Simulation-based Dynamic Traffic Assignment for Planning Applications

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Context: Motivation

- Technical
  - Many transportation planning problems require dynamic models
- Practical
  - Effