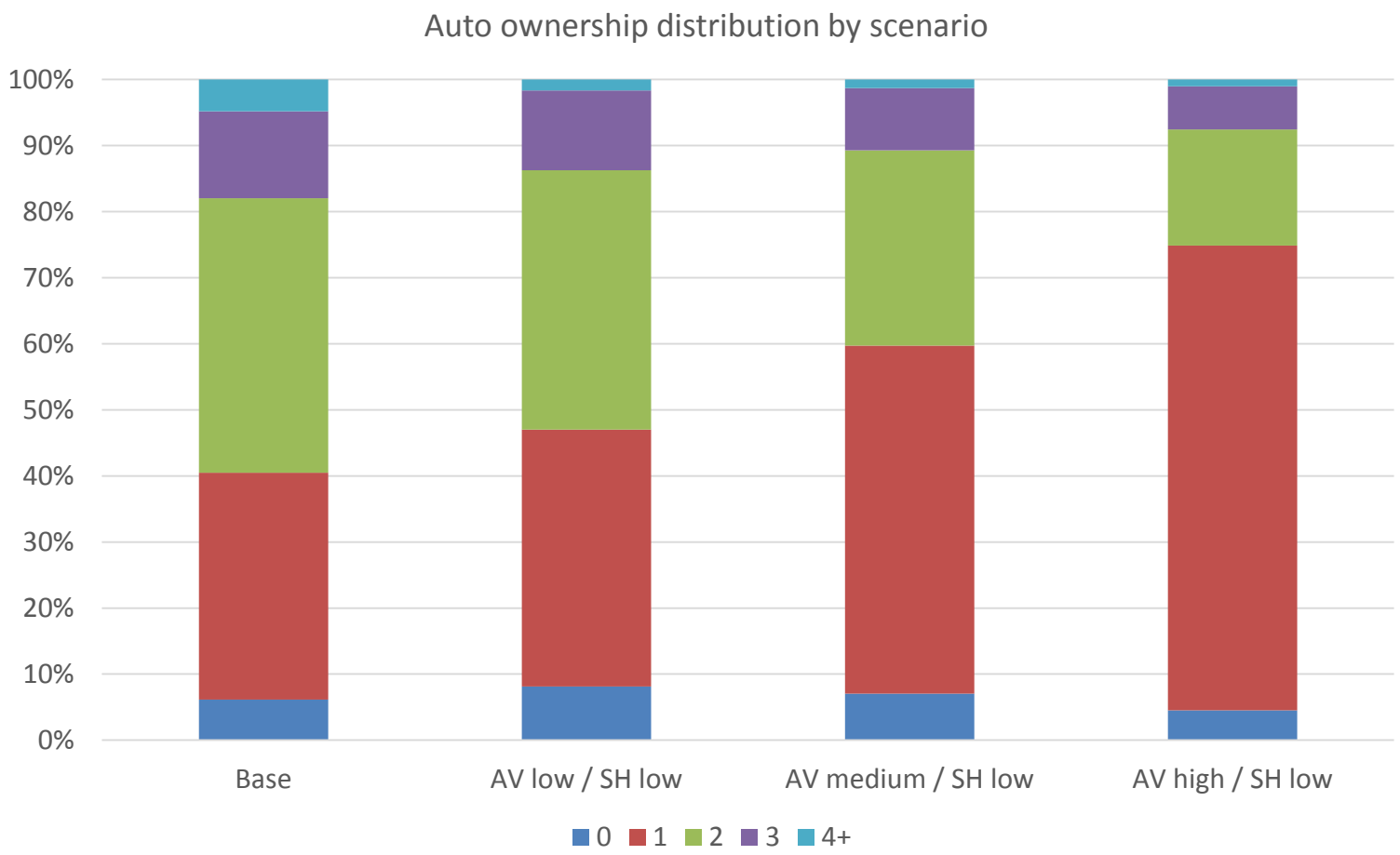
Phase 1: Demand Adaptations for AB Model

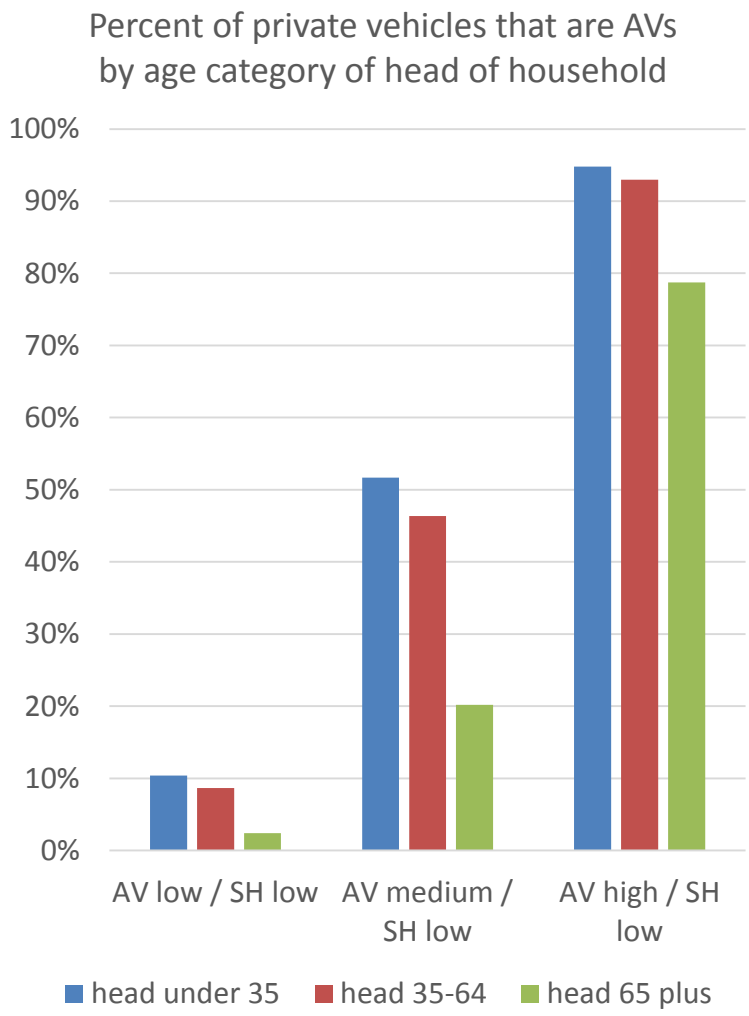
Assumptions for private auto type choice (CV / AV vs conventional)

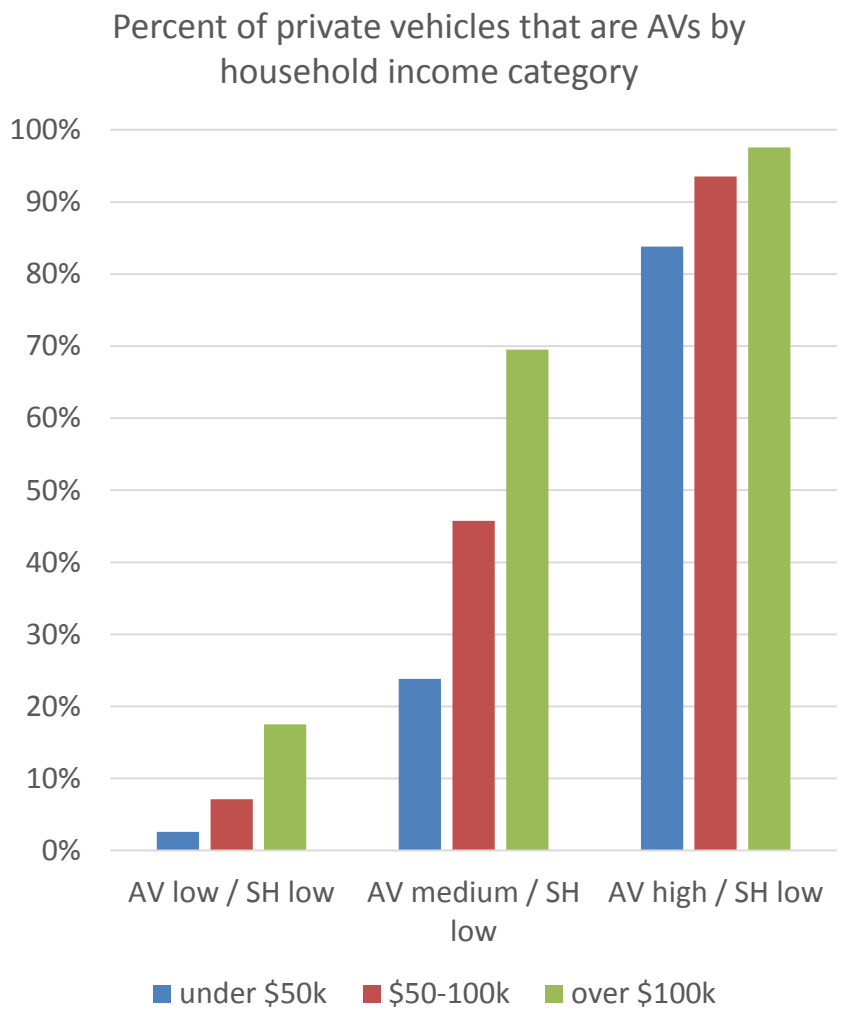
- Alternative-specific constant affecting overall penetration rate
- Adoption rate is lower for households with older adults
- Adoption rate is higher for higher income households
- Adoption rate is higher for households with longer commute distances
- Households choosing AVs are less likely to own multiple vehicles

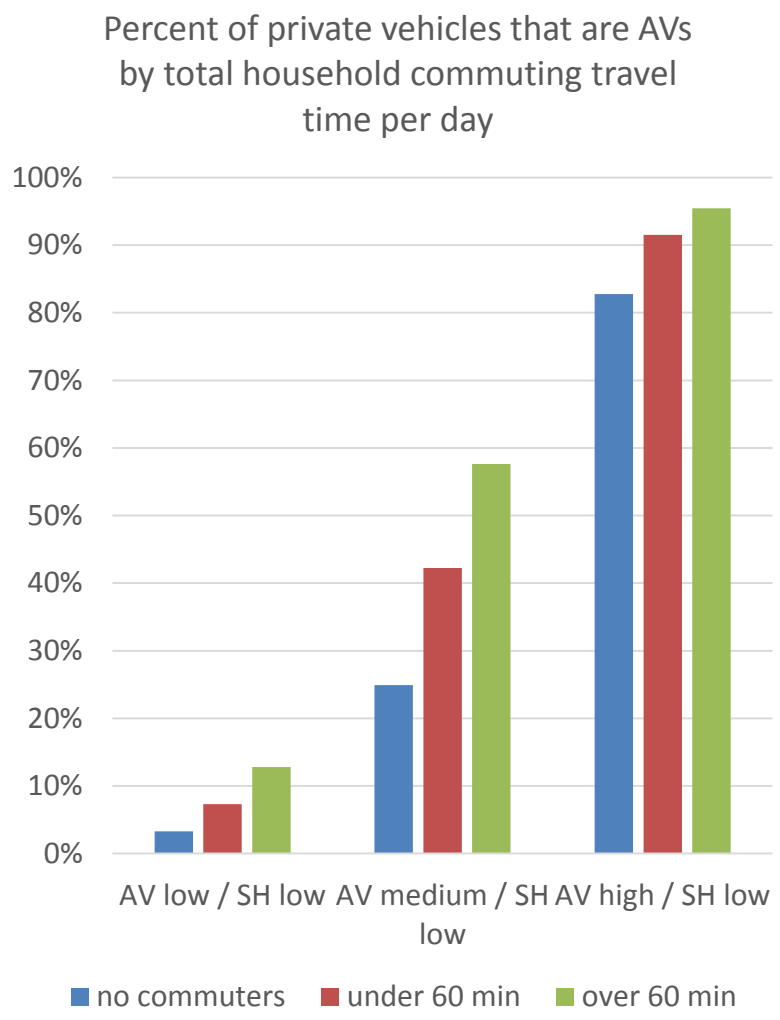

Percent of private vehicles that are AV's by AV scenario
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Base
AV low / SH low
AV medium / SH low
AV high / SH low

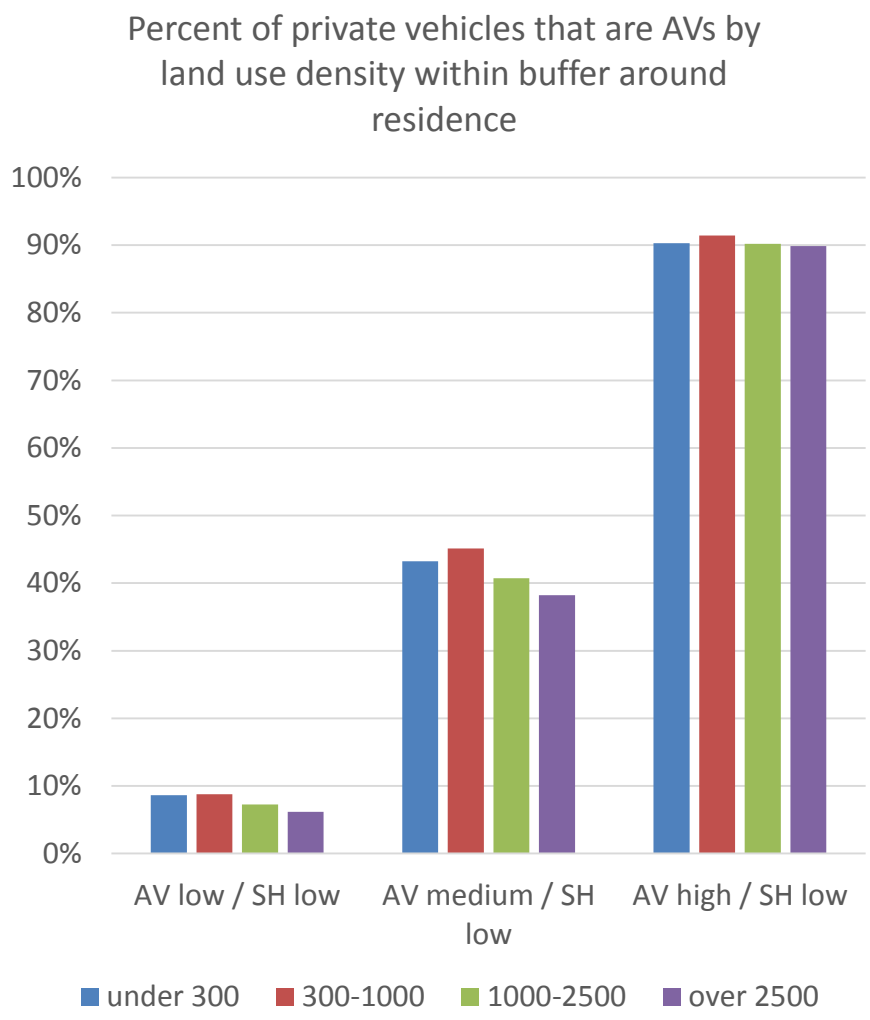

Avg. vehicles/household by AV scenario
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Base
AV low / SH low
AV medium / SH low
AV high / SH low

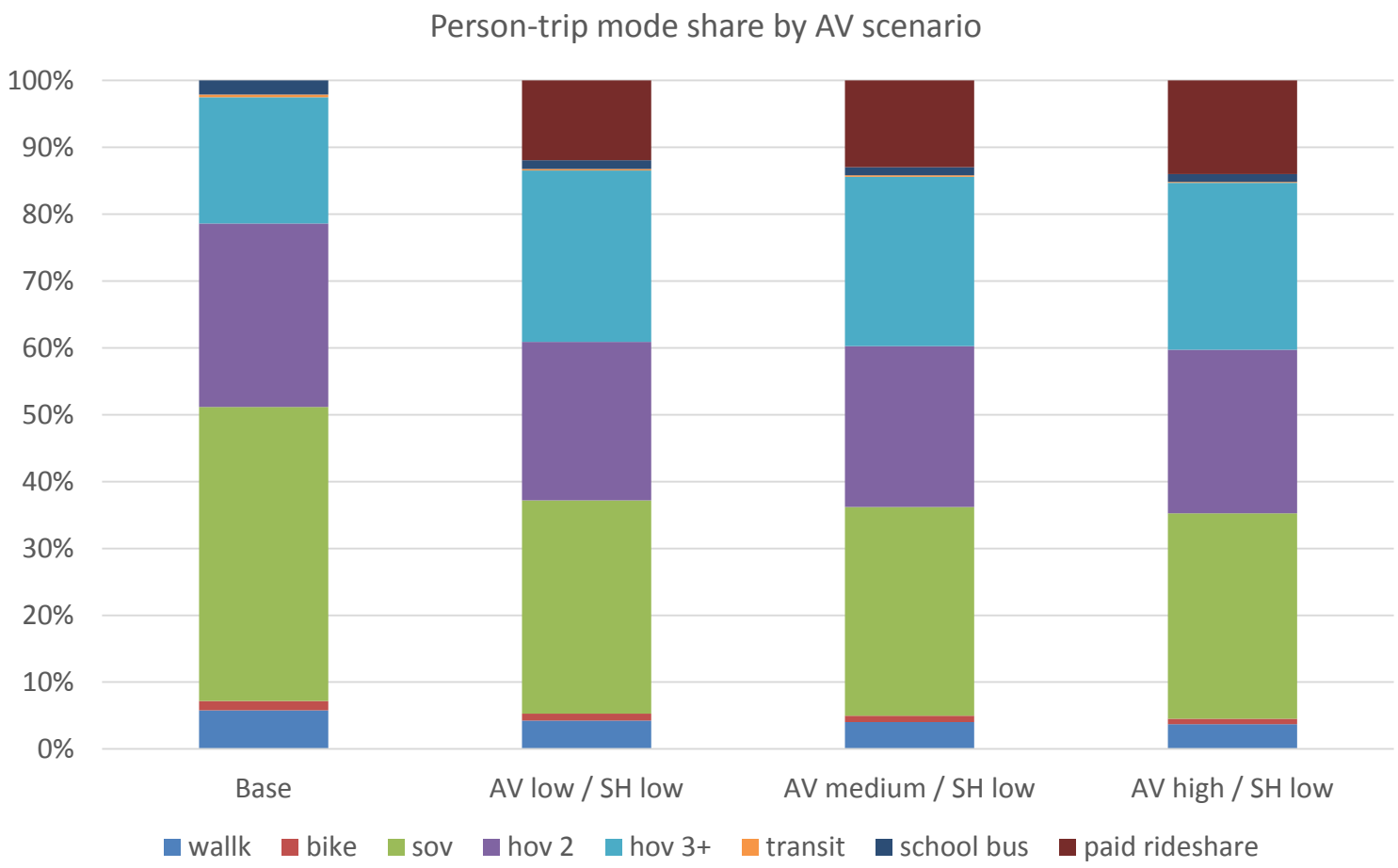

Auto ownership distribution by scenario
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Base
AV low / SH low
AV medium / SH low
AV high / SH low
0
1
2
3
4+

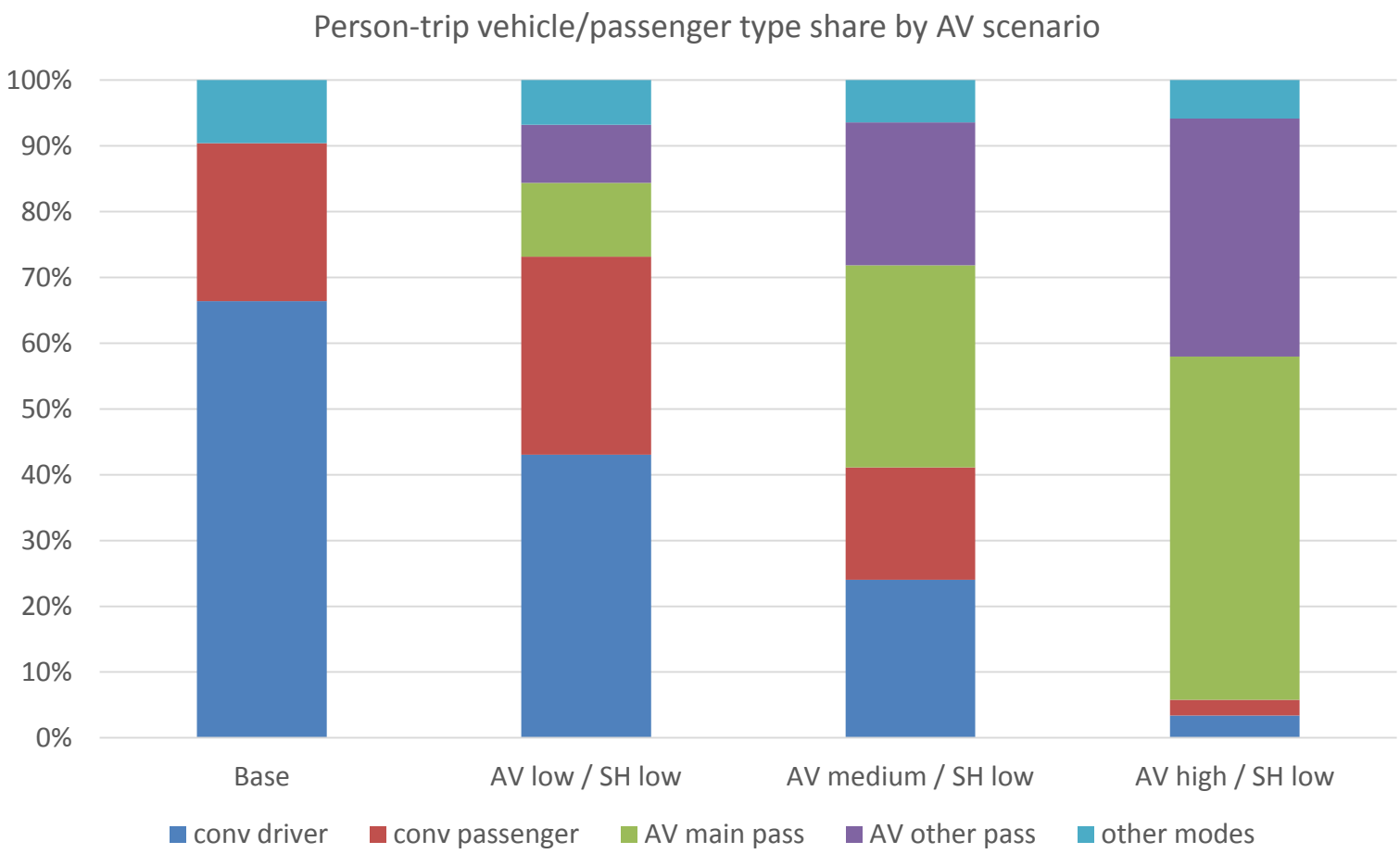

Percent of private vehicles that are AVs by age category of head of household
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
AV low / SH low
AV medium / SH low
AV high / SH low
head under 35
head 35-64
head 65 plus


Percent of private vehicles that are AVs by household income category
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
AV low / SH low
AV medium / SH low
AV high / SH low
under $50k
$50-100k
over $100k


Percent of private vehicles that are AVs by total household commuting travel time per day
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
AV low / SH low
AV medium / SH low
AV high / SH low
no commuters
under 60 min
over 60 min


Percent of private vehicles that are AVs by land use density within buffer around residence
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
AV low / SH low
AV medium / SH low
AV high / SH low
under 300
300-1000
1000-2500
over 2500


Person-trip mode share by AV scenario
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Base
AV low / SH low
AV medium / SH low
AV high / SH low
wallk
bike
sov
hov 2
hov 3+
transit
school bus
paid rideshare



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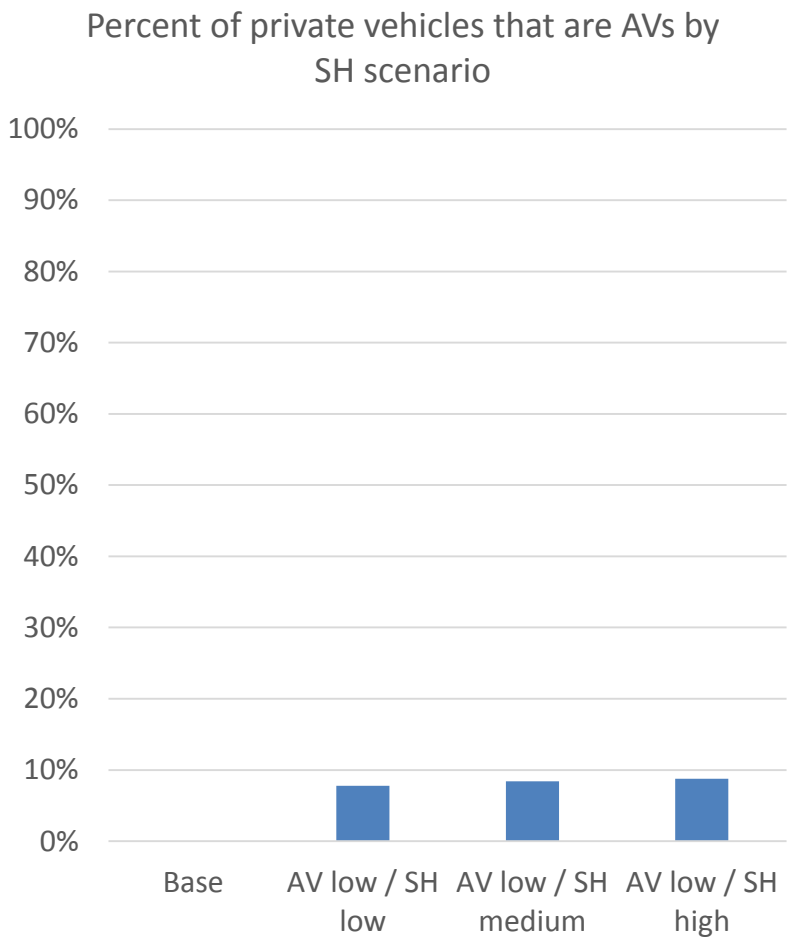
Phase 1: Demand Adaptations for AB Model

Assumptions for private auto type choice (CV / AV vs conventional)

- Alternative-specific constant affecting overall penetration rate
- Adoption rate is lower for older households
- Adoption rate is higher for higher income households
- Adoption rate is higher for households with longer commute distances
- Households choosing AVs are less likely to own multiple vehicles

Assumptions for usage of AV-based vehicle sharing services

- Mode-specific constant affecting overall mode shares
- Usage rate is highest for trips originating in denser areas (supply effect)
- Usage rate is higher for younger households
- Higher usage is associated with lower private ownership ("sharing economy")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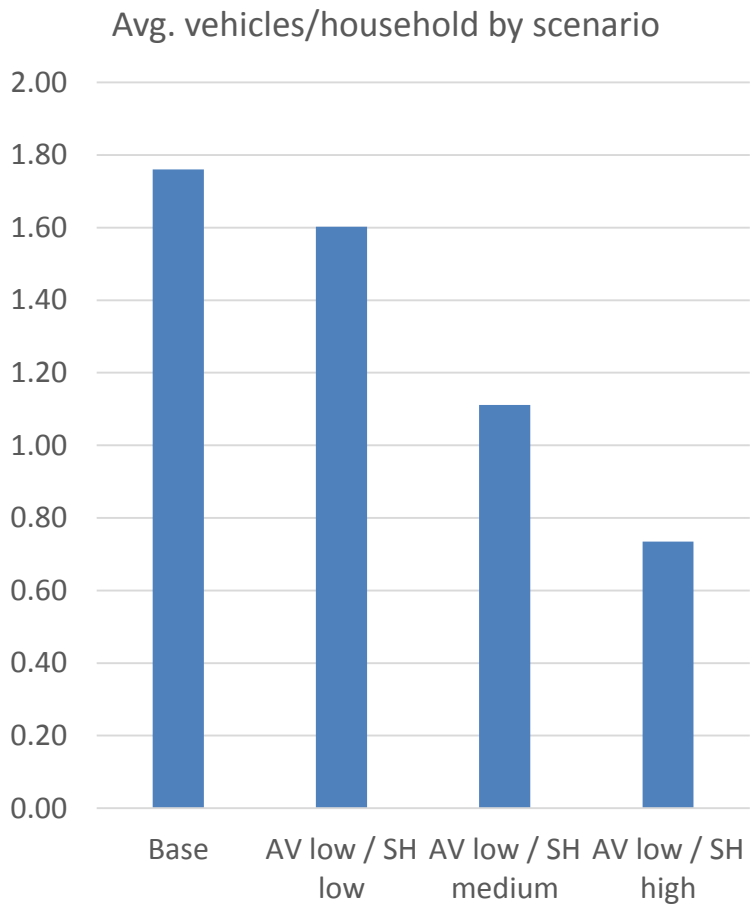
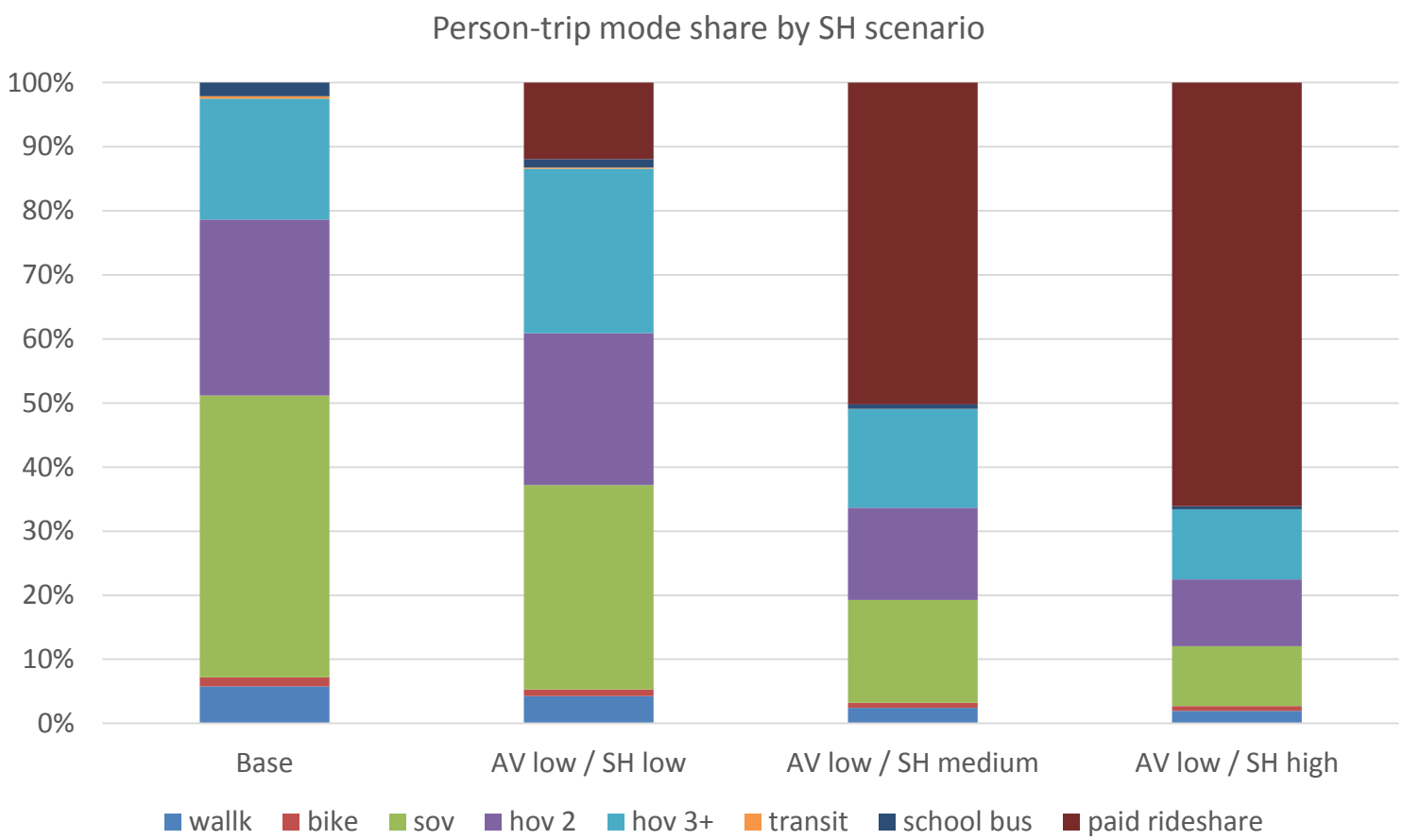
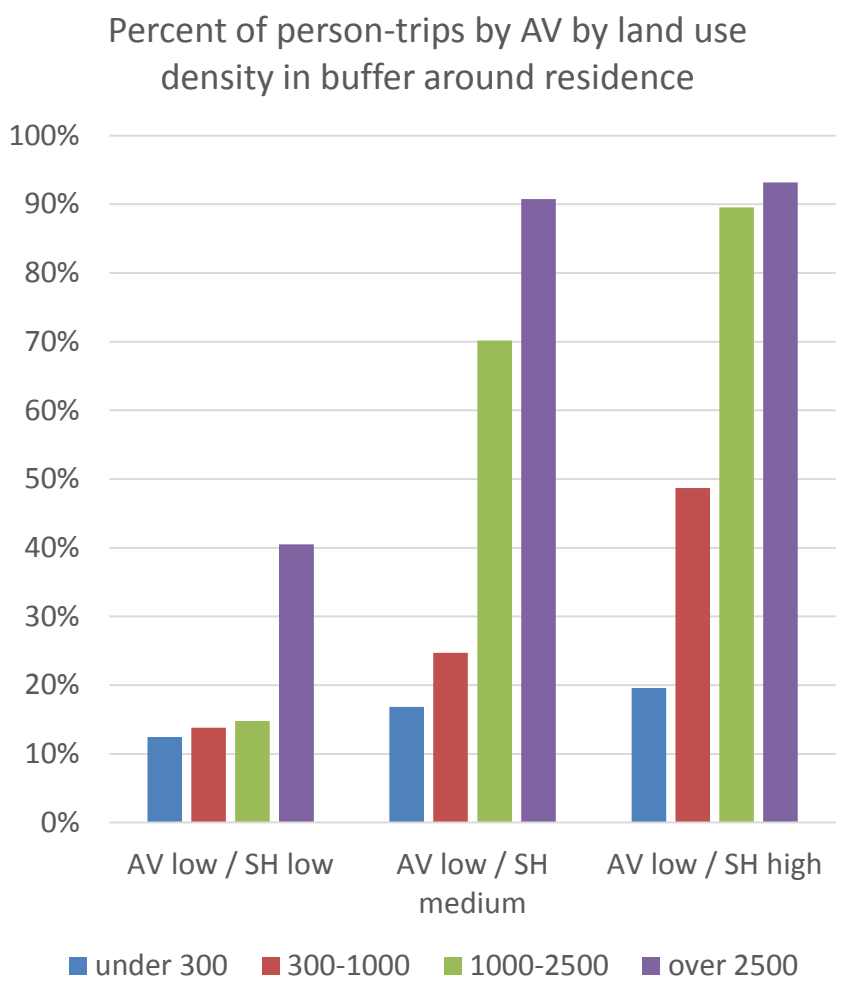
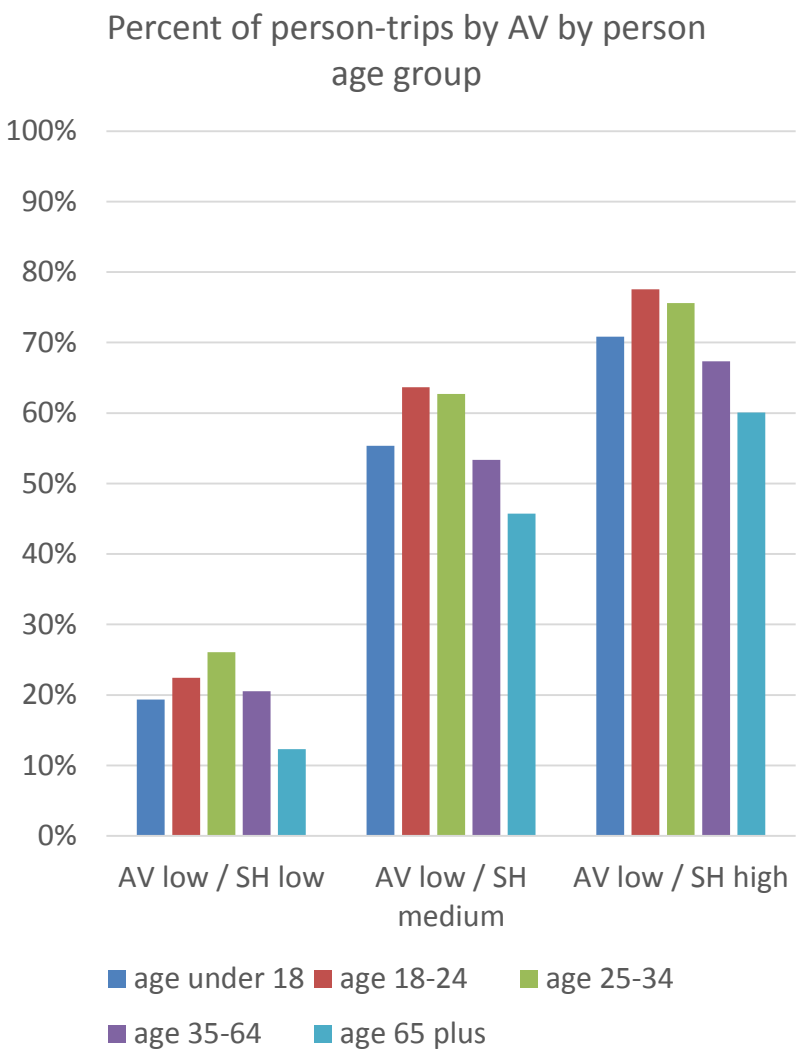
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Base
AV low / SH low
AV low / SH medium
AV low / SH high


Avg. vehicles/household by scenario
2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Base
AV low / SH low
AV low / SH medium
AV low / SH high


Person-trip mode share by SH scenario
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Base
AV low / SH low
AV low / SH medium
AV low / SH high
wallk
bike
sov
hov 2
hov 3+
transit
school bus
paid rideshare


Percent of person-trips by AV by land use density in buffer around residence
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
AV low / SH low
AV low / SH medium
AV low / SH high
under 300
300-1000
1000-2500
over 2500


Percent of person-trips by AV by person age group
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
AV low / SH low
AV low / SH medium
AV low / SH high
age under 18
age 18-24
age 25-34
age 35-64
age 65 plus

Phase 1: Demand Adaptations for AB Model

Assumptions for private auto type choice (CV / AV vs conventional)

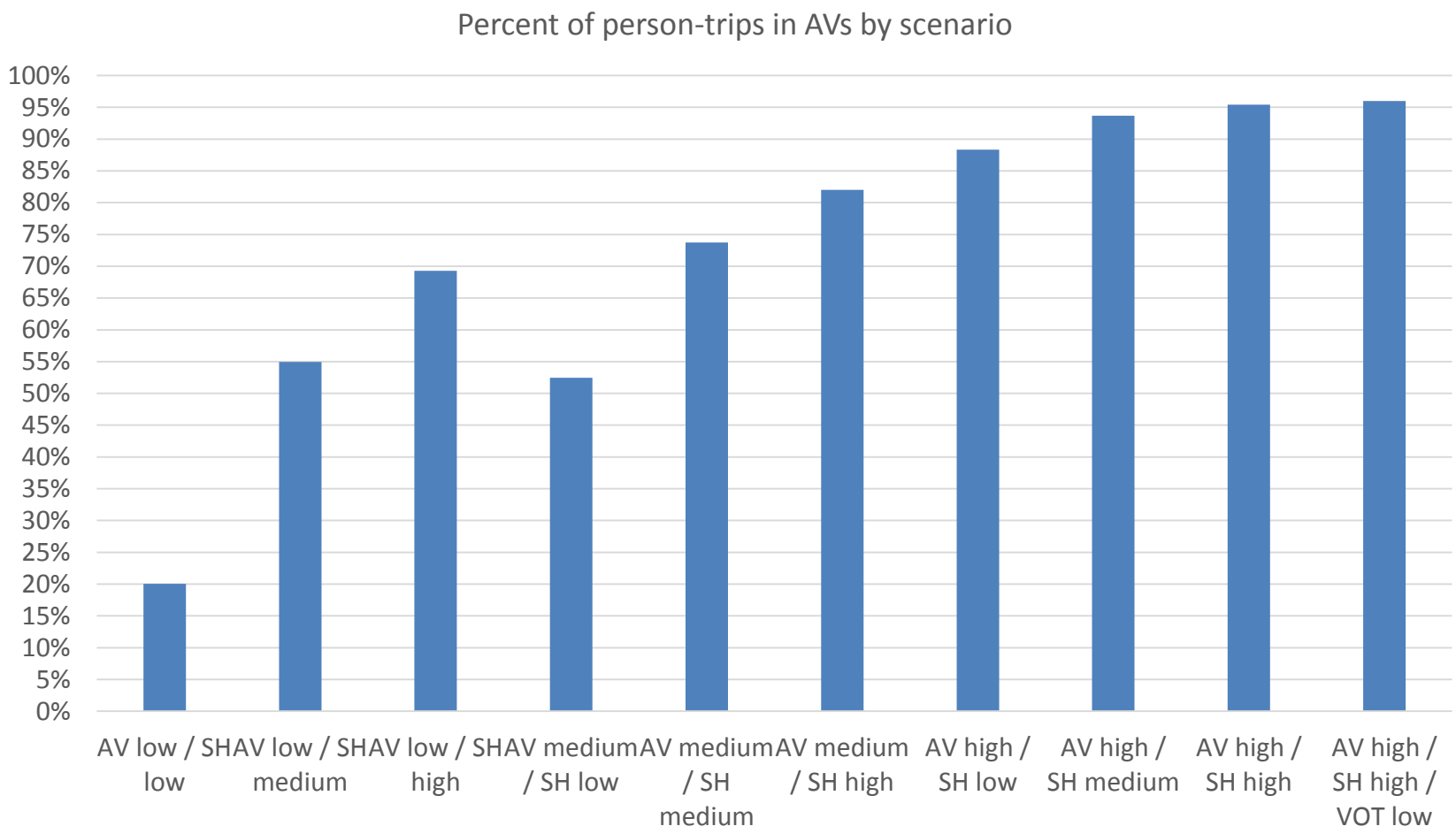
- Alternative-specific constant affecting overall penetration rate
- Adoption rate is lower for older households
- Adoption rate is higher for higher income households
- Adoption rate is higher for households with longer commute distances
- Households choosing AVs are less likely to own multiple vehicles

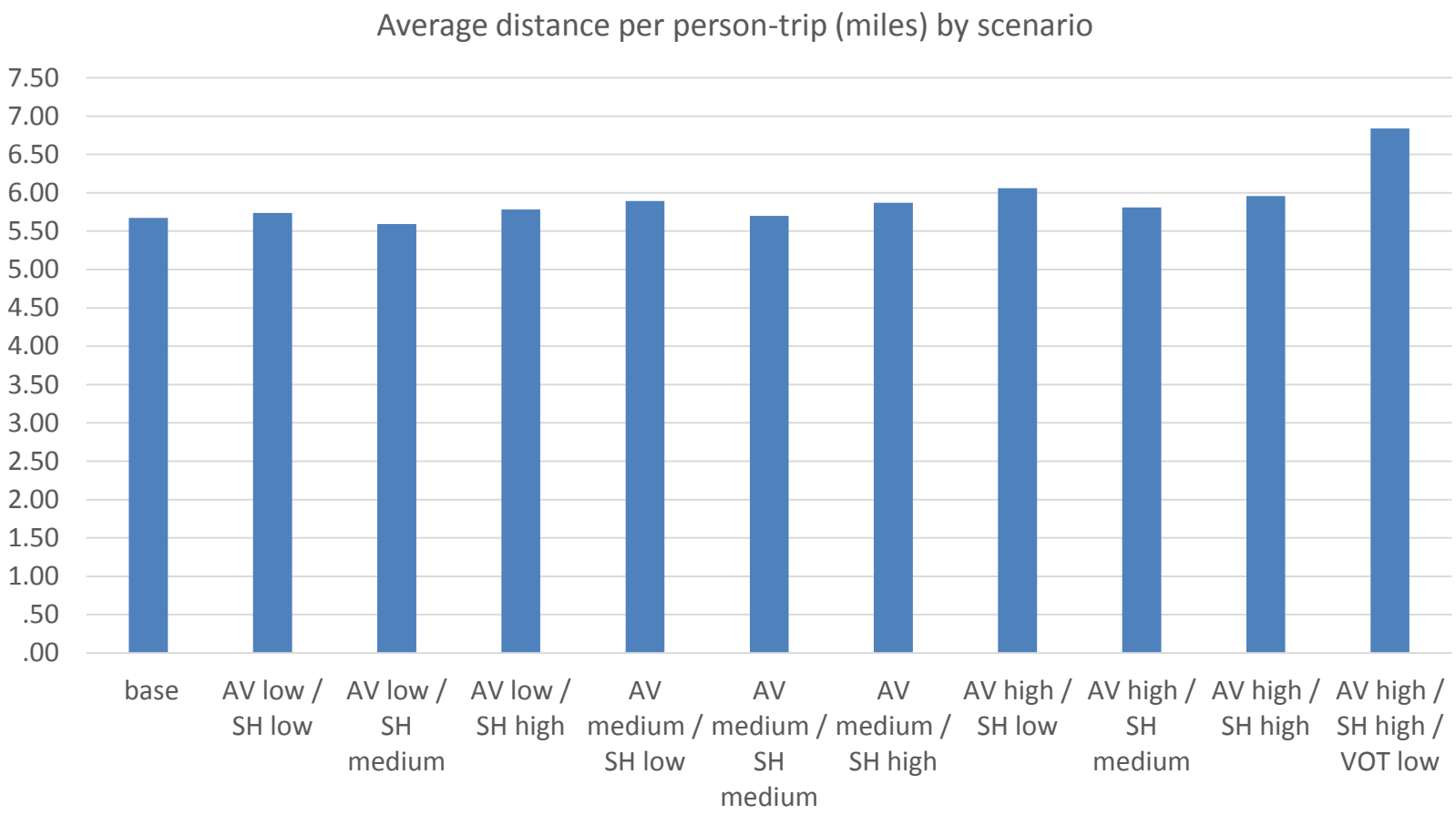
Assumptions for usage of AV-based vehicle sharing services

- Mode-specific constant affecting overall mode shares
- Usage rate is highest for trips originating in denser areas (supply effect)
- Usage rate is higher for younger households
- Higher usage is associated with lower private ownership ("sharing economy")

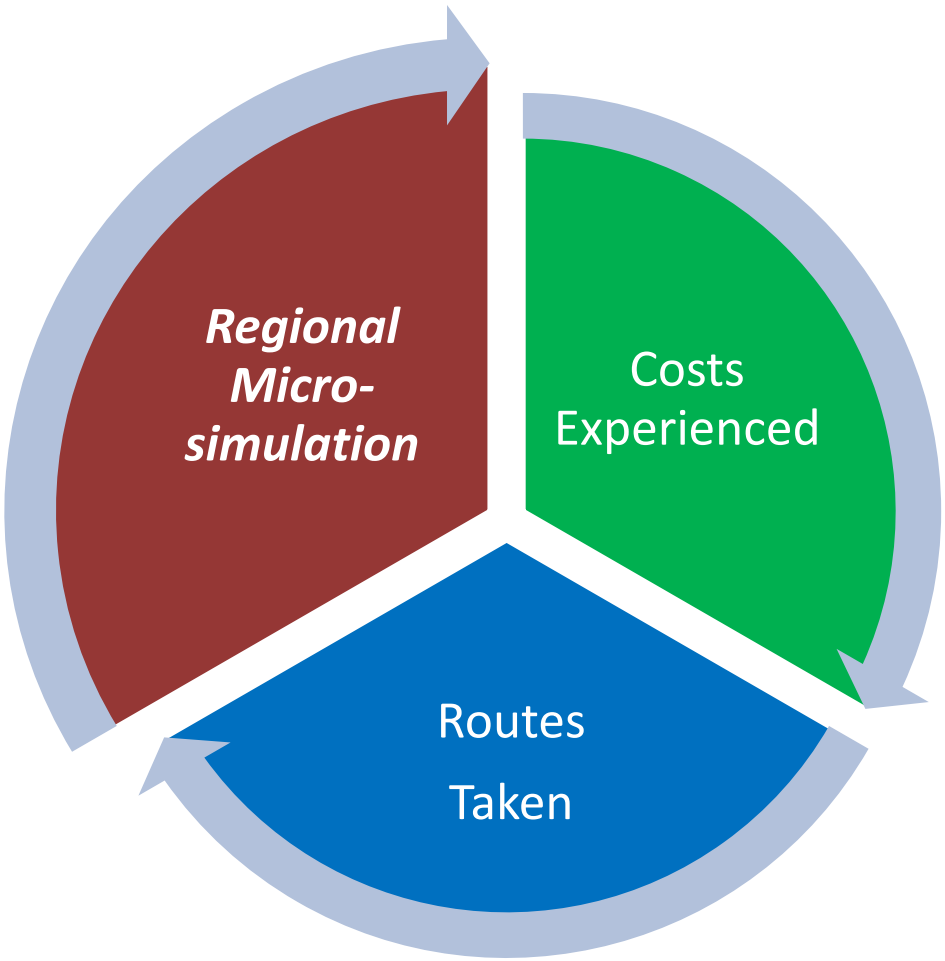
Assumptions for lower disutility of AV in-vehicle time

- Travel time disutility per minute is lower in AVs, by a specified percentage


Percent of person-trips in AVs by scenario
100%
95%
90%
85%
80%
75%
70%
65%
60%
55%
50%
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
AV low / SH low
AV low / SH medium
AV low / SH high
AV medium / SH low
AV medium / SH medium
AV medium / SH high
AV high / SH low
AV high / SH medium
AV high / SH high
AV high / SH high / VOT low


Average distance per person-trip (miles) by scenario
7.50
7.00
6.50
6.00
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
.50
.00
base
AV low / SH low
AV low / SH medium
AV low / SH high
AV medium / SH low
AV medium / SH medium
AV medium / SH high
AV high / SH low
AV high / SH medium
AV high / SH high
AV high / SH high / VOT low

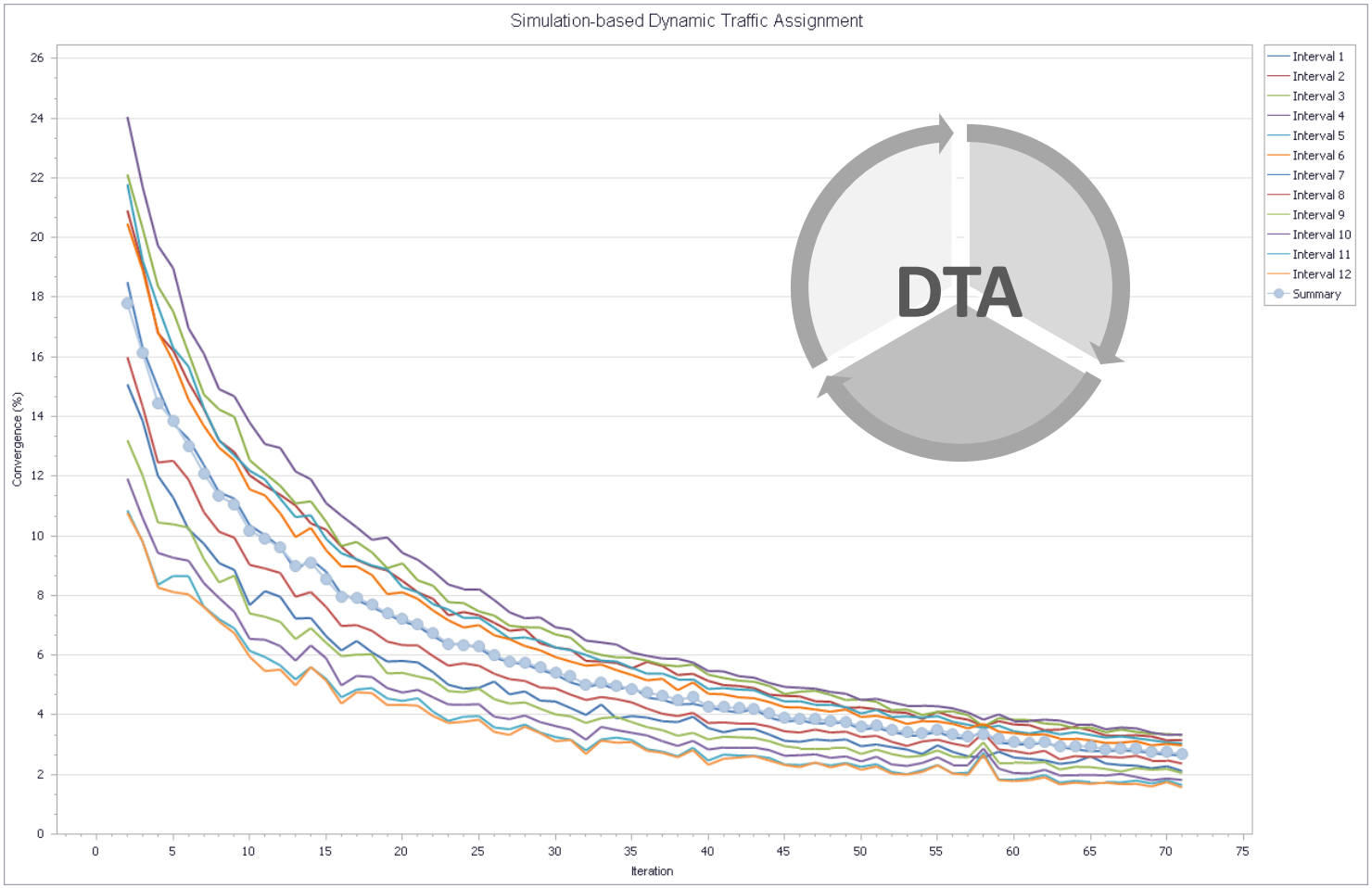
Phase 1: Supply Adaptations for DTA Model



DTA

A traffic assignment in which ***routes taken*** are motivated by ***costs experienced*** as derived from a ***regional microsimulation***

Phase 1: Supply Adaptations for DTA Model



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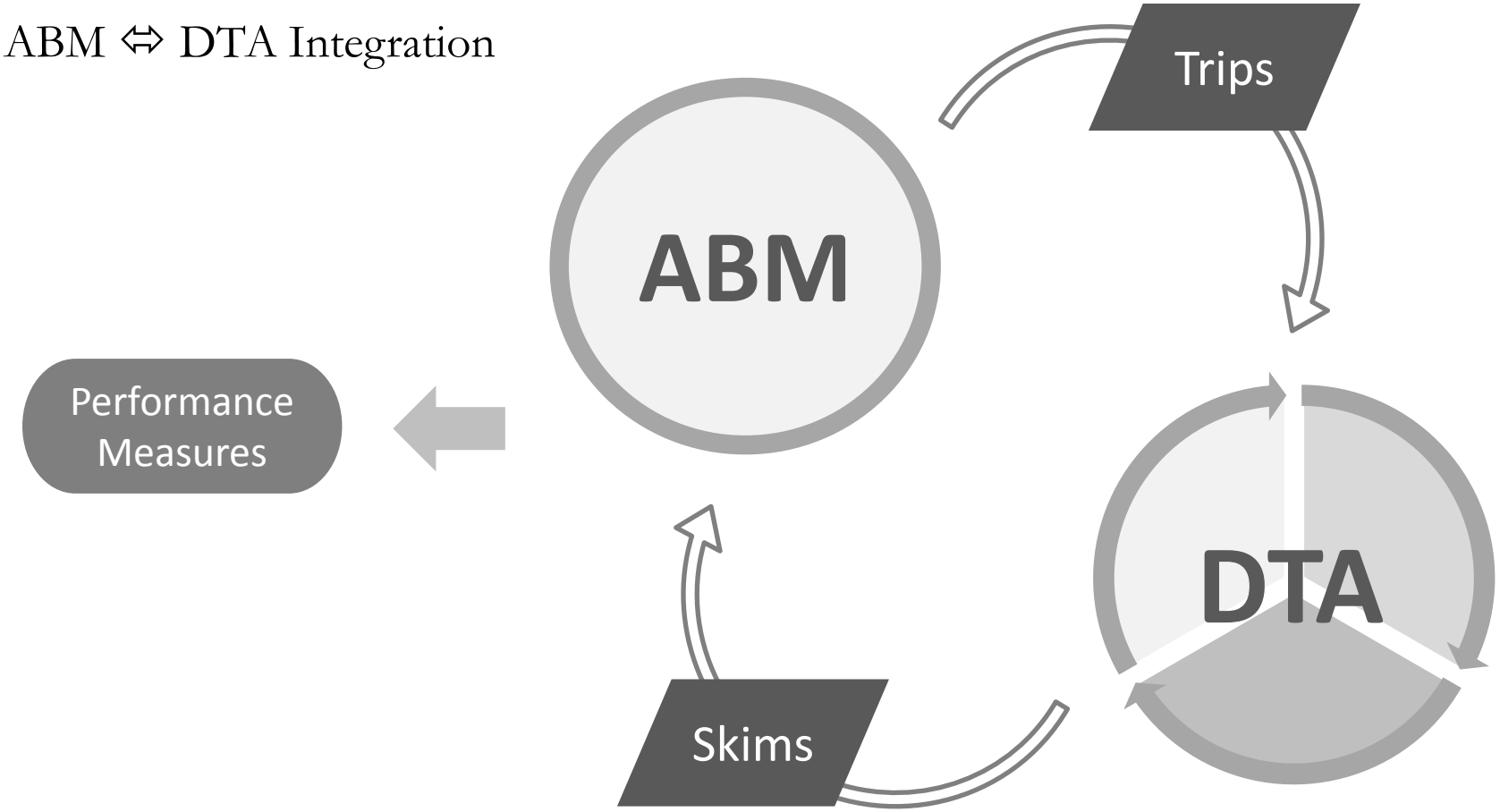
Phase 1: Supply Adaptations for DTA Model

ABM ⇔ DTA Integration



Phase 1: Supply Adaptations for DTA Model

Vehicle automation: Adoption of SAE International six levels of automation

SAE level	Name	Narrative Definition	Execution of Steering and Acceleration/ Deceleration	*Monitoring* of Driving Environment	Fallback Performance of *Dynamic Driving Task*	System Capability *(Driving Modes)*
***Human driver* monitors the driving environment**						
0	No Automation	the full-time performance by the *human driver* of all aspects of the *dynamic driving task*, even when enhanced by warning or intervention systems	Human driver	Human driver	Human driver	n/a
1	Driver Assistance	the *driving mode*-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	Human driver and system	Human driver	Human driver	Some driving modes
2	Partial Automation	the *driving mode*-specific execution by one or more driver assistance systems of both steering and acceleration/ deceleration using information about the driving environment and with the expectation that the *human driver* perform all remaining aspects of the *dynamic driving task*	**System**	Human driver	Human driver	Some driving modes
***Automated driving system* ("system") monitors the driving environment**						
3	Conditional Automation	the *driving mode*-specific performance by an *automated driving system* of all aspects of the dynamic driving task with the expectation that the *human driver* will respond appropriately to a *request to intervene*	System	**System**	Human driver	Some driving modes
4	High Automation	the *driving mode*-specific performance by an automated driving system of all aspects of the *dynamic driving task*, even if a *human driver* does not respond appropriately to a *request to intervene*	System	System	**System**	Some driving modes
5	Full Automation	the full-time performance by an *automated driving system* of all aspects of the *dynamic driving task* under all roadway and environmental conditions that can be managed by a *human driver*	System	System	System	**All driving modes**

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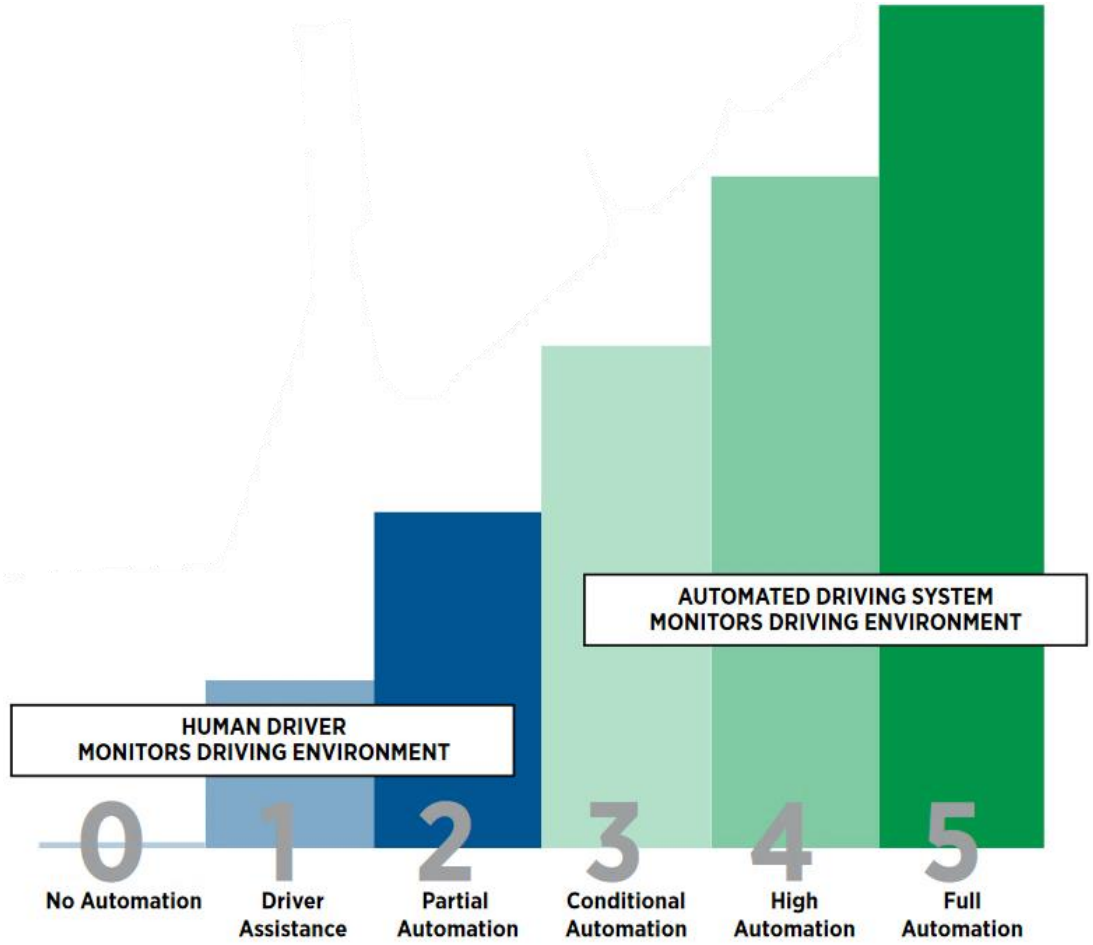
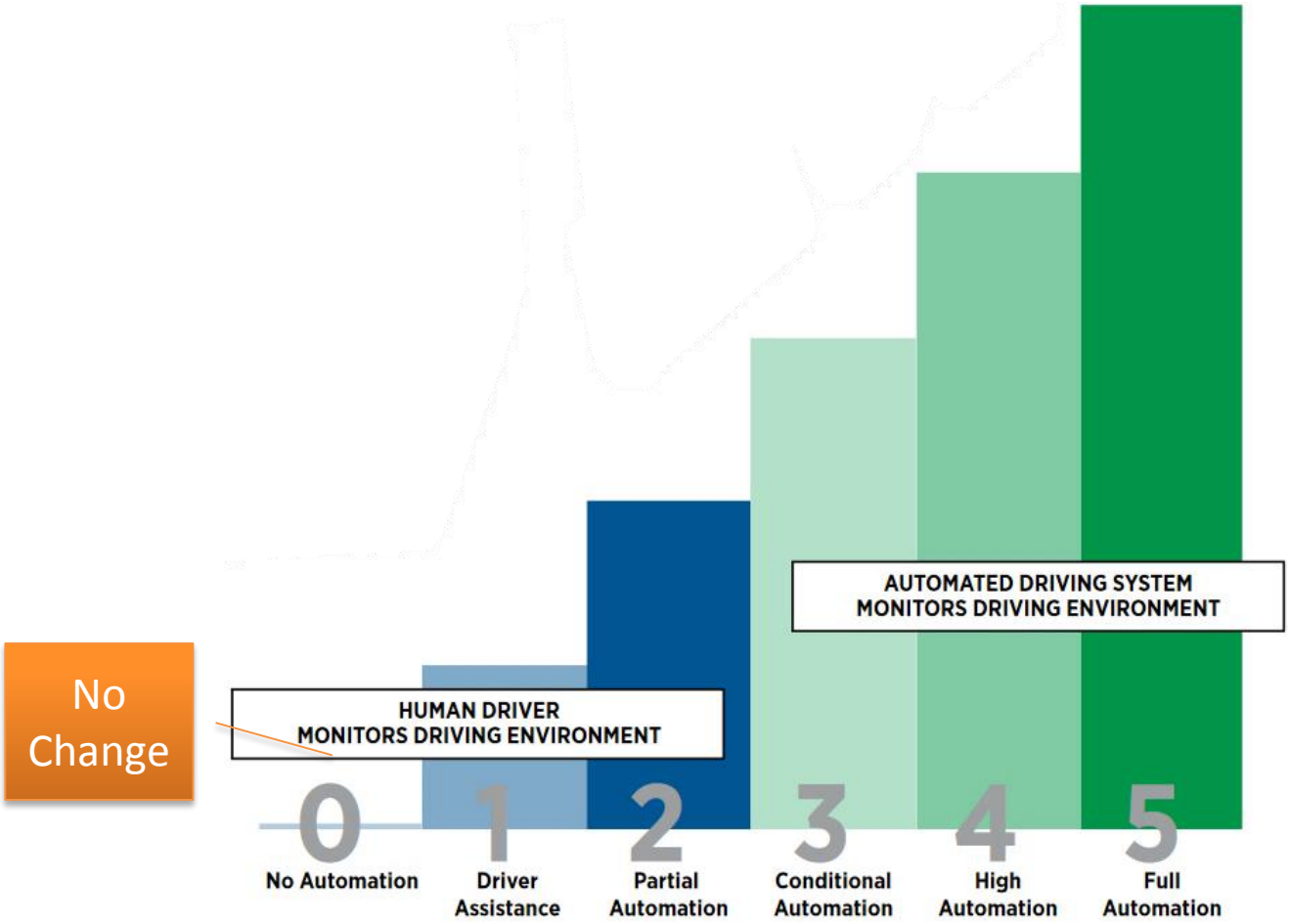
Phase 1: Supply Adaptations for DTA Model



https://www.sae.org/misc/pdfs/automated_driving.pdf

Phase 1: Supply Adaptations for DTA Model



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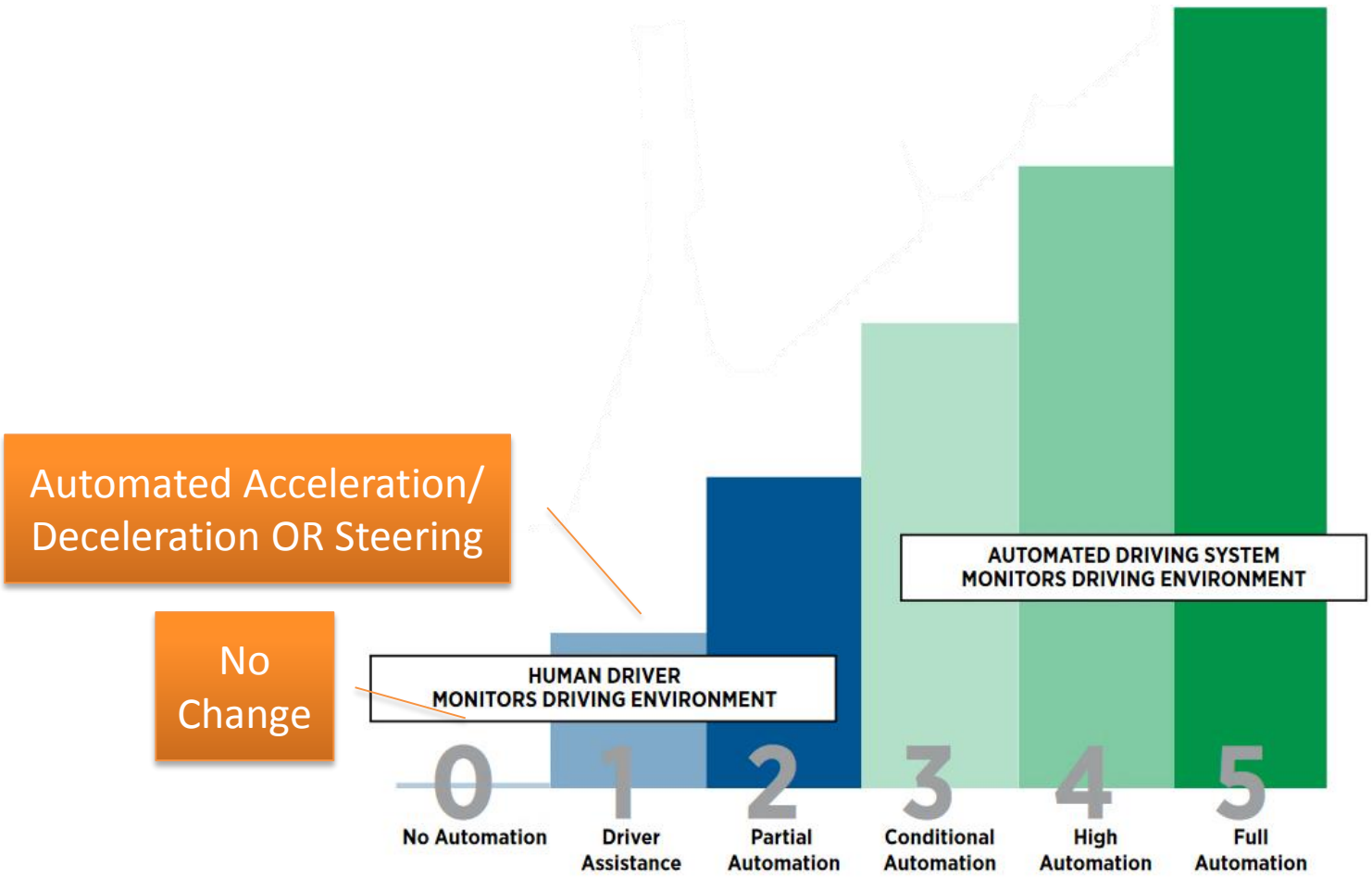
Phase 1: Supply Adaptations for DTA Model



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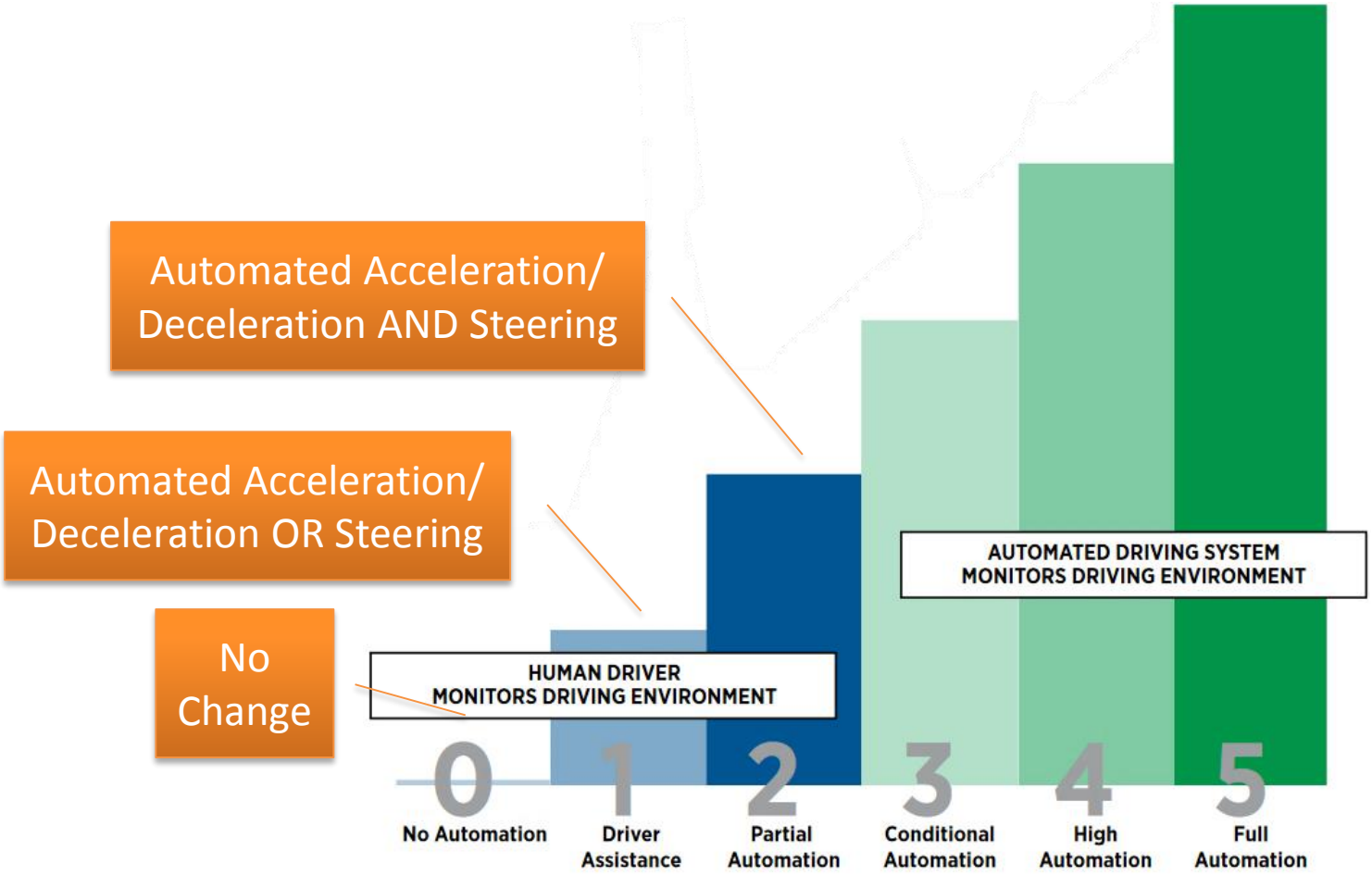
Phase 1: Supply Adaptations for DTA Model



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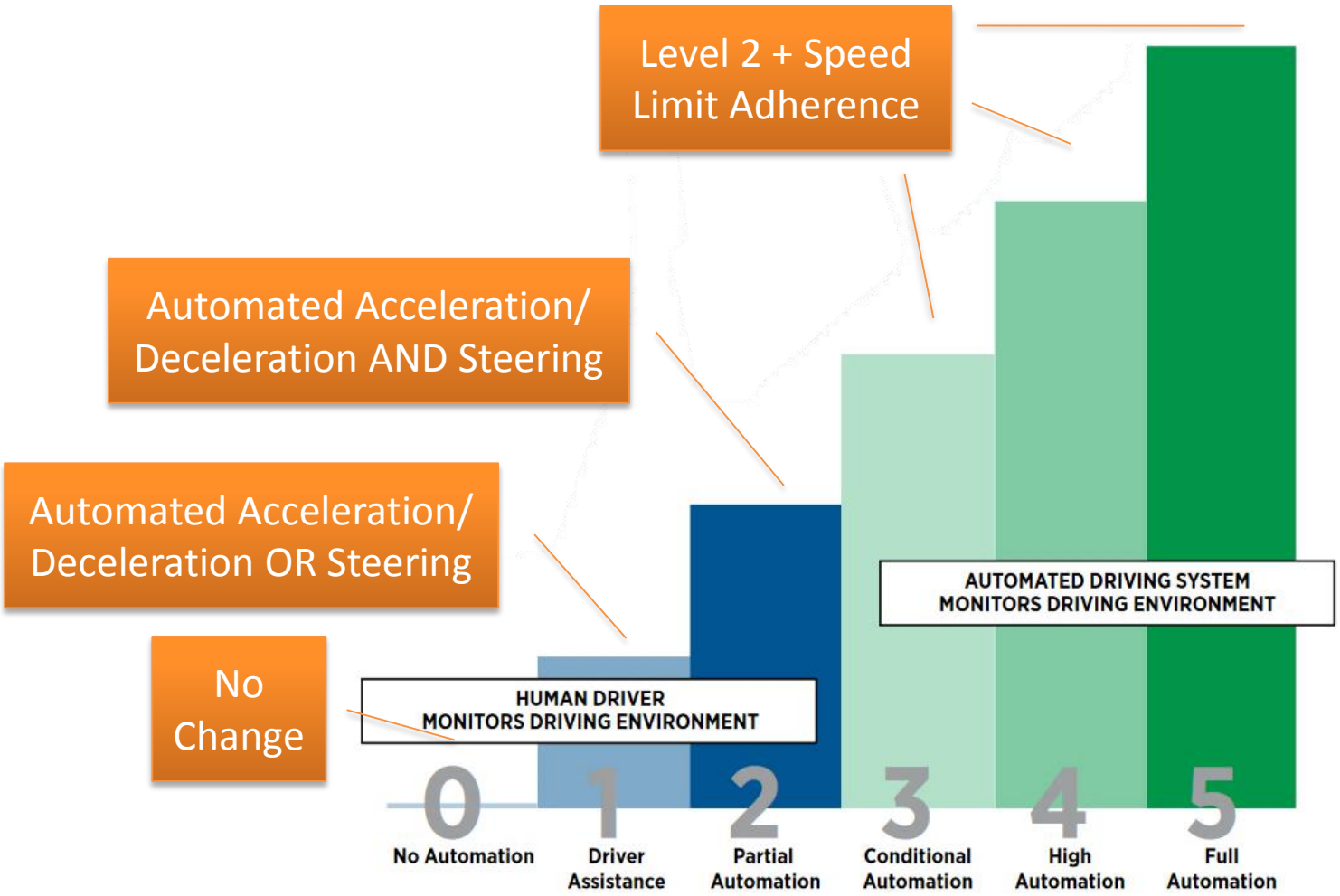
Phase 1: Supply Adaptations for DTA Model



https://www.sae.org/misc/pdfs/automated_driving.pdf

Phase 1: Supply Adaptations for DTA Model

- Other supply side strategies:
  - **Speed Harmonization**: dynamic vehicle speed adjustments to reduce speed differentials using vehicle-to-infrastructure (V2I) highway systems
  - **Cooperative Adaptive Cruise Control (CACC)**: allows vehicles to use tighter spacing on the roadway by using wireless connectivity
  - **Queue Warning (Q-WARN)**: providing warnings sufficiently upstream of developing congestion to allow drivers to brake or modify their routes before reaching the back of queue
  - **Exclusive AV Lanes/Facilities**: reserving lanes (or entire facilities) for AV vehicles only to optimize flow

