



Gen3 Model Development Project

Travel Forecasting Subcommittee Meeting

January 28, 2022

IN PARTNERSHIP WITH



Metropolitan Washington
Council of Governments

Discussion Topics

- Phase 1 Model Calibration and Validation Results
- Phase 1 Sensitivity Testing Update
- Phase 2 Development Schedule





Calibration Process

Gen3 Phase 1 Model Calibration

- Phased approach to model development
 - Phase 1: prototype model that can be tested by the COG/TPB staff. Learning model.
 - Phase 2: production-use model that can be used for regional planning work
- Initial deployment and calibration efforts to inform the scope for phase 2

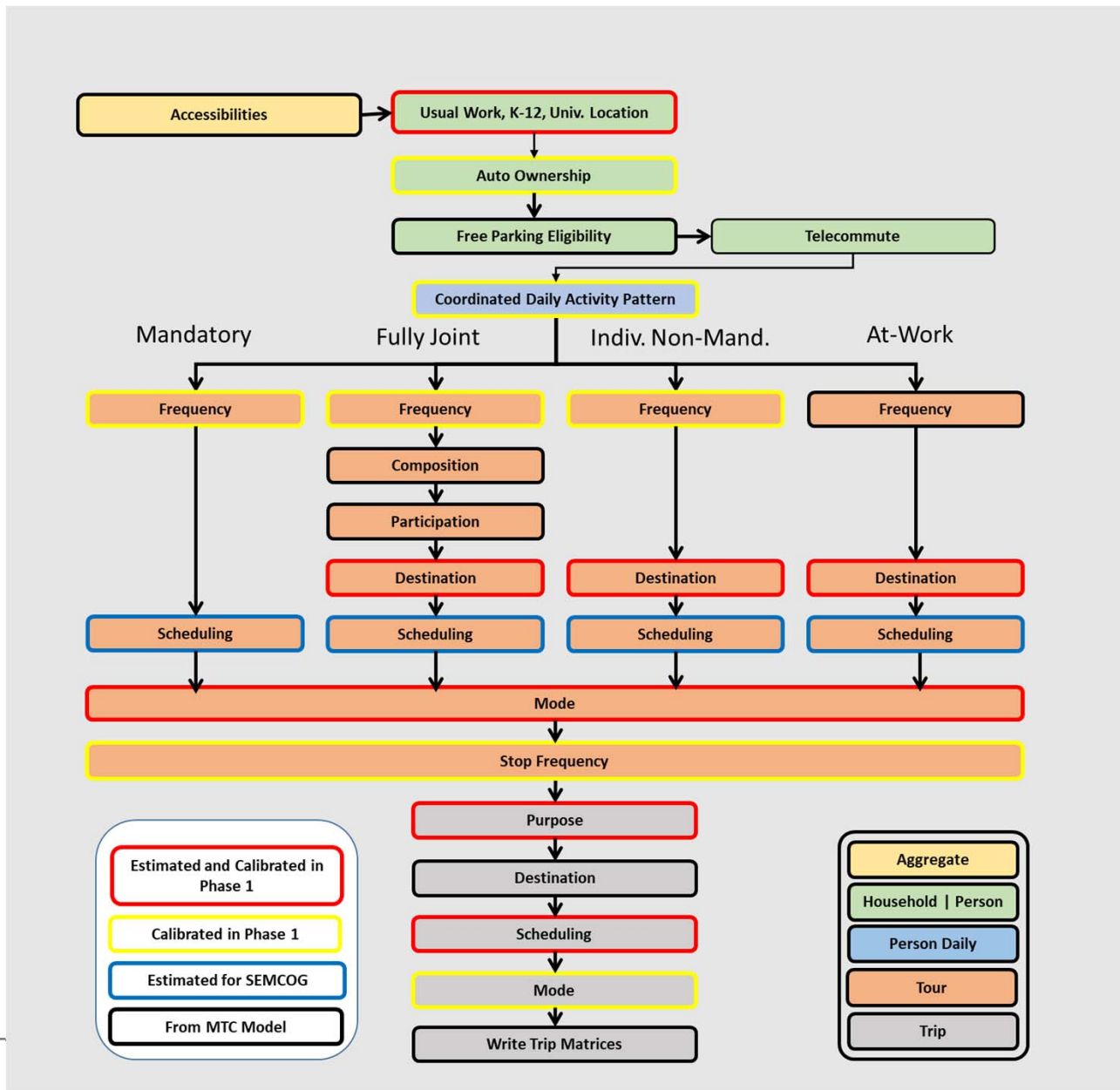


Phase 1 Activities

- Data preparation
 - Household survey (RTS/MTS) coding and expansion
 - Transit on-board survey data coding (external transit)
 - Land-use data (school enrollment, open space)
 - Traffic counts
- Synthetic population created in PopulationSim
- ActivitySim model system transferred from the Southeast Michigan Council of Governments (SEMCOG) region
 - Network skimming and assignment procedures
- Tour mode choice and tour destination choice models estimated and implemented.



Models Estimated and Calibrated in Phase 1



Models calibrated in Phase 1

- Auto ownership
 - Regional calibration, not geographic
- Coordinated daily activity pattern
- Individual non-mandatory tour frequency
 - Mandatory = work & school, non-mandatory = everything else
- Tour destination choice (slight adjustments)
- Tour mode choice
 - Aggregate transit calibration, not detailed line-haul modes
- Intermediate stop frequency
- Stop location choice
- Trip mode choice



Calibration procedure

- Compare observed distributions of a given travel attribute against the predicted outputs.
 - For example, estimated versus observed tour frequency by person type and purpose
 - The ABM Visualizer is used to make this comparison.

If model distributions do not match the target distributions:

1. Alternative-specific constant (ASC) adjustments are calculated in a spreadsheet or using a Jupyter notebook as follows for each alternative:
 - a.
$$\text{New ASC} = \text{Old ASC} + \ln\left(\frac{\text{Target Proportion}}{\text{Model Proportion}}\right)$$
2. The ActivitySim specification and coefficients file for the appropriate model is updated with the new coefficients.
3. The model is run with the updated coefficients.
4. If the model reasonably matches the observed data, stop; otherwise, go to step 1.



Current Phase 1 Status

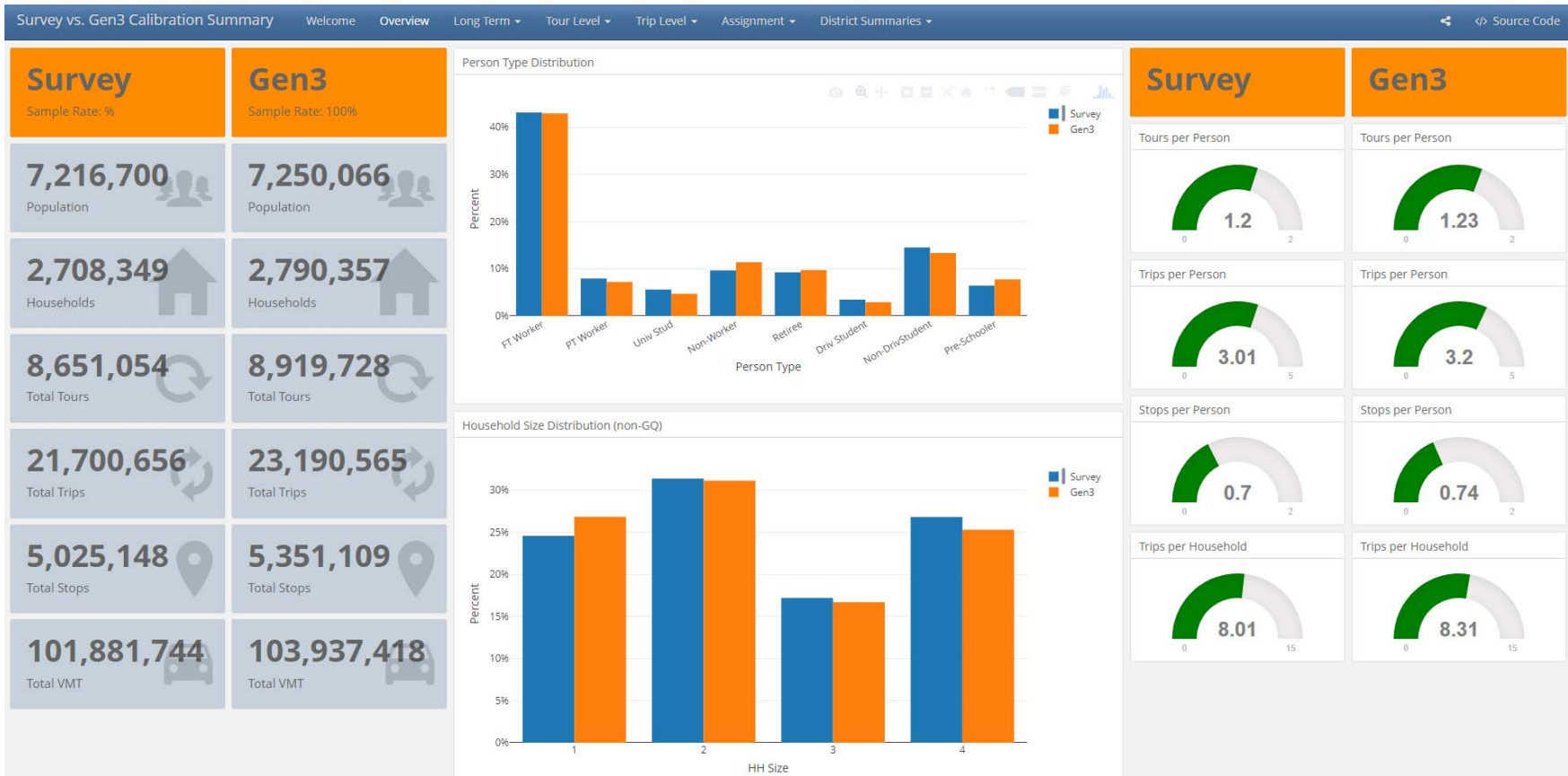
- Model calibration and validation complete
- Sensitivity testing started
- End of February deadline...then phase 2



