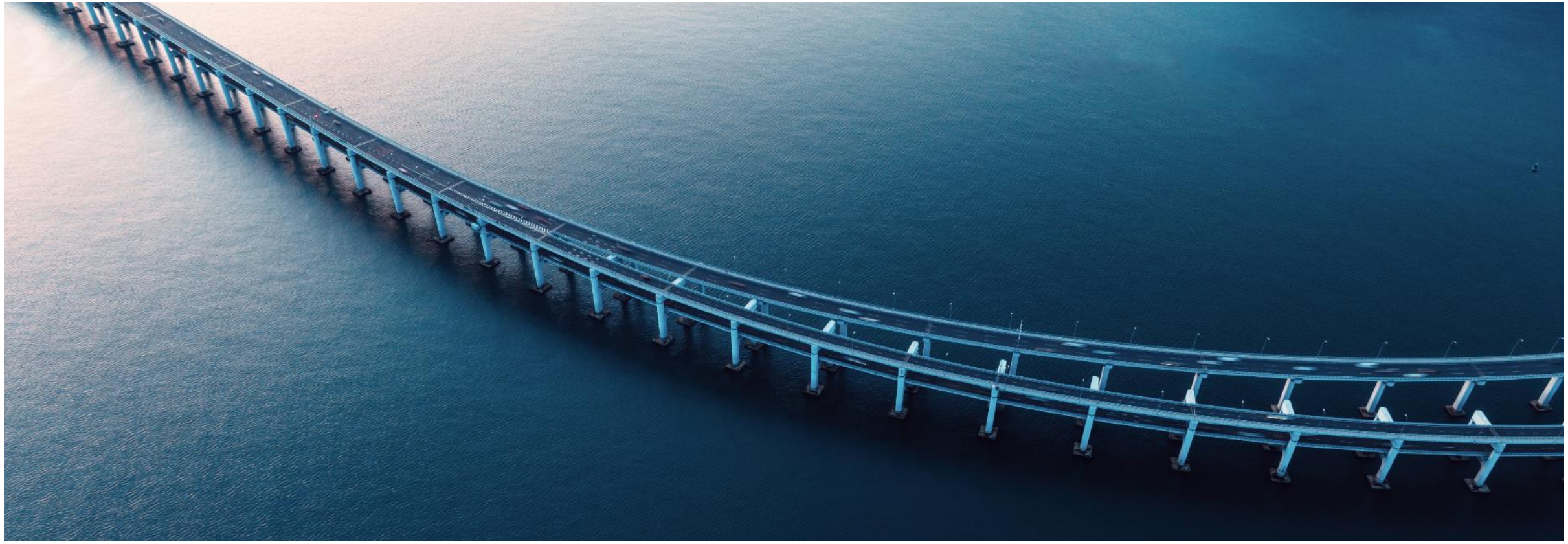
Accelerating DTA for Large-Scale Applications with a Multiresolution Approach

Modeling Mobility 2025



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Multi-resolution vs. Multi-model

Multi-resolution – common usage today:

- Combination of *different types* of models, i.e. macro, meso, *and* micro
- These are more aptly defined as **multi-model**, rather than multi-resolution

Multi-resolution – traditional usage:

- *Single type* of model (macro, meso, *or* micro) that can be mathematically solved (computed) at different levels of resolution
- Lower resolution: model outputs are less precise but run time is faster
- Higher resolution: more precise but with higher run times

Multi-resolution – example:

- Traffic micro-simulation models can be run at 0.1 or 1.0 s resolution

Multi-resolution – advantages:

- Underlying properties are the same at different resolution: e.g. level of congestion for a given demand
- Avoids undesirable / systematic bias that is common in multi-model approach

Methodology: demand sampling and simulation scaling

Demand Sampling

- Simulation model is fed with only a fraction of the total demand
- Commonly done in activity-based demand modeling to reduce run time
- For fixed-demand DTA: demand matrices are bucket-rounded

Simulation Scaling

- Simulation parameters are scaled so that model outputs approximate those obtained with a regular simulation run with 100% demand
- Scaling applies to *all components* of the simulation: car following, lane changing, gap acceptance, etc...