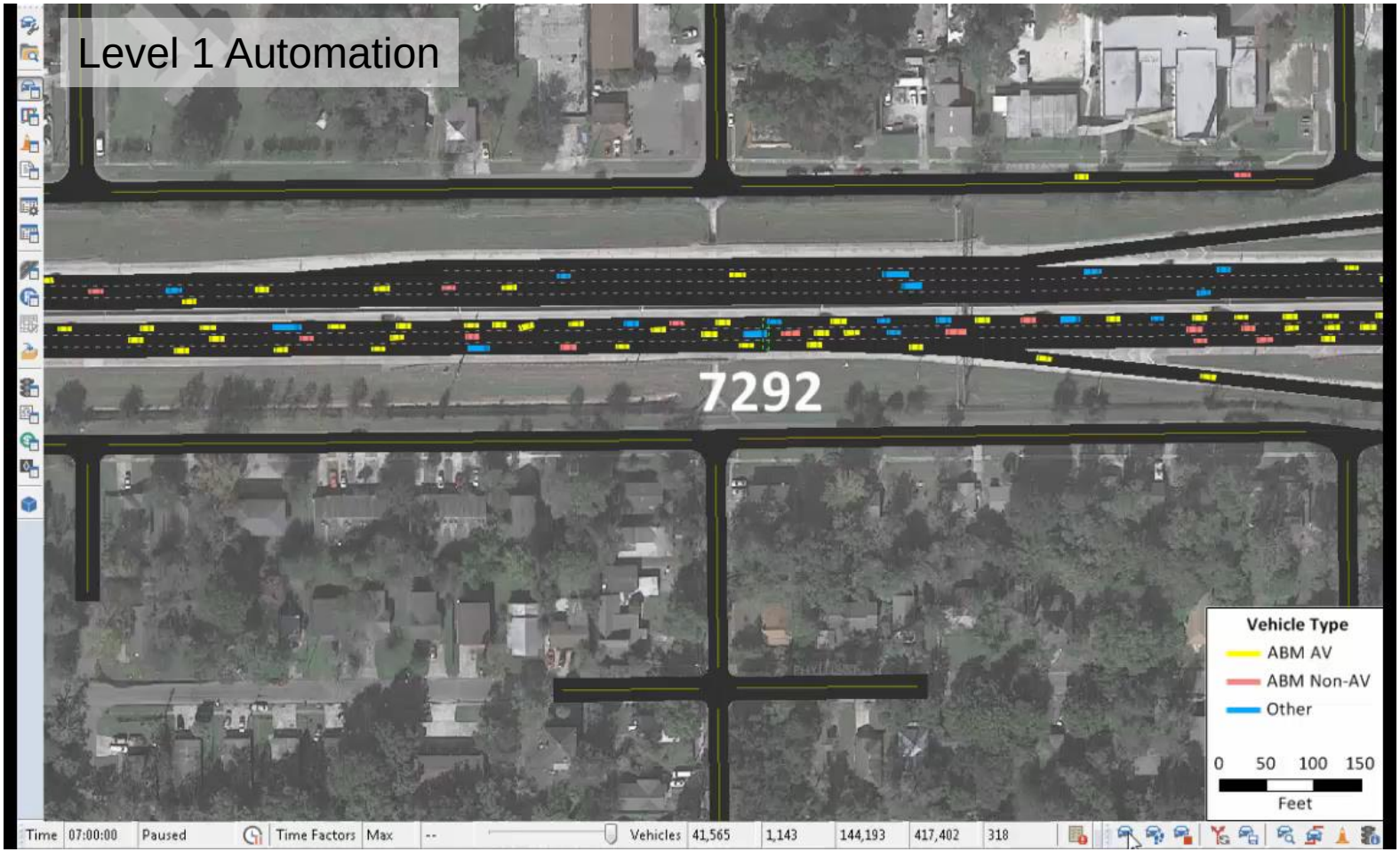
Phase 1: Supply Adaptations for DTA Model

- Aspects of Driving Behavior Identified for Adaptation
  - Acceleration/deceleration
  - Car following headways
  - Choice of travel speed
  - Gap acceptance in lane changing
- Vehicle and Driving Behavior Assumptions
  - Removal of the random/human element from aspects controlled by the vehicle
  - Aspects deterministic, predictable, homogeneous

Phase 1: Example Supply Scenarios

- Base – Current Situation
- Varying levels of automation
  - Autonomous Automation: Levels 1-5
  - Cooperative (e.g., V2V, V2I) Automation (e.g., Speed Harmonization, CACC, Q-WARN)
- Facility/lane use privileges
  - AV operation of vehicle permitted on all facilities in all lanes
  - AV operation of vehicle permitted on select facilities in all lanes
  - AV operation of vehicle permitted on select lanes

Visualizations



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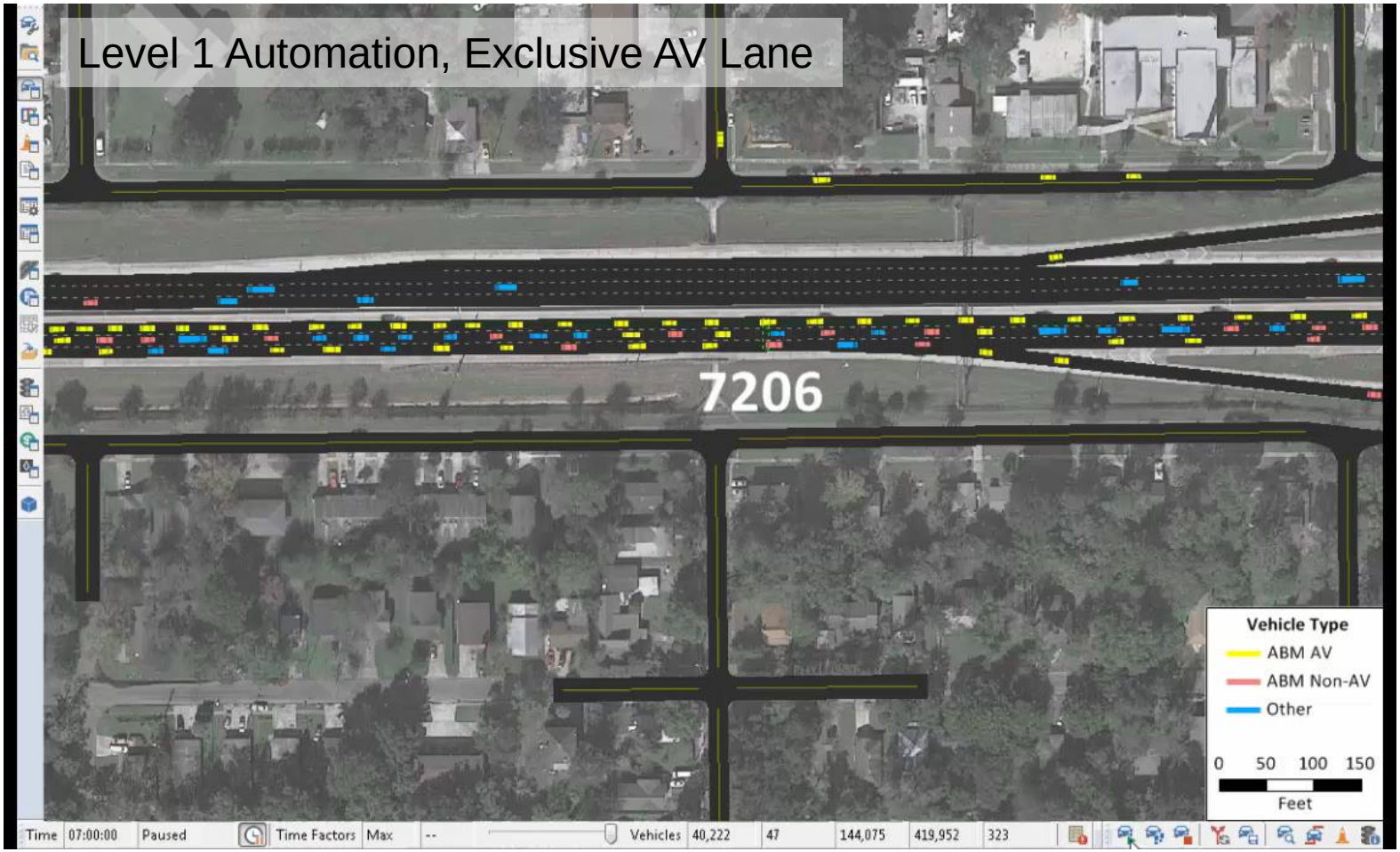
Visualizations



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Phase 2 – Next Steps

- Additional adaptation and testing of DaySim and TransModeler code, particularly related to:
  - Parking supply and behavior (including empty trips)
  - Operation of shared vehicle services on the network (including dispatching and empty trips)
  - Adaptation of within-household schedule coordination to better utilize AVs (including generation of empty trips)
  - Treatment of empty vehicle-trips on the network
- New series of runs for EMA analysis
- In-depth exploratory analysis of outputs
- Final documentation, guidance, and presentations

Q&A

Discussion

Demand scenario settings (for reference)

	FBB Base year-as is	FLL Low AV share, Low vehicle sharing	FLM Low AV share, Medium vehicle sharing	FLH Low AV share, High vehicle sharing	FML Medium AV share, Low vehicle sharing	FMM Medium AV share, Medium vehicle sharing	FMH Medium AV share, High vehicle sharing	FHL High AV share, Low vehicle sharing	FHM High AV share, Medium vehicle sharing	FHH High AV share, High vehicle sharing	FHH2 High AV share, High vehicle sharing, Low VOT
AV_IncludeAutoTypeChoice	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
AV_AutoTypeConstant	-2.5	-2.5	-2.5	-2.5	0	0	0	3	3	3	3
AV_HHIncomeUnder50KCoefficient	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
AV_HHIncomeOver100KCoefficient	1	1	1	1	1	1	1	1	1	1	1
AV_HHHeadUnder35Coefficient	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
AV_HHHeadOver65Coefficient	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
AV_CoefficientPerHourCommuteTime	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
AV_Own0VehiclesCoefficientForAVHouseholds	1	1	1	1	1	1	1	1	1	1	1
AV_Own1VehicleCoefficientForAVHouseholds	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
AV_InVehicleTimeCoefficientDiscountFactor	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.75
PaidRideShareModeIsAvailable	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
PaidRideShare_Age26to35Coefficient	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
PaidRideShare_Age18to25Coefficient	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
PaidRideShare_AgeOver65Coefficient	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
AV_PaidRideShareModeUsesAVs	FALSE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE	TRUE
AV_PaidRideShare_ModeConstant	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5	-2.5
AV_PaidRideShare_DensityCoefficient	0.002	0.002	0.006	0.01	0.002	0.006	0.01	0.002	0.006	0.01	0.01
AV_PaidRideShareAVOwnerCoefficient	1	1	1	1	1	1	1	1	1	1	1
AV_PaidRideShare_ExtraCostPerDistanceUnit	1	1	0.75	0.5	1	0.75	0.5	1	0.75	0.5	0.5
AV_PaidRideShare_FixedCostPerRide	5	5	5	5	5	5	5	5	5	5	5
AV_SharingEconomy_DensityCoefficientFor0Vehicles	0	0	0.001	0.002	0	0.001	0.002	0	0.001	0.002	0.002
AV_SharingEconomy_ConstantFor1Vehicle	0	0	-0.5	-1	0	-0.5	-1	0	-0.5	-1	-1
AV_SharingEconomy_ConstantFor2Vehicles	0	0	-1	-2	0	-1	-2	0	-1	-2	-2
AV_SharingEconomy_ConstantFor3Vehicles	0	0	-1	-2	0	-1	-2	0	-1	-2	-2
AV_SharingEconomy_ConstantFor4Vehicles	0	0	-1	-2	0	-1	-2	0	-1	-2	-2