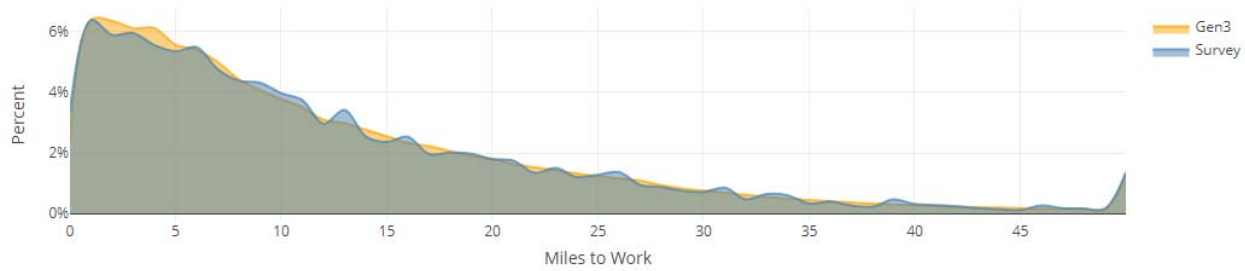


Calibration Results

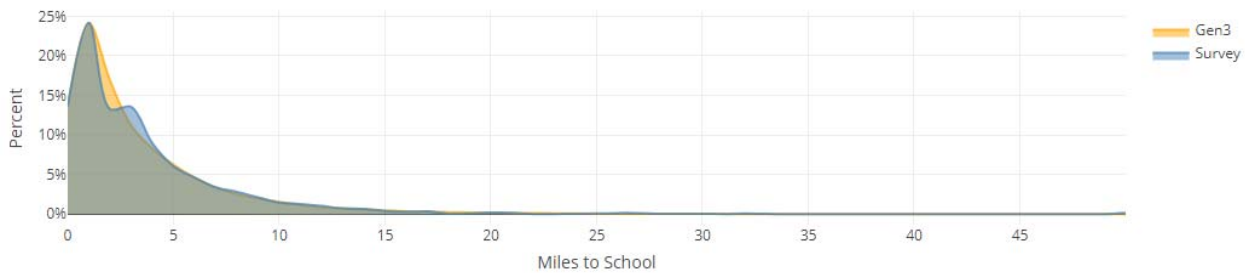
Overview Comparison to RTS/MTS Survey



Mandatory Tour Length Distributions



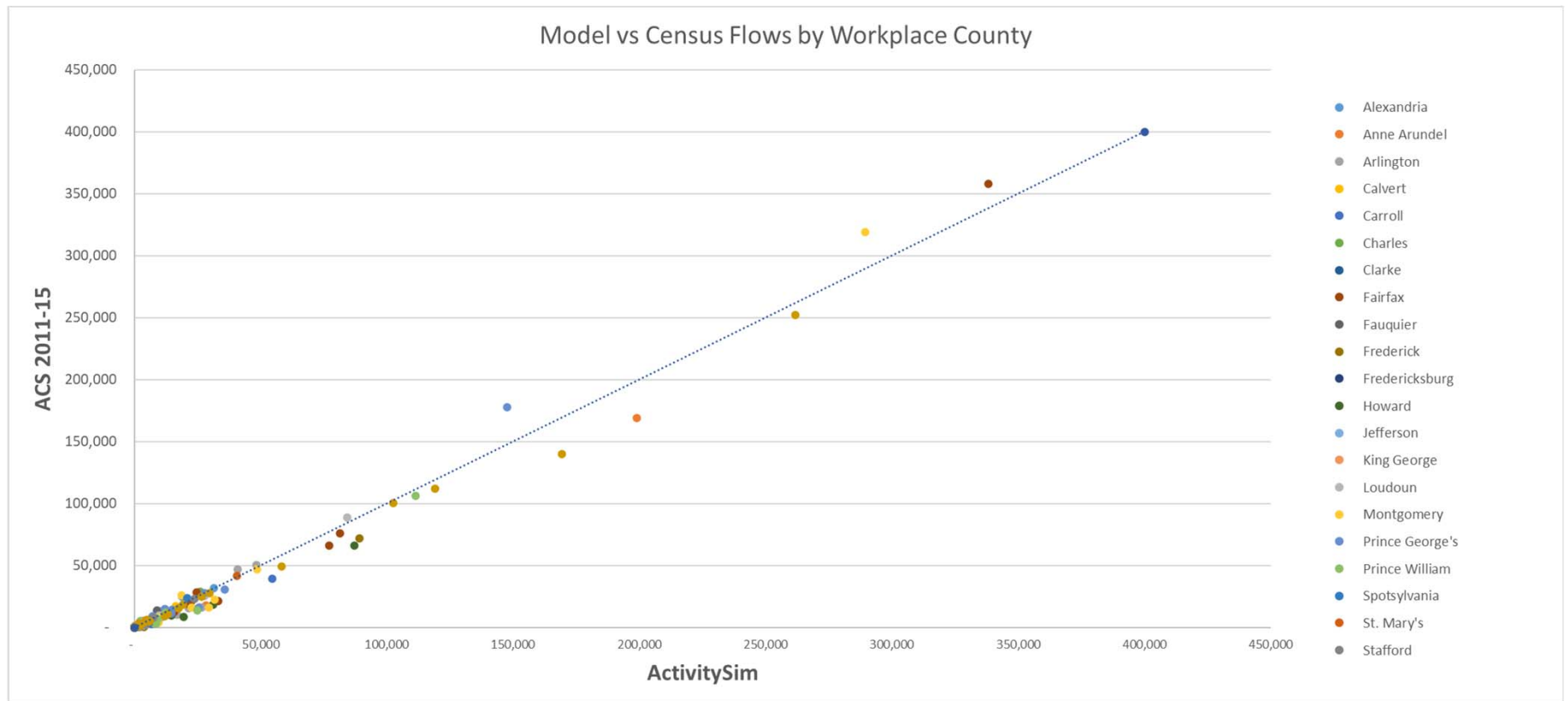
HOME TO WORK DISTANCE FREQUENCY DISTRIBUTION



HOME TO SCHOOL DISTANCE FREQUENCY DISTRIBUTION



Model Versus Census Worker Flows

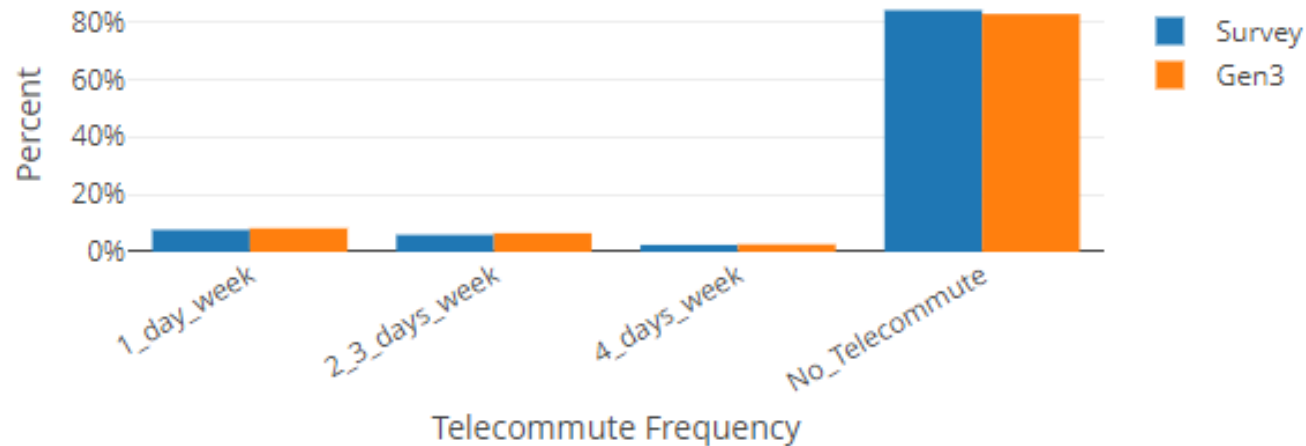


Estimated vs. Observed Home-Work Length By Residence Jurisdiction

County	Survey	Model	Difference	Percent Difference
Alexandria	8.3	8.4	0.1	2%
Anne Arundel	15.2	13.5	-1.8	-12%
Arlington	7.8	6.8	-1.0	-13%
Calvert	21.4	23.9	2.6	12%
Carroll	17.8	16.5	-1.2	-7%
Charles	21.7	22.0	0.3	1%
Clarke	27.9	29.5	1.6	6%
Fairfax	11.2	11.4	0.3	2%
Fairfax City	11.6	10.7	-0.9	-8%
Falls Church	14.2	9.4	-4.8	-34%
Fauquier	21.4	25.2	3.8	18%
Frederick	18.5	16.1	-2.5	-13%
Fredericksburg	8.9	10.2	1.4	15%
Howard	14.8	13.0	-1.9	-13%
Jefferson	21.8	23.6	1.8	8%
King George	21.1	25.9	4.8	23%
Loudoun	15.3	16.0	0.7	4%
Manassas	11.0	13.3	2.3	21%
Manassas Park	13.5	15.0	1.5	11%
Montgomery	11.5	11.8	0.3	3%
Prince George's	12.5	12.6	0.1	1%
Prince William	16.5	16.8	0.4	2%
Spotsylvania	15.2	14.9	-0.4	-2%
St Mary's	18.4	16.9	-1.5	-8%
Stafford	20.1	19.5	-0.7	-3%
Washington D.C.	5.9	5.4	-0.4	-7%
Total	12.9	12.8	-0.1	-1%



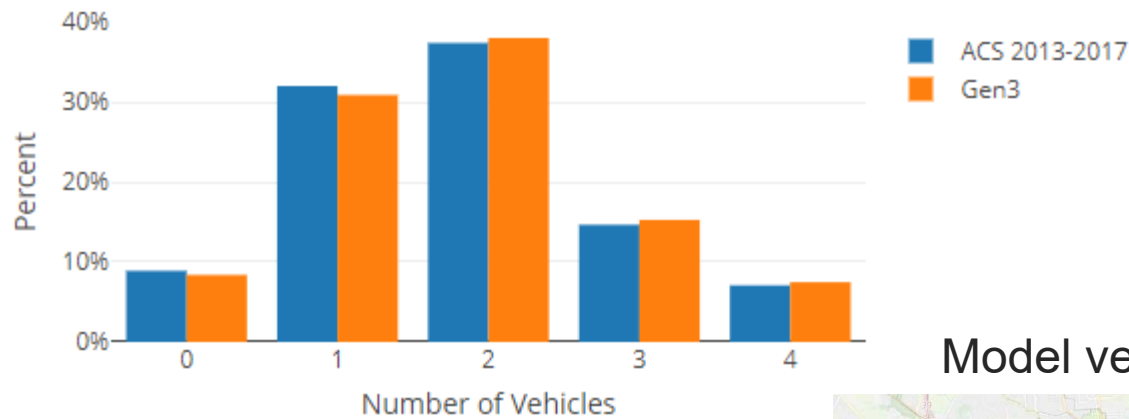
Telecommute Frequency



- Predicts number of days per week workers with regular out-of-home workplace telecommute to work
- Affects daily activity pattern, tour frequency, and stop frequency models
- Can be used to test COVID-related scenarios and will be used in sensitivity testing

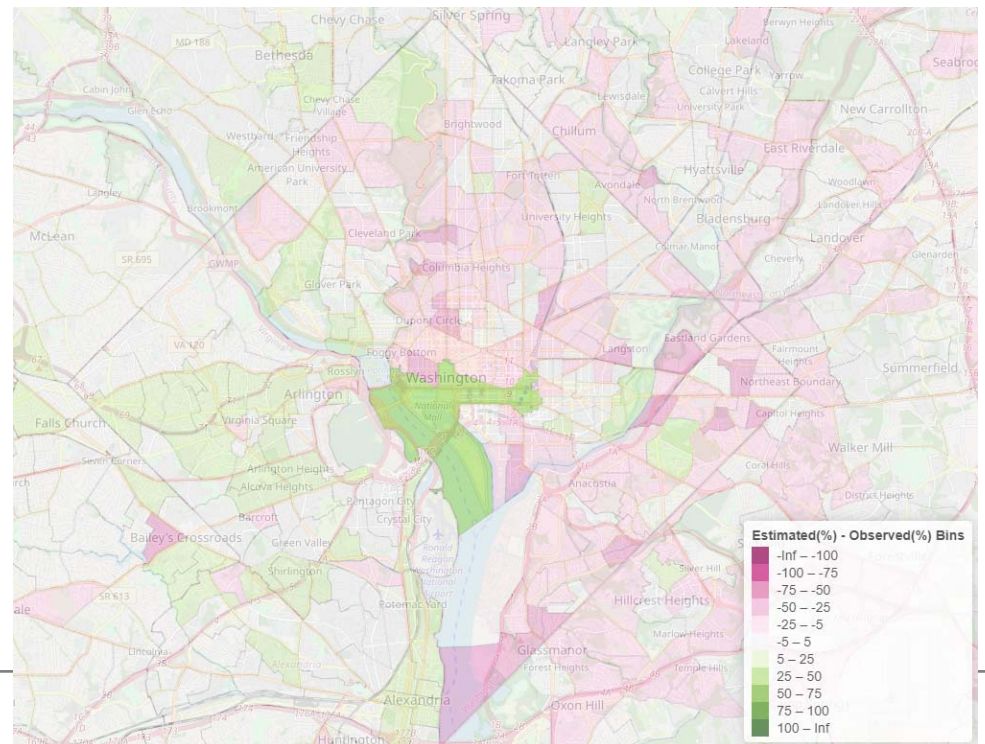


Auto ownership

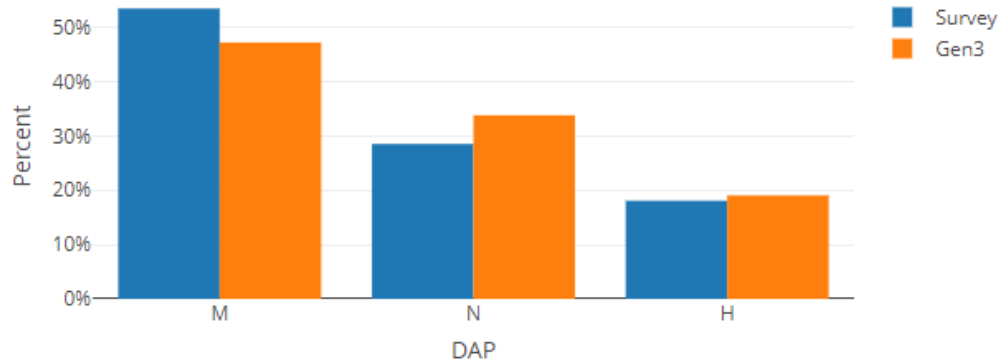


Model versus Census 0-auto households

- Calibrated regionally
- Appears to be under-predicting 0-car households in DC



Daily Activity Pattern



M = Mandatory – at least one work or school tour

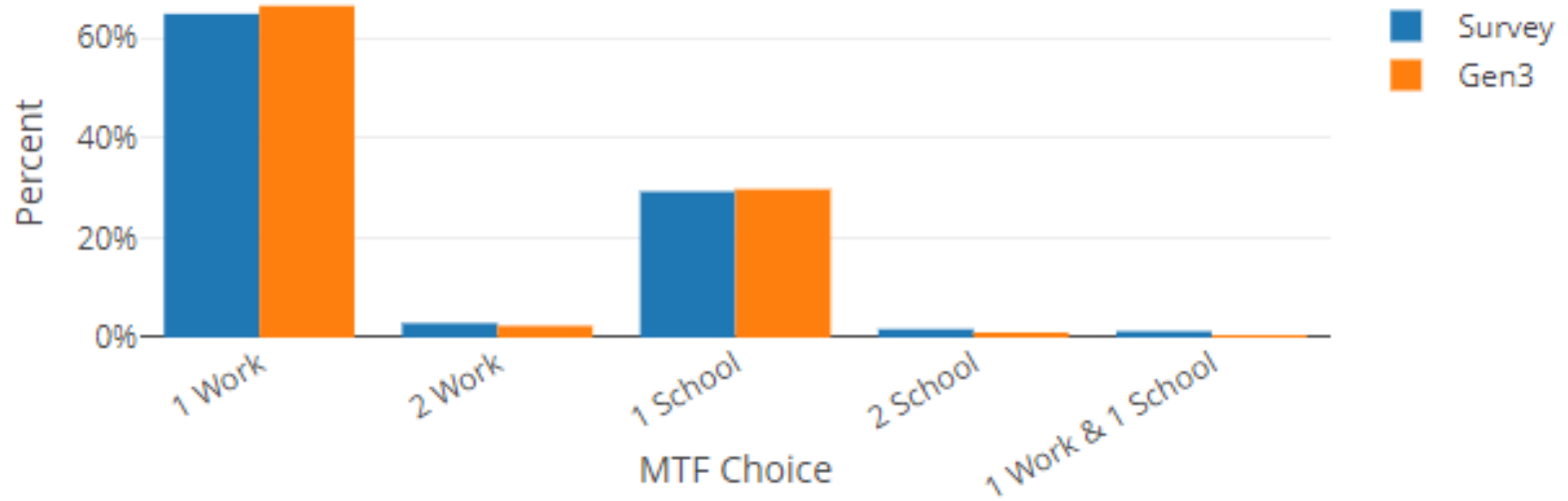
N = Non-Mandatory – no work or school, at least one non-mandatory tour

H = Home - No travel

Person Type	Day Pattern	Observed Share	Estimated Share	Difference
Full-time Worker	Mandatory	76%	69%	-7%
	Non-Mandatory	14%	18%	3%
	Home	10%	14%	4%
Part-time Worker	Mandatory	39%	35%	-4%
	Non-Mandatory	39%	42%	3%
	Home	22%	24%	2%
College/Univ Student	Mandatory	54%	64%	10%
	Non-Mandatory	21%	25%	4%
	Home	25%	11%	-14%
Non-Working Adult	Mandatory	0%	0%	0%
	Non-Mandatory	64%	66%	1%
	Home	36%	34%	-1%
Retiree	Mandatory	0%	0%	0%
	Non-Mandatory	69%	69%	0%
	Home	31%	31%	0%
Driving-Age Student	Mandatory	73%	73%	1%
	Non-Mandatory	11%	12%	1%
	Home	16%	15%	-1%
Non-Driving Student	Mandatory	76%	73%	-3%
	Non-Mandatory	11%	14%	3%
	Home	13%	13%	-1%
Pre-School	Mandatory	18%	4%	-15%
	Non-Mandatory	55%	73%	17%
	Home	27%	24%	-3%
Total	Mandatory	53%	47%	-6%
	Non-Mandatory	29%	34%	5%
	Home	18%	19%	1%



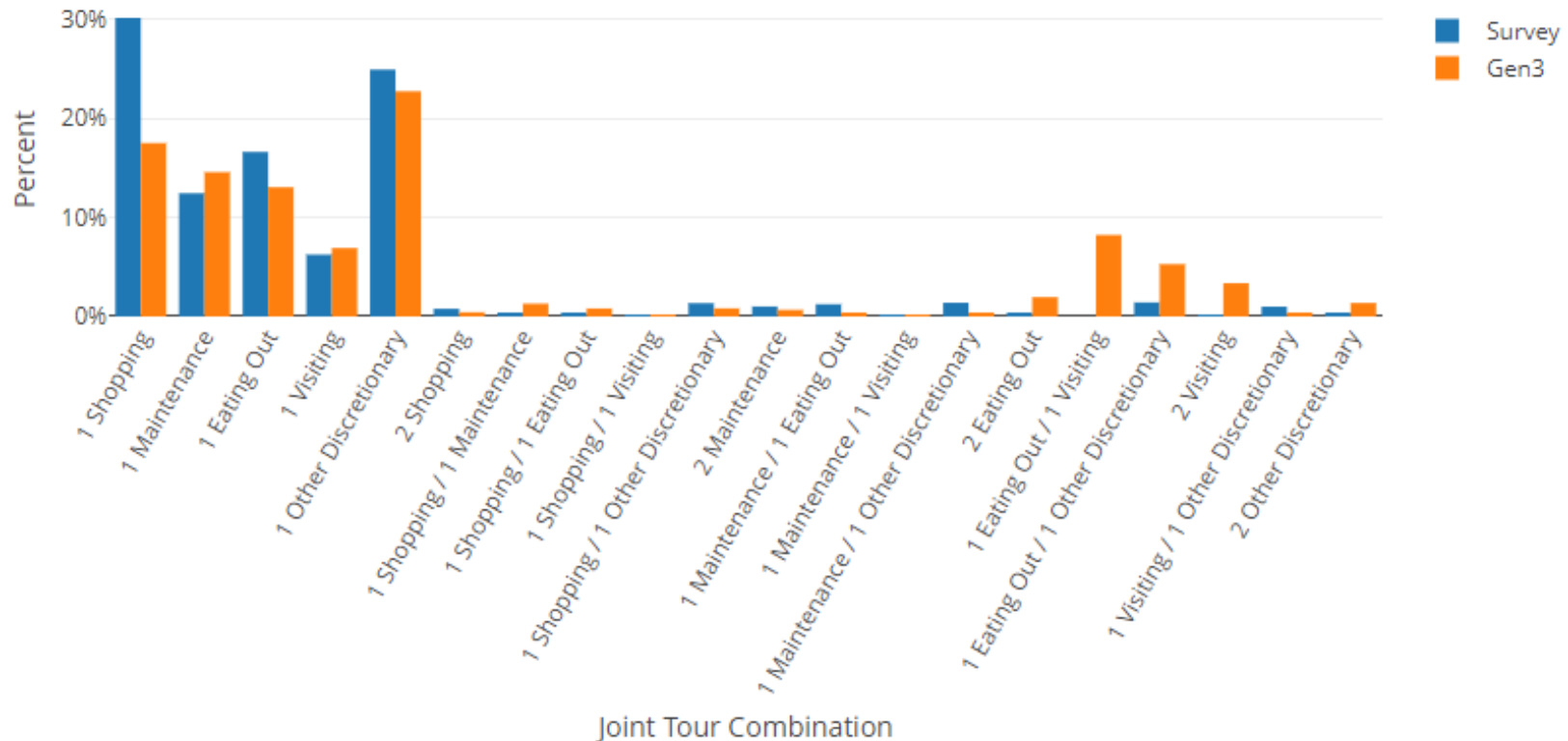
Mandatory Tour Frequency



Predicts exact number of mandatory (work and school) tours



Fully Joint Tours

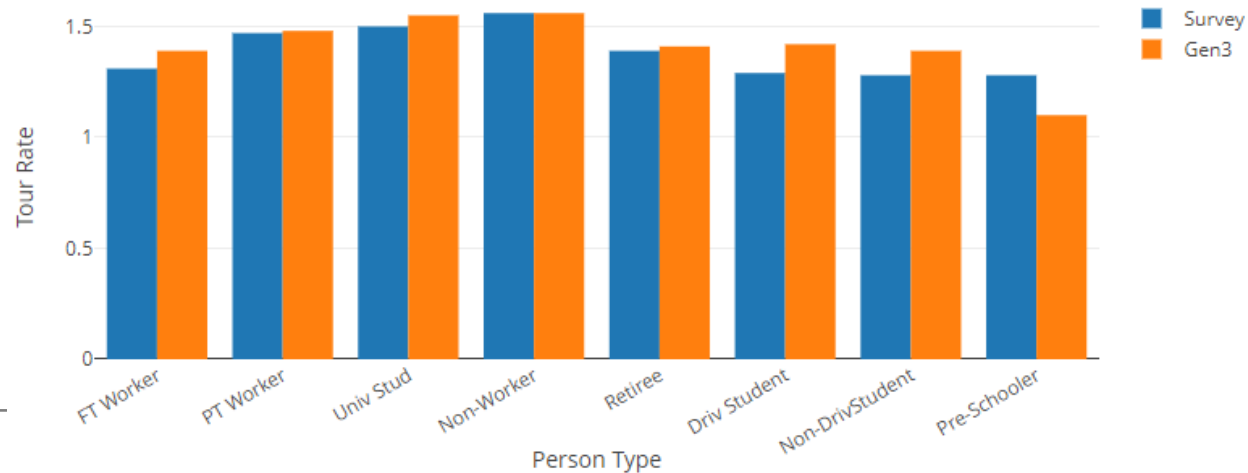
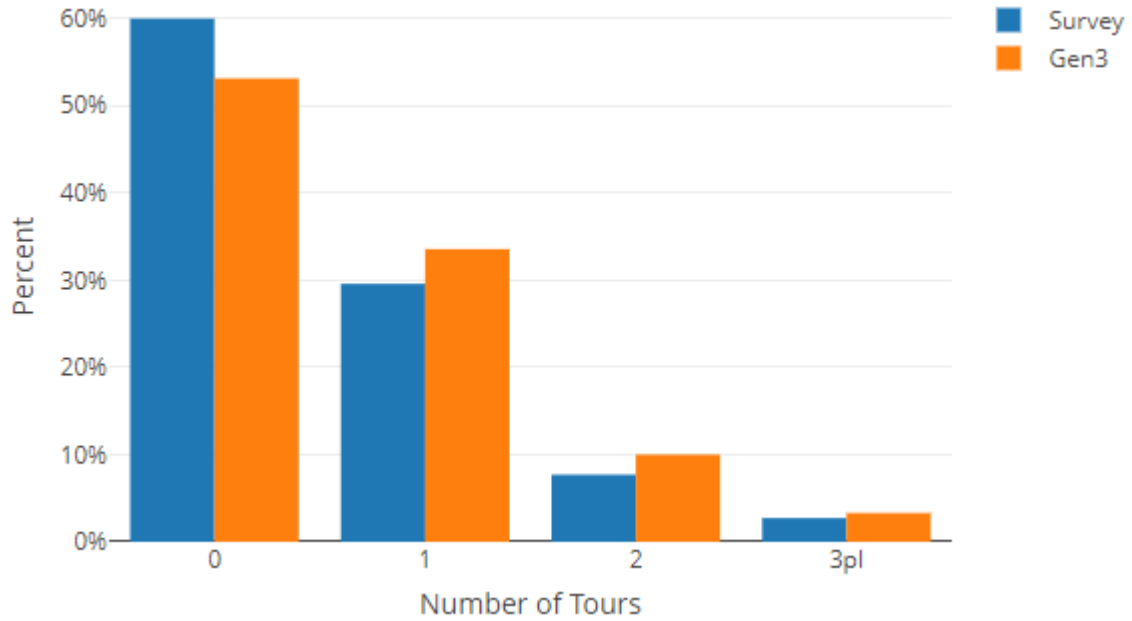


Fully joint tours: Tours where at least two household members travel together for the entire tour

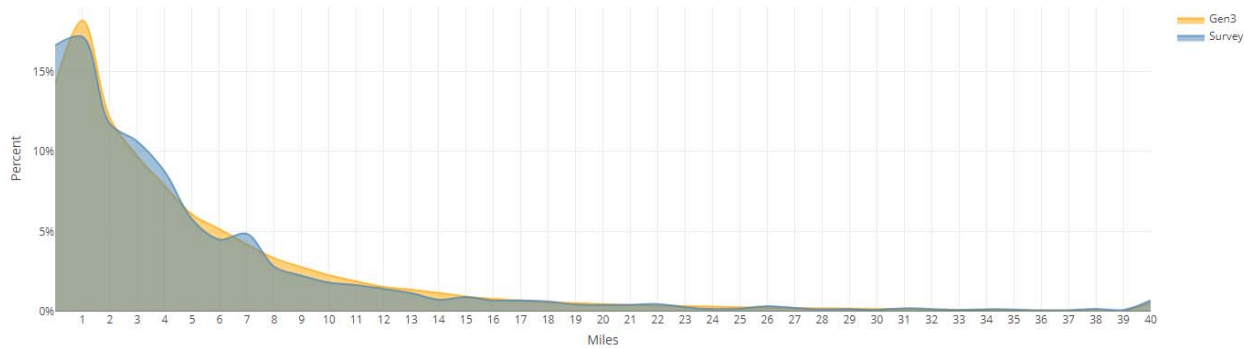
Not calibrated: Not enough shopping tours, too many households with 2 joint tours; will calibrate further in Phase 2



Individual Non-Mandatory Tours, Total Tours



Non-Mandatory Destination Choice

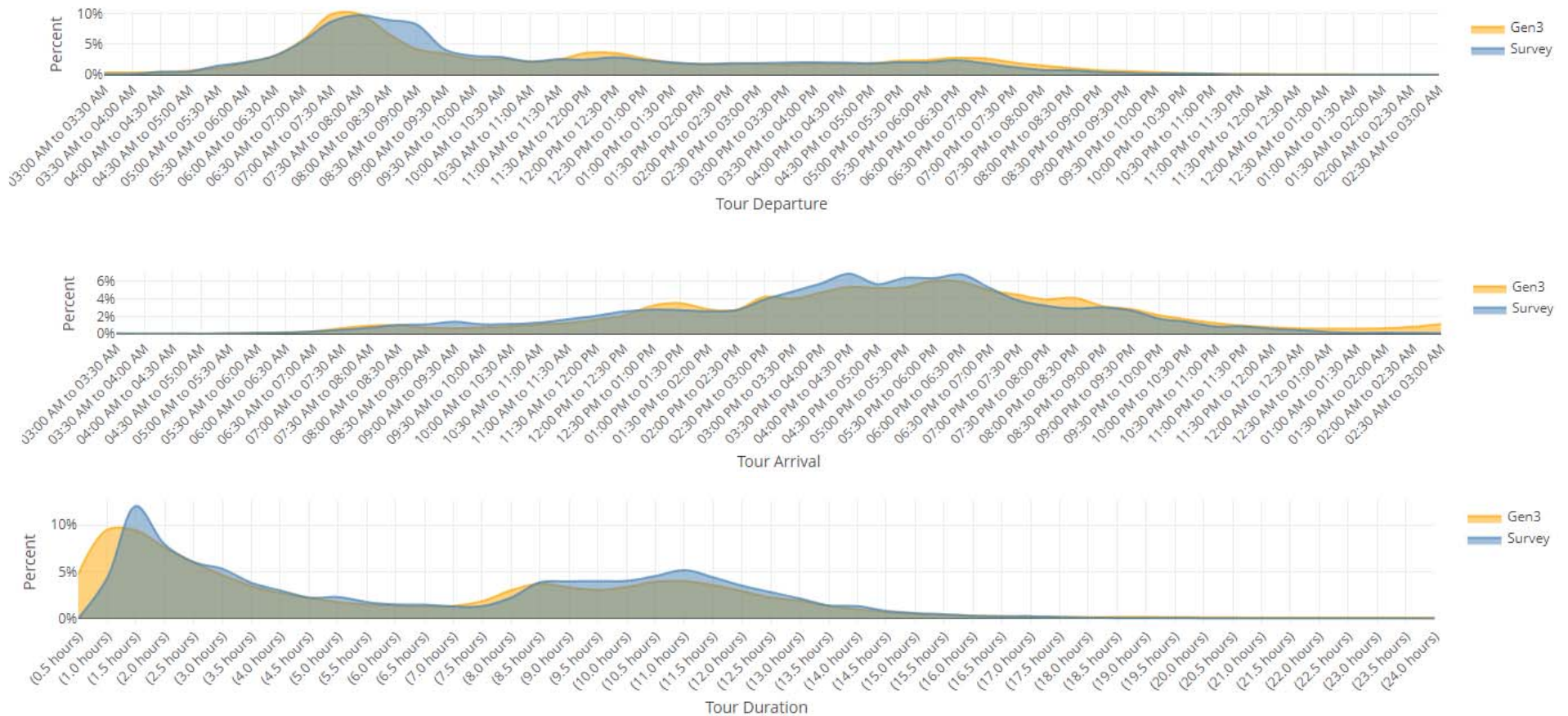


There are separate models by purpose (shopping, eating out, etc.)

Purpose	Observed	Estimated	Difference	Percent Difference
Escorting	4.2	4.2	0.0	-1.0%
Individual Maintenance	5.6	5.6	0.0	-0.7%
Individual Discretionary	6.4	6.0	-0.4	-6.2%
Joint Maintenance	6.8	7.1	0.3	4.1%
Joint Discretionary	7.0	7.2	0.2	3.1%
At-work Subtours	5.4	5.0	-0.4	-7.2%
Total	5.7	5.8	0.1	2.1%



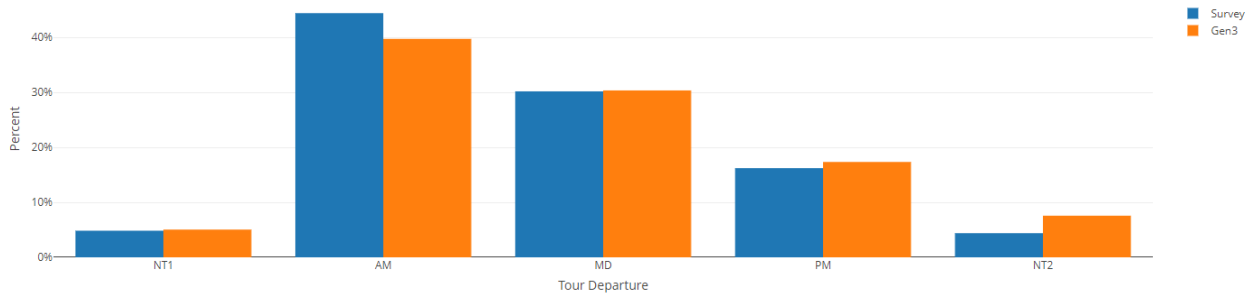
Tour Scheduling – All Tours



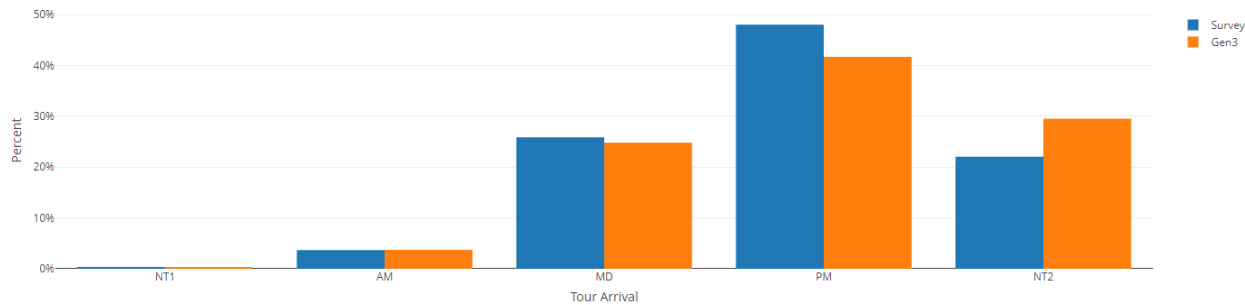
Models applied by purpose; some purposes need adjustment in Phase 2



Tour Scheduling – All Tours



Tour Departure (Aggregate Time Periods, all Purposes)

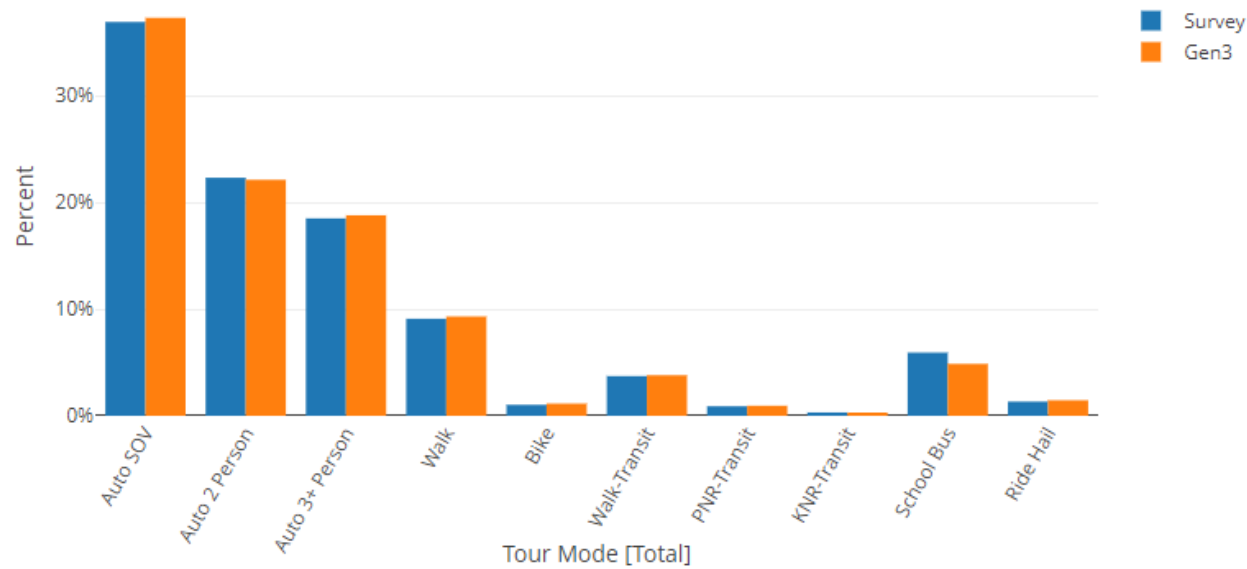


Tour Arrival (Aggregate Time Periods, all Purposes)

Too many tours in NT2 period (7 PM to 3 AM), not enough in AM peak



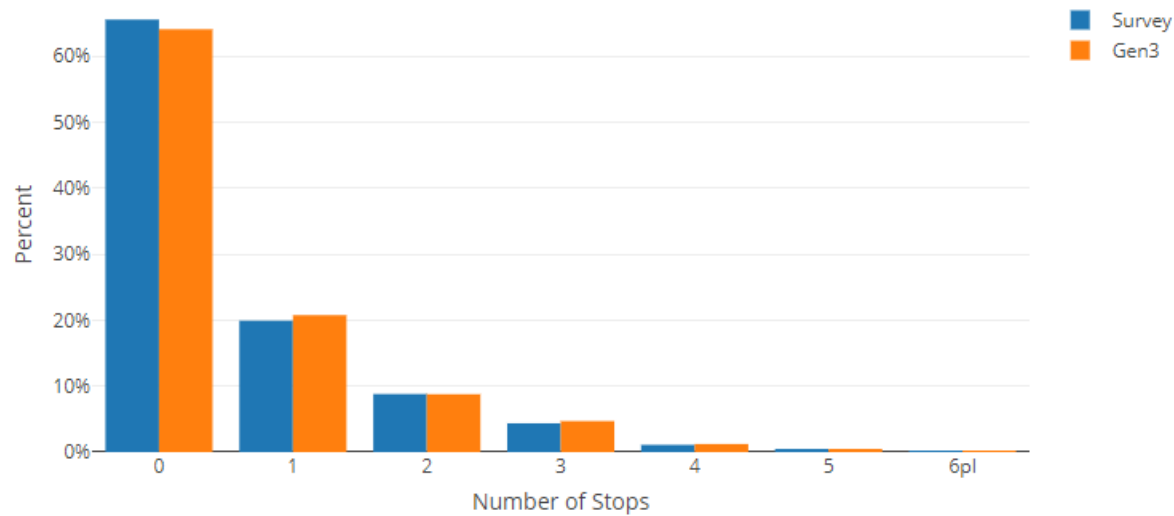
Tour Mode Choice



Predicts the primary mode for the tour based on round-trip level of service, household, person, land-use, and tour variables



Intermediate Stop Frequency

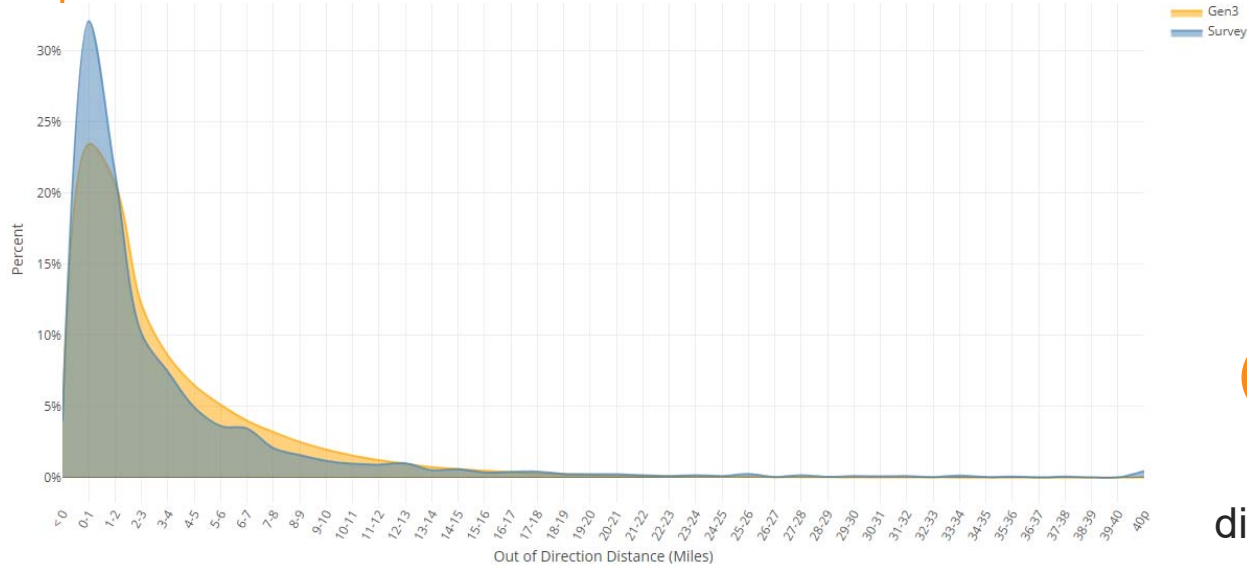


Intermediate stops = stops that occur on the way from the tour origin to the primary destination, or on the way back.

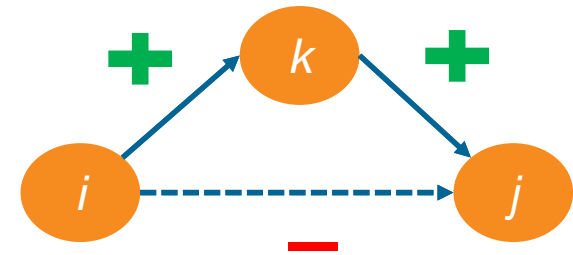
Around 35% of tours have intermediate stops



Intermediate Stop Location



Out-of-direction distance



$$\text{distance}_{ik} + \text{distance}_{kj} - \text{distance}_{ij}$$

where:

i = origin

j = destination

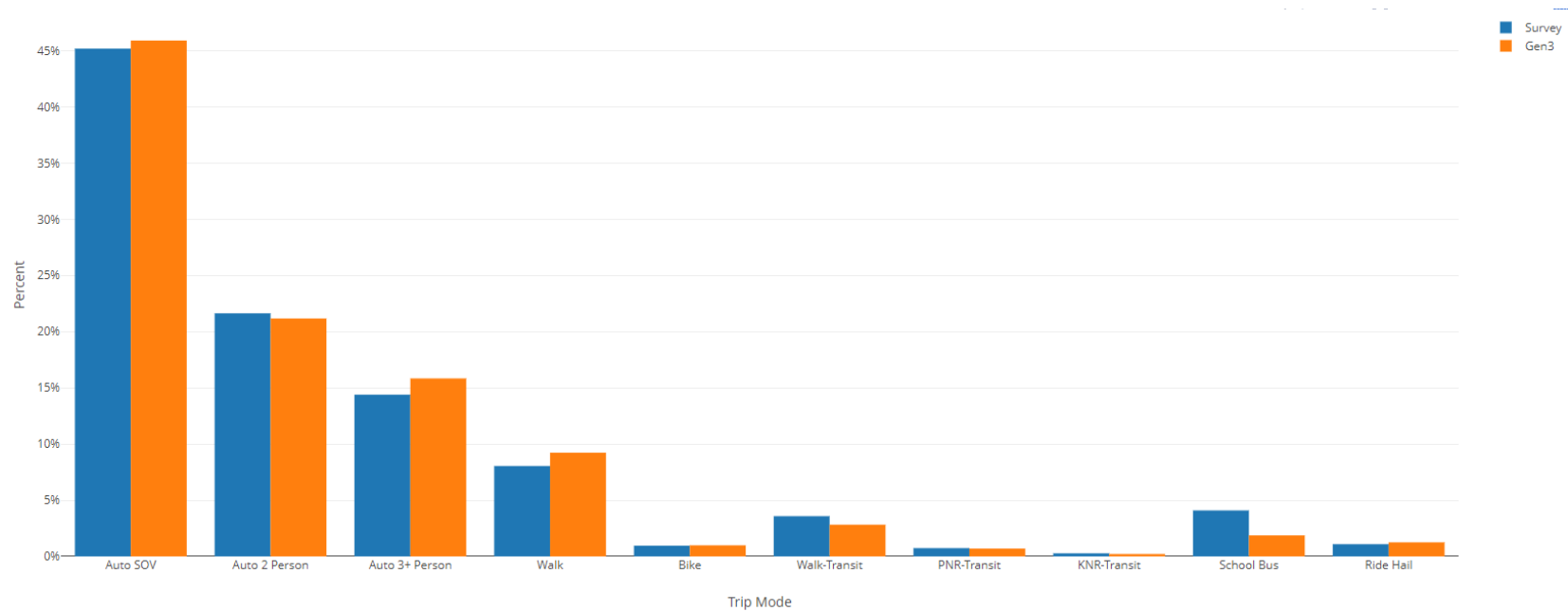
k = stop location

Purpose	Observed	Estimated	Difference	Percent Difference
Work	3.4	3.5	0.0	1.5%
University	4.3	3.7	-0.6	-14.8%
School	4.4	3.6	-0.9	-19.3%
Escorting	3.3	3.6	0.2	6.6%
Individual Maintenance	3.2	3.5	0.4	11.4%
Individual Discretionary	3.4	3.6	0.2	5.3%
Joint Maintenance	3.2	3.7	0.5	15.9%
Joint Discretionary	3.4	3.6	0.2	6.0%
At-Work Subtours	2.1	2.2	0.1	4.7%
Total	3.2	3.5	0.3	7.7%



Estimated out-direction distance somewhat long compared to survey

Trip Mode (Switching) Choice



- Model reflects mode switching on tours; primary mode controls what modes are available.
- Calibrated by tour purpose and tour mode



Trip Mode Choice: Auto Tours

TOUR MODE	SOV		Shared ride2		Shared ride 3	
	Model (%)	Survey (%)	Model (%)	Survey (%)	Model (%)	Survey (%)
SOV	100%	100%	27%	27%	12%	11%
Shared ride2	0%	0%	72%	73%	18%	19%
Shared ride 3	0%	0%	0%	0%	69%	70%
Walk	0%	0%	1%	0%	0%	0%
Bike	0%	0%	0%	0%	0%	0%
Walk transit	0%	0%	0%	0%	0%	0%
PNR transit	0%	0%	0%	0%	0%	0%
KNR transit	0%	0%	0%	0%	0%	0%
School bus	0%	0%	0%	0%	0%	0%
TNC single	0%	0%	0%	0%	0%	0%
TNC shared	0%	0%	0%	0%	0%	0%
Taxi	0%	0%	0%	0%	0%	0%

Mixing of auto trips by occupancy on tours reflects pickups and drop-offs: tour mode set based on maximum occupancy.

Note: No mode mixing on walk (all-the-way) and bike (all-the-way) tours



Trip Mode Choice: Transit Tours

TOUR MODE	Walk-Transit		PNR-Transit		KNR-Transit	
TRIP MODE	Model (%)	Survey (%)	Model (%)	Survey (%)	Model (%)	Survey (%)
SOV	0%	0%	0%	0%	0%	0%
Shared ride2	3%	3%	0%	0%	0%	0%
Shared ride 3	1%	1%	0%	0%	0%	0%
Walk	16%	13%	0%	0%	0%	0%
Bike	0%	0%	0%	0%	0%	0%
Walk transit	79%	80%	0%	0%	0%	0%
PNR transit	0%	0%	96%	91%	0%	0%
KNR transit	0%	0%	0%	7%	99%	95%
School bus	0%	0%	0%	0%	0%	0%
TNC single	0%	2%	1%	1%	0%	4%
TNC shared	0%	0%	2%	0%	1%	0%
Taxi	0%	1%	1%	1%	0%	0%

- Shared-ride and walking allowed on walk-transit tours. Significant shares of walking combined with transit on same tour.
- Intermediate stops currently prohibited on drive-transit tours in ActivitySim, ensuring symmetry in use of auto on outbound and return leg of tour



Trip Mode Choice: School bus and ride-hail

TOUR MODE	School Bus		Ride-Hail	
TRIP MODE	Model (%)	Survey (%)	Model (%)	Survey (%)
SOV	0%	0%	0%	0%
Shared ride2	16%	10%	7%	5%
Shared ride 3	17%	11%	10%	3%
Walk	3%	2%	3%	12%
Bike	0%	0%	0%	0%
Walk transit	0%	0%	0%	0%
PNR transit	0%	0%	0%	0%
KNR transit	0%	0%	0%	0%
School bus	64%	77%	0%	0%
TNC single	0%	0%	26%	37%
TNC shared	0%	0%	0%	6%
Taxi	0%	0%	55%	37%

- Significant mixing of shared-ride and school bus on same tour (kids get dropped off in morning, take bus on the way back home, etc.)
- Also mixing of walk and carpooling on tours with at least one Taxi or TNC trip





Validation Results

Traffic count ratio by Area Type

Gen3 Phase 1

Estimate/Observed Ratio								
Area Type	Facility Type							TOTAL
	Freeway	Major Arterial	Minor Arterial	Collector	Expressway	Ramp		
1	1.03	1.47	1.36	1.45	1.17	-	1.33	
2	1.00	1.12	1.09	1.03	1.01	-	1.07	
3	1.00	1.00	0.95	0.77	0.92	-	0.97	
4	1.09	1.14	1.01	0.89	1.03	-	1.06	
5	1.07	1.13	1.06	0.86	1.10	0.73	1.07	
6	1.19	1.15	1.46	0.92	1.01	-	1.23	
TOTAL	1.04	1.15	1.11	0.94	1.02	0.73	1.08	

Ver.2.4

Estimate/Observed Ratio								
Area Type	Facility Type							TOTAL
	Freeway	Major Arterial	Minor Arterial	Collector	Expressway	Ramp		
1	0.95	1.12	1.01	0.95	0.97	-	1.04	
2	1.01	1.01	0.97	0.84	0.88	-	0.98	
3	1.02	0.97	0.92	0.70	0.86	-	0.96	
4	1.09	1.10	0.97	0.80	0.99	-	1.03	
5	1.04	1.12	1.03	0.78	1.02	0.97	1.04	
6	1.22	1.21	1.36	0.86	0.96	-	1.23	
TOTAL	1.04	1.06	1.02	0.80	0.92	0.97	1.02	

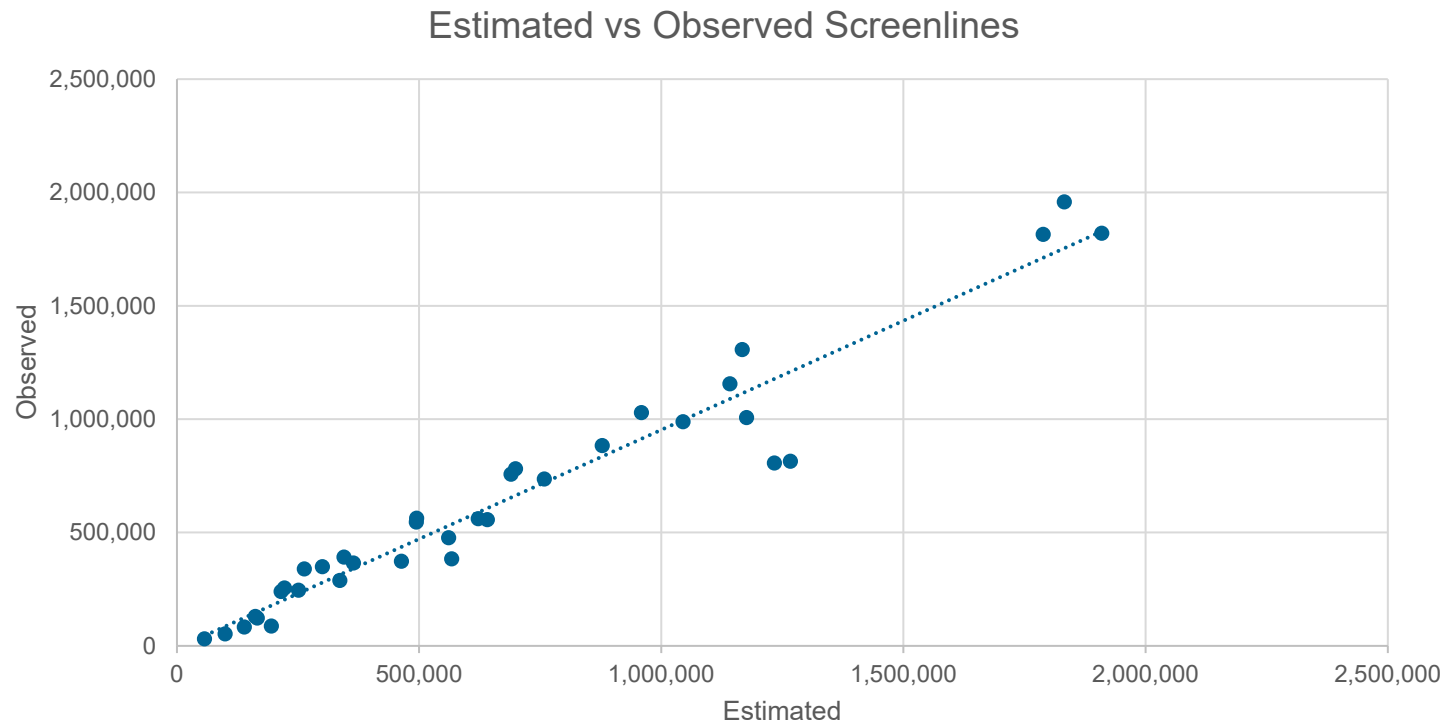
Gen3 Phase 1 over-estimates counts by 8%, correlated with tour/stop over-estimate.