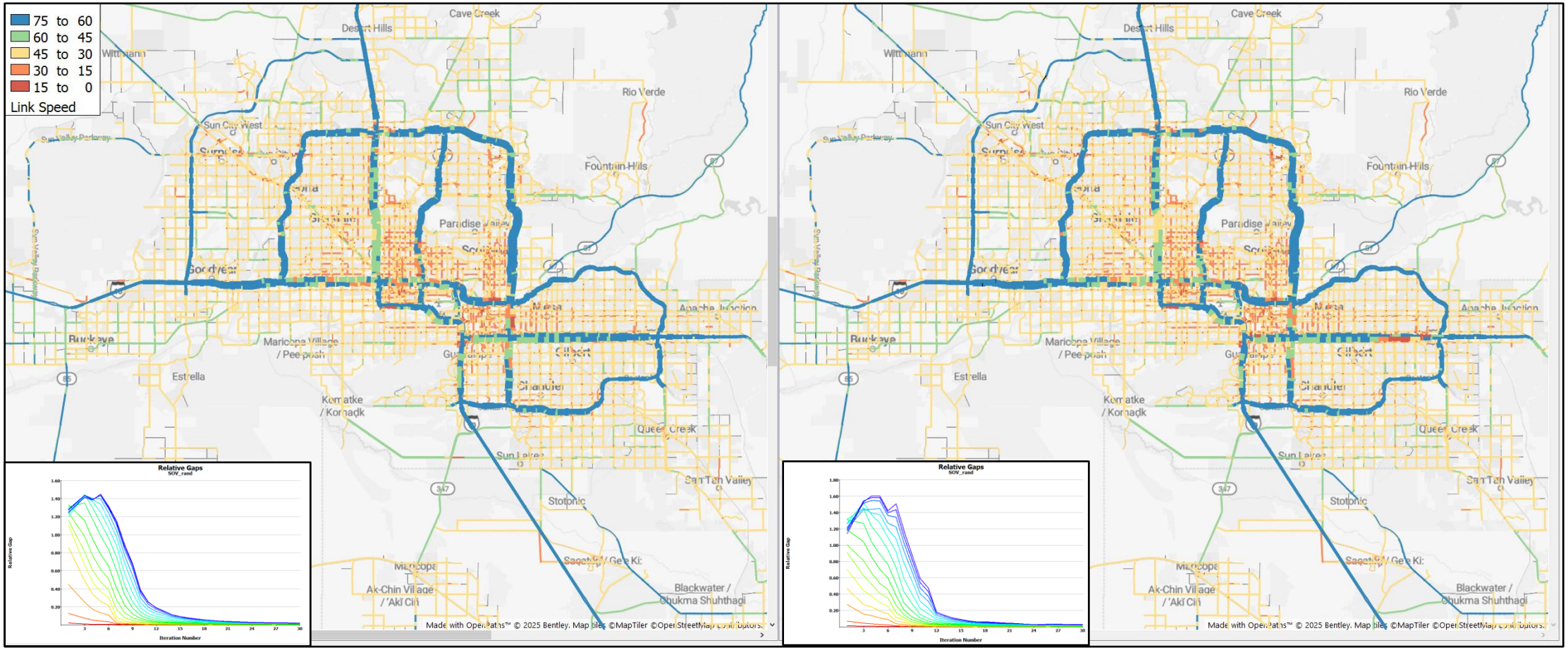
Advantages

- Simulation run time is largely determined by demand
- Lower resolution (lower sampling) can yield dramatic reduction in run time

Example: Flows and Speeds (peak hour)

100% Sample

20% Sample

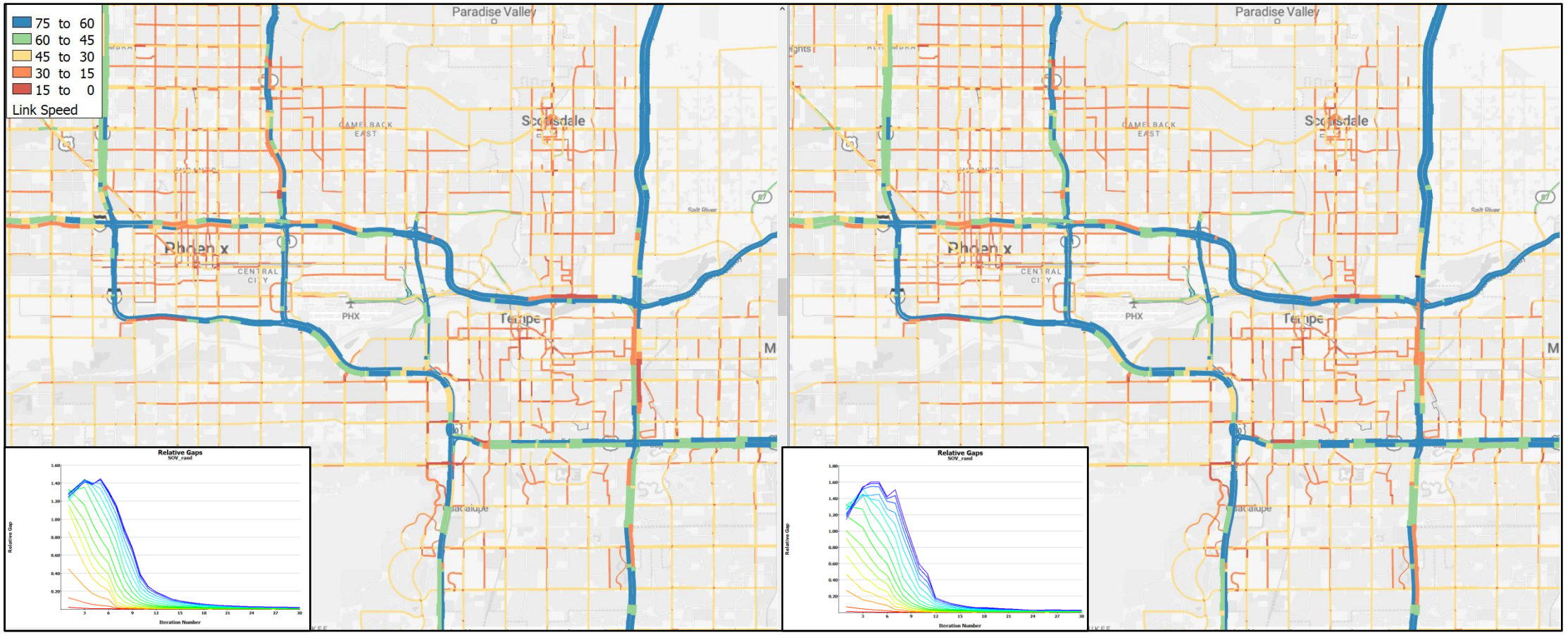


- Low resolution model runs provide very similar results compared to high resolution but at a fraction of the run time!

Example: Flows and Speeds (peak hour): Zoomed

100% Sample

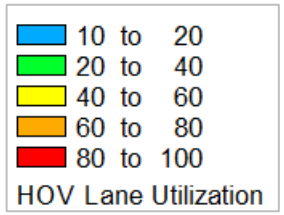
20% Sample

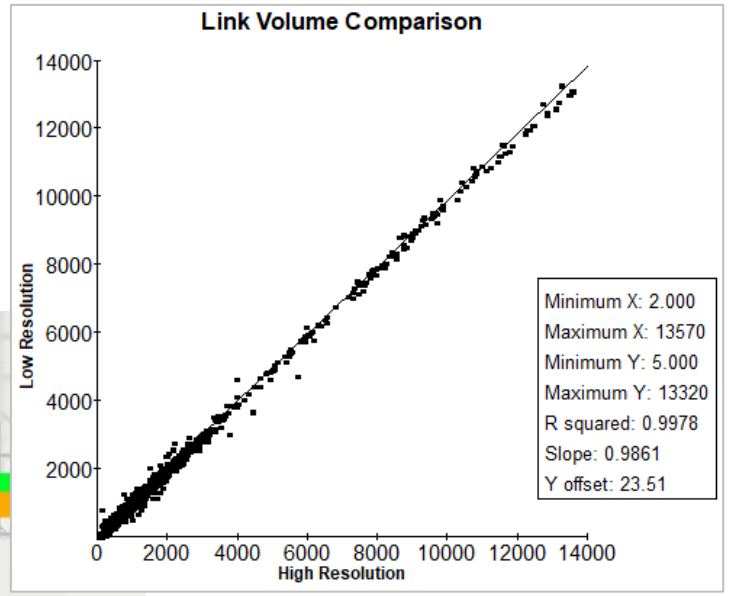


- Low resolution model runs provide very similar results compared to high resolution but at a fraction of the run time!

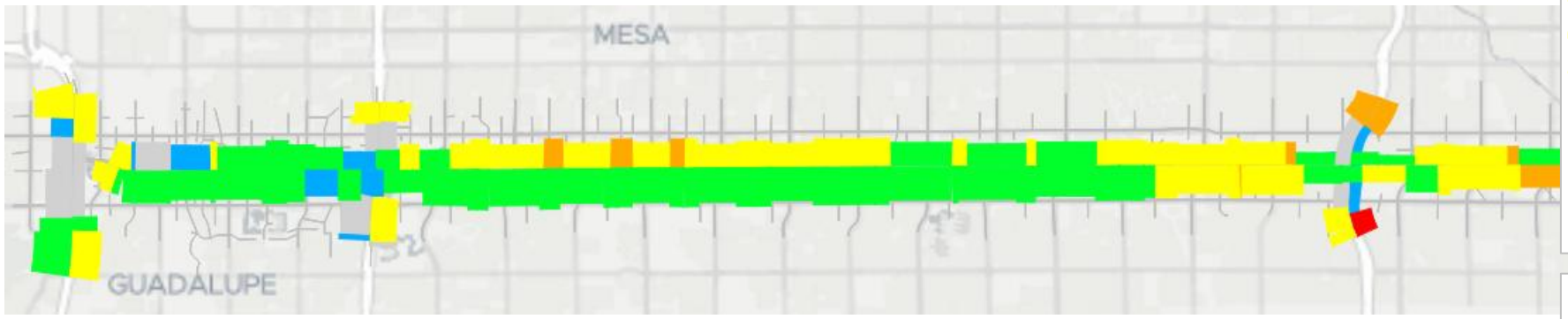
Example: Freeway HOV Lane Utilization (peak hour)

- Low resolution model runs provide very similar results compared to high resolution but at a fraction of the run time!

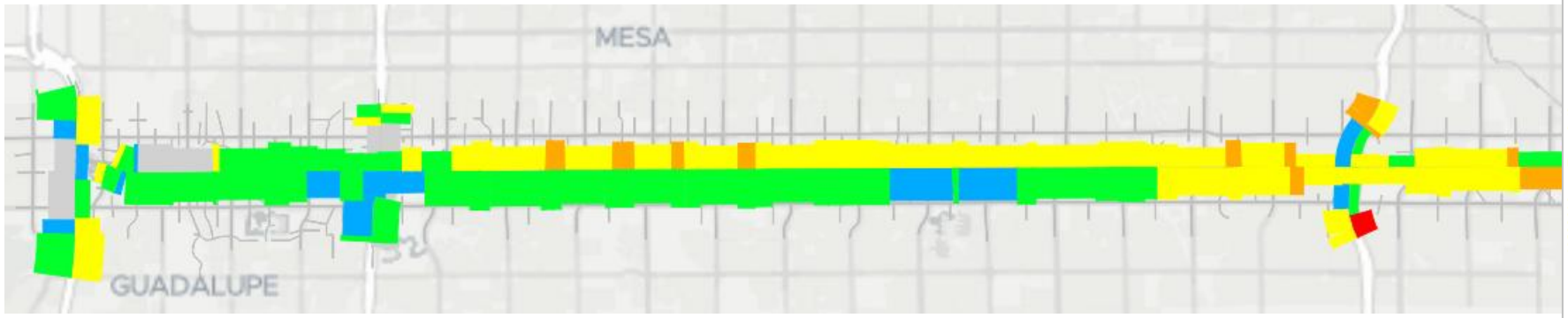


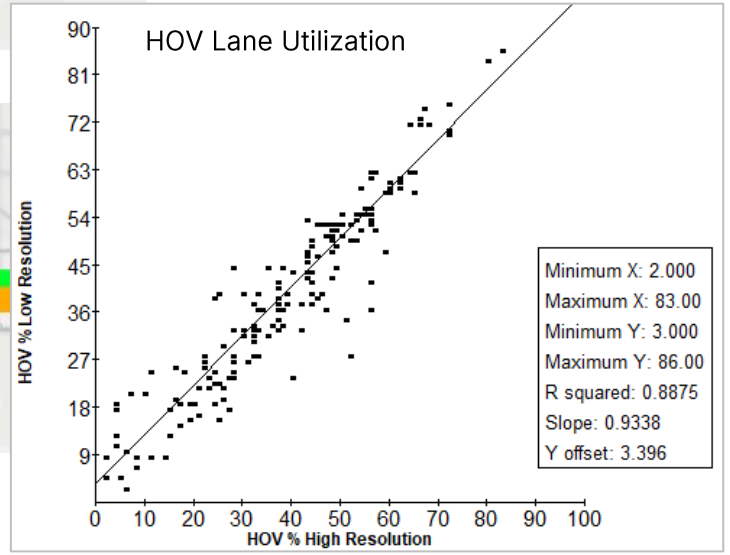


High Resolution



Low Resolution



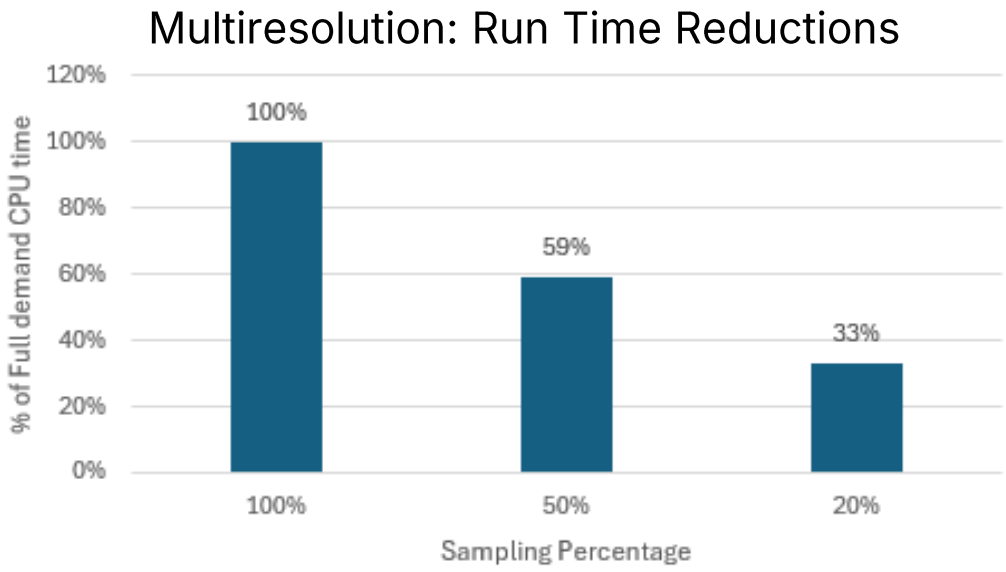


HOV lane utilization is the % of HOV vehicles using the HOV lane

Example: Run Times

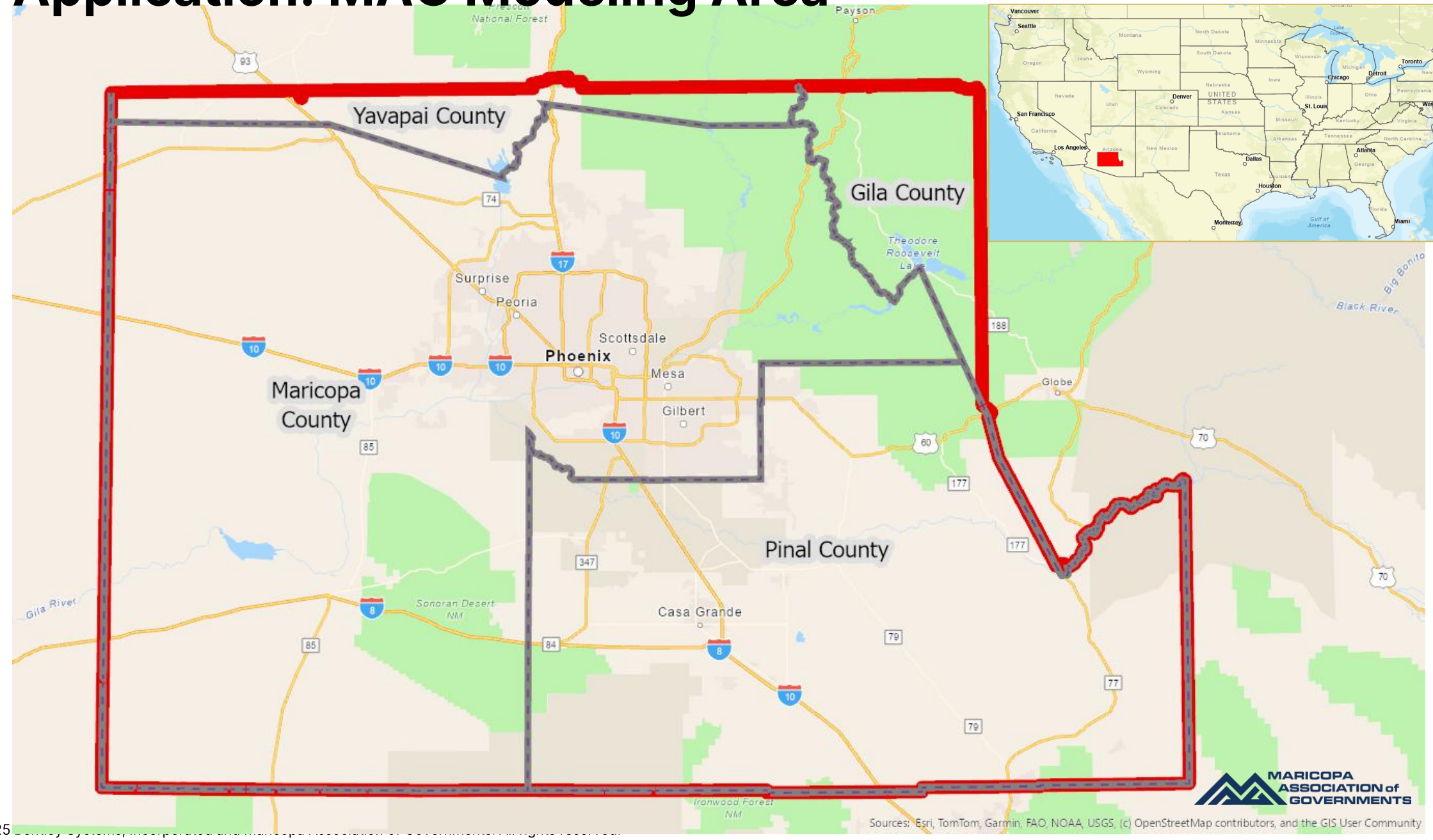
Multiresolution Mesoscopic Simulation based on Demand Sampling

- Simulation parameters are scaled “under the hood” for all simulation components: car following, lane changing, gap acceptance
- Produces link volumes and speeds that approximate outputs obtained with a 100% demand
- Dramatic reduction in DTA run time with modest reduction in fidelity



Run times from MAG future year scenario: run times are for the full DTA run, including all other computational modules (e.g. TDSP)

Application: MAG Modeling Area



Application: MAG Regional Model ABM-DTA Model

Base year model

15M trips (24 h)

Future year model (2050)

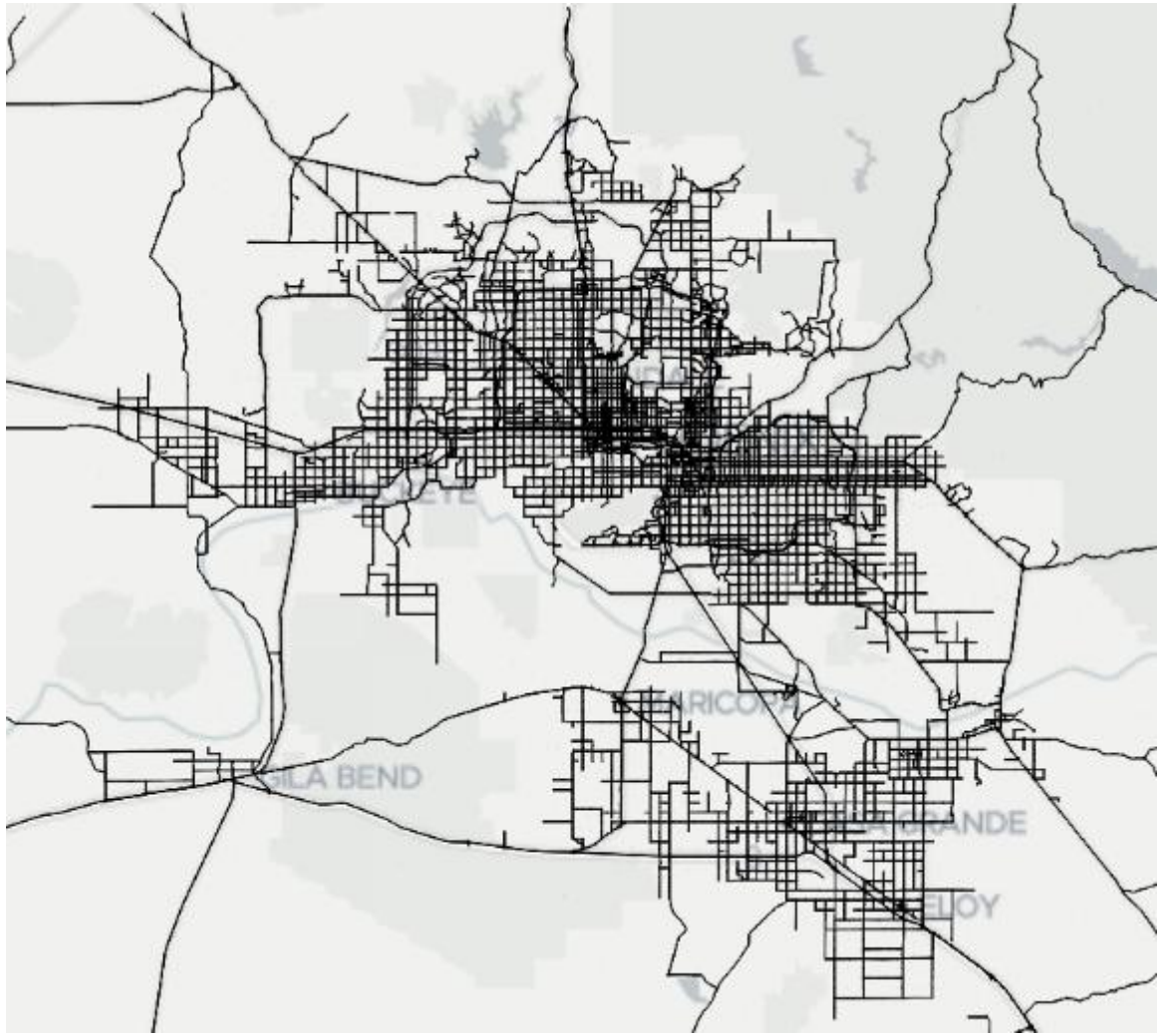
20M trips, 5am – 8pm

Scenario: managed lanes policies