Collectors and expressways better estimated. Arterials over-estimated.

CBD significantly over-estimated compared to v2.4

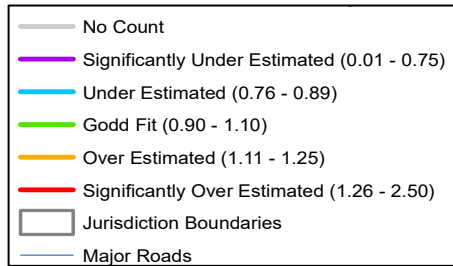
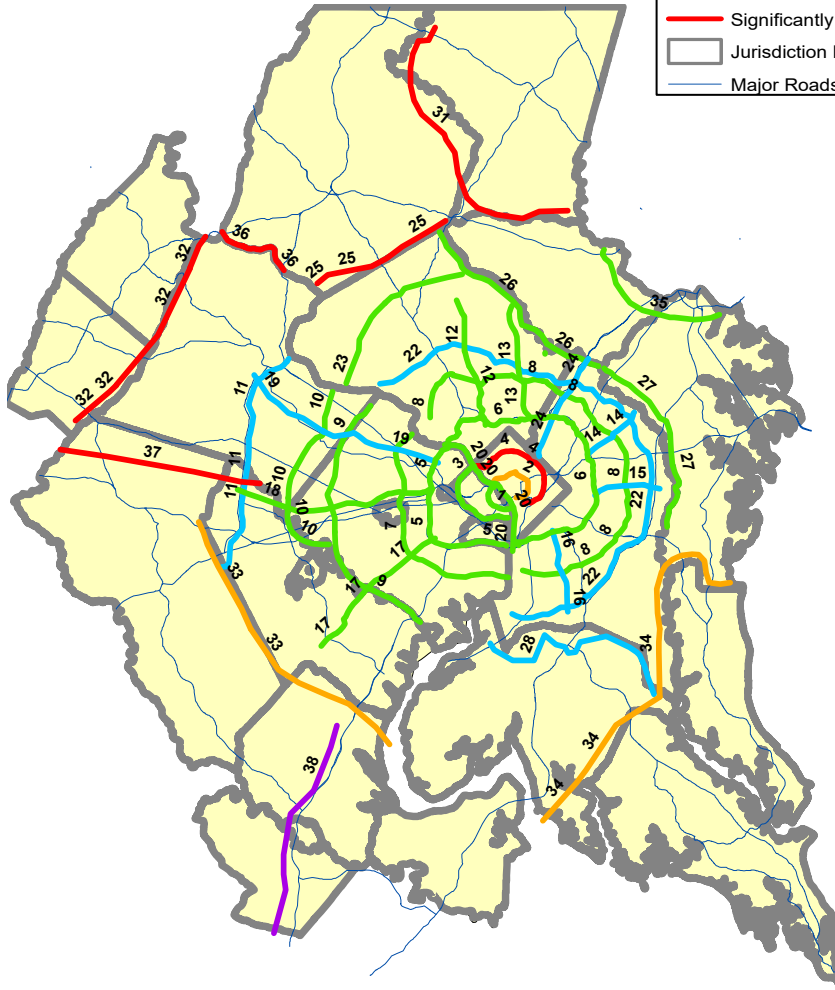


Screenlines

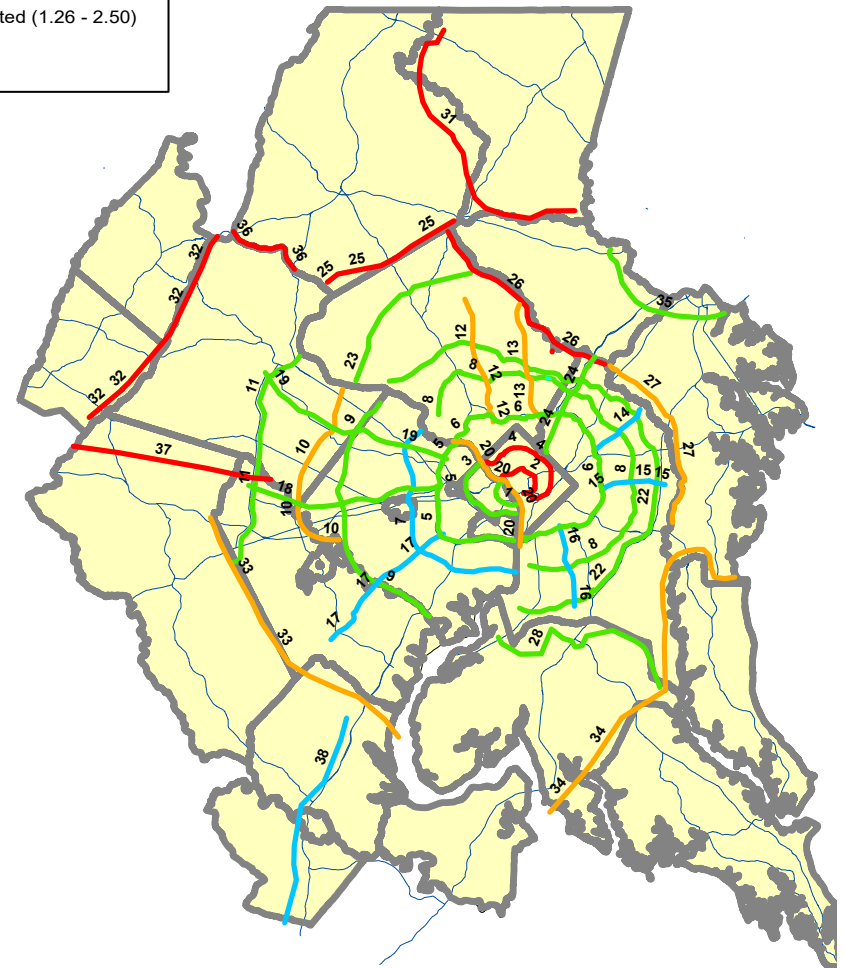


Screenlines

Ver.2.4



Gen3 Phase 1



Similar trend; Gen3 has greater over-estimate in DC;
district level constants may be necessary



Transit Validation – Mode Boarding Summary

Mode	Mode Name	Gen 3 Phase 1	2018 Observed Boardings	Ratio E/O for Boardings
1	Local Metrobus	319,049	381,637	0.84
2	Express Metrobus	21,319	23,472	0.91
3	Metrorail	561,049	605,909	0.93
4	Commuter Rail	44,565	57,989	0.77
6	Other Local Bus in the WMATA Area	154,216	150,554	1.02
7	Other Express Bus in the WMATA Area	1,831	3,583	0.51
8	Other Local Bus beyond the WMATA Area	27,736	5,500	5.04
9	Other Express Bus beyond the WMATA Area	22,767	21,438	1.06
10	Bus Rapid Transit and Streetcar	0		n/a
1, 2, 6, 7, 8, and 9	All Bus	546,917	586,184	0.93
	All Modes	1,152,532	1,250,082	0.92

Does not include intra-station transfers



Transit Validation – Metrorail Boarding Summary

Station Group Name	Gen3 Phase 1	2018 Observed Station Entries	Ratio E/O
Total Red Line Ridership	222,492	239,246	0.93
Total Green Line Ridership	95,199	111,805	0.85
Total Blue/Yellow Line Ridership	55,153	69,952	0.79
Total Orange/Blue Line Ridership	175,690	169,687	1.04
Total Silver Line Ridership	12,515	15,219	0.82
Grand Total	561,049	605,909	0.93





Recommendations for Phase 2

Recommendations for Phase 2

- Auto ownership (re-estimation and) calibration
- Further calibration of tour\stop frequency
- District level summaries for non-work travel
- Mode choice calibration
 - Mode specific constants
 - District summaries
 - Transit trip lengths (especially commuter rail)
- Highway validation
 - Focus on screenlines, particularly over-estimates on D.C. and outlying screenlines



Other items for Phase 2

- Estimation of subset of models
- Sensitivity testing
- Documentation
- Training





the science of *insight*



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