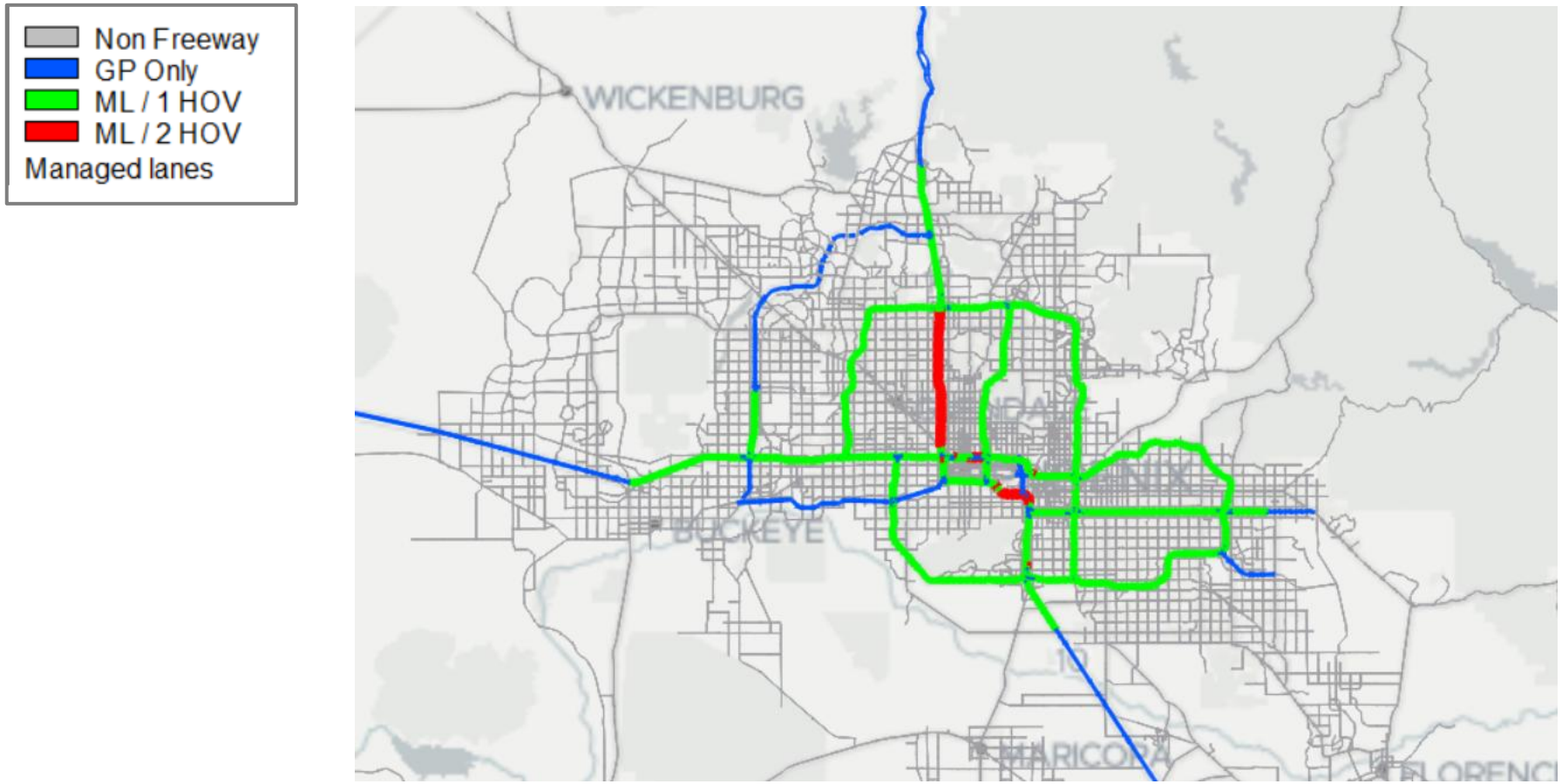
- Major increase in the vehicle fleet that is allowed to access the reserved lanes on the freeway (1.5+ x)
- Assess resulting utilization of the reserved lanes and potential for unexpected bottlenecks

Unique example of lane-based mesoscopic model at regional scale

- Reserved lanes used throughout major freeway network



MAG 2050 - Managed Lanes Map



MAG 2050 – HOV lane study

Vehicle classes

- SOV
  - non-Electric Vehicles
  - Electric Vehicles
- HOV2, HOV3+
- Other: multiple truck classes, taxi, TNC

Scenario	HOV lane access	HOV Demand
Base	HOV2, HOV3+	500K+
HOV Test	HOV2, HOV3+, **SOV-EV**	**800K+**

HOV Test Model Runs

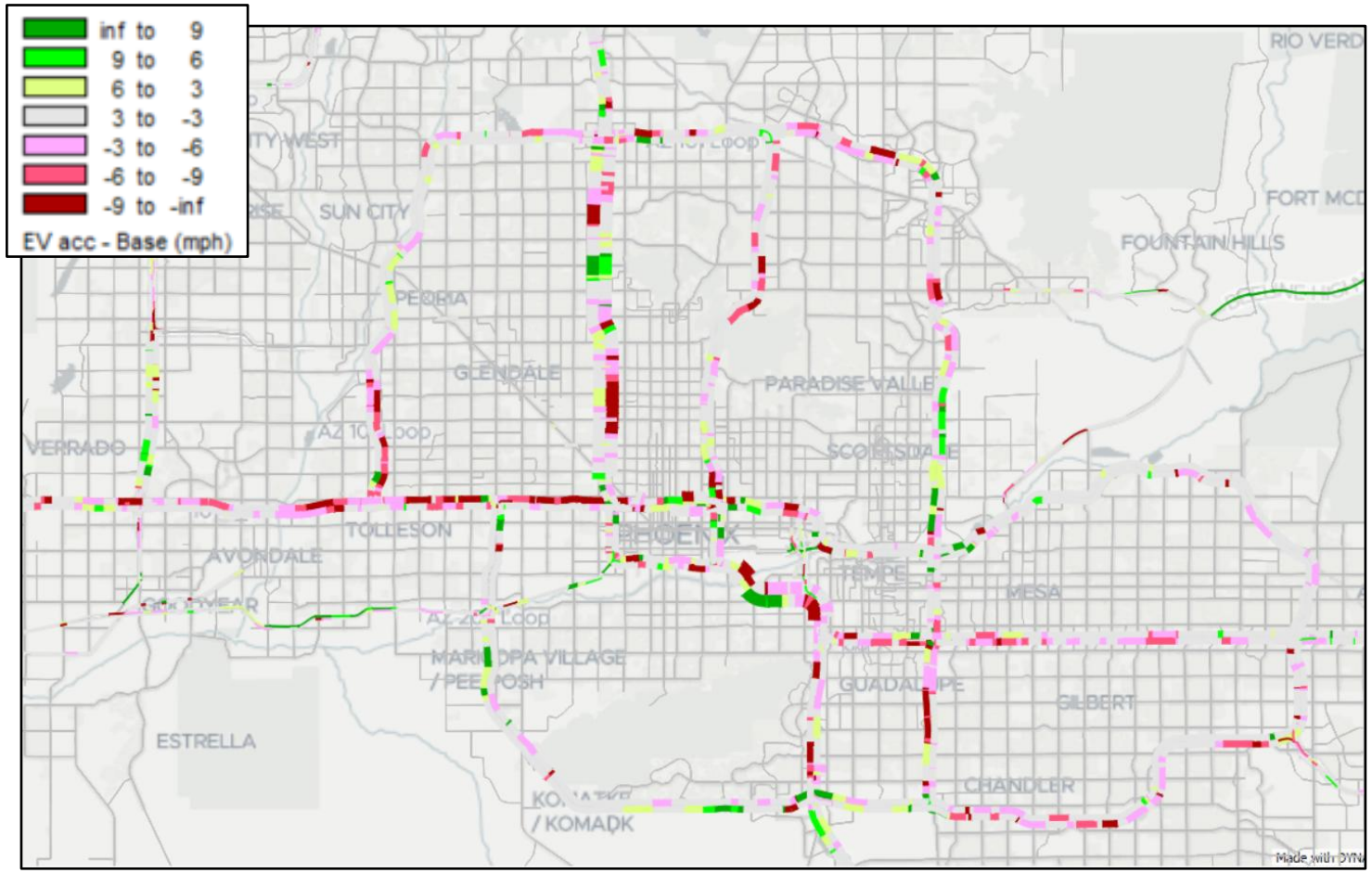
- Fixed-Demand DTA
- Integrated ABM-DTA

Results presented below

- Integrated ABM-DTA runs
- Speed difference in managed lanes: HOV Test vs. Base
- 5-6 pm peak hour

Speed Difference: SOV-EV access to HOV lanes

Vehicle Class: **HOV2**

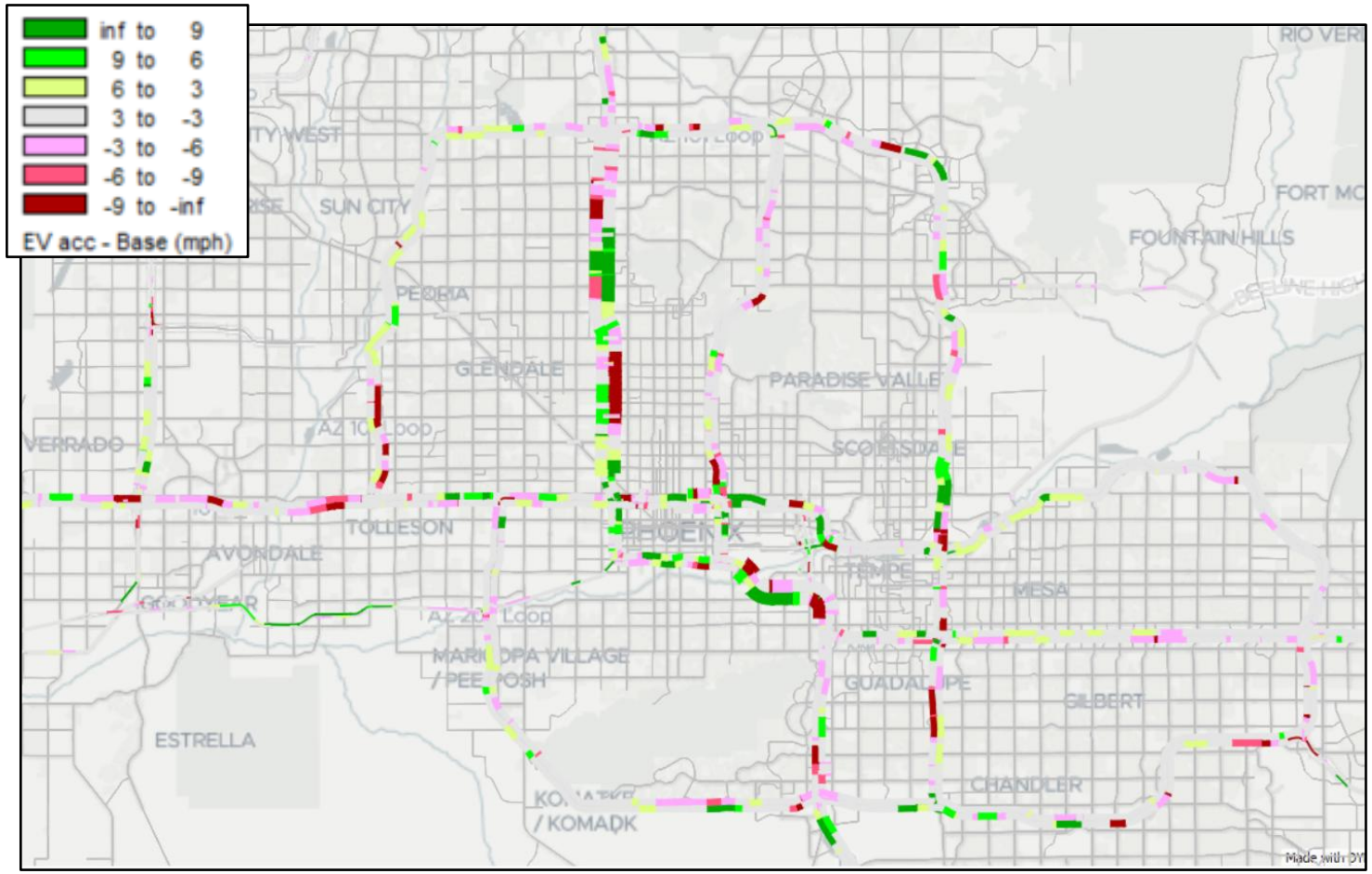


HOV2

- In general: *reduced* speeds on HOV sections for existing HOV-lane vehicles (HOV2, HOV3+)
- Sections with *increased* speed: exhibit improved conditions overall (all classes), likely due to changes in route choice

Speed Difference: SOV-EV access to HOV lanes

Vehicle Class: **SOV Non-EV**

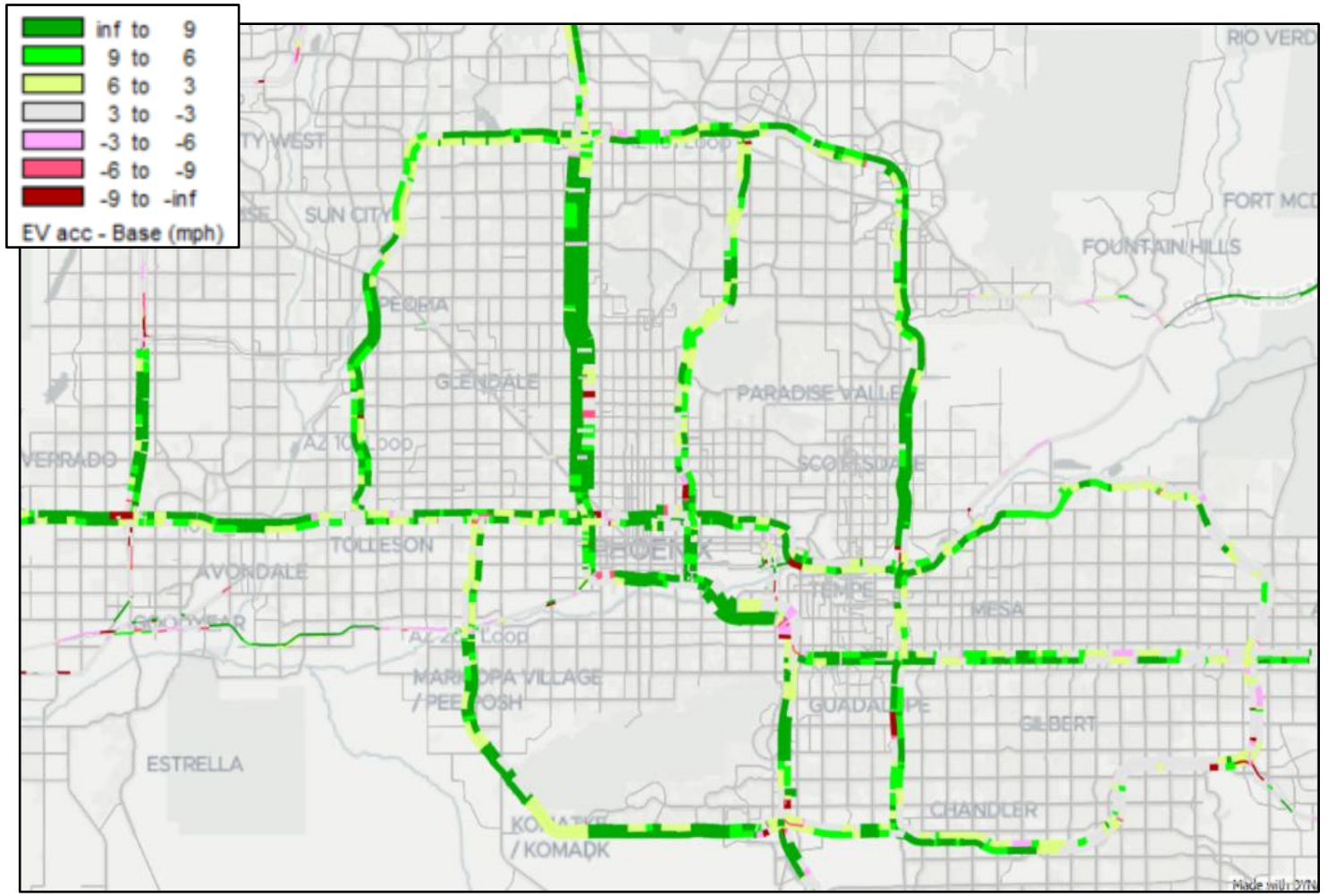


SOV Non-EV

- In general: *increased* speeds on HOV sections
  - Fewer SOV-EV vehicles on the GP lanes leading to improved LOS
- Sections with *decreased* speed: critical bottlenecks which have worsened, likely due to changes in route choice

Speed Difference: SOV-EV access to HOV lanes

Vehicle Class: **SOV EV**



SOV EV

- *increased* speeds on HOV sections:
  - HOV lanes have enough unused capacity to accommodate SOV-EV vehicles

Conclusions

- Projected SOV-EV volume (300K+), can be handled by the planned Managed Lanes network
- No significant access/egress issues identified (choke points)

Conclusions: Multiresolution Mesoscopic Simulation and DTA

- Very effective trade-off between resolution and run time
  - >60% reduction in run time at 25% sampling
  - Very good approximation of flows and speeds
- Successful application to a regional ABM-DTA for a managed lanes application
  - Unique combination of regional scale and lane-based traffic modeling
- Methodology has broad application for large-scale DTA: both fixed-demand and ABM-DTA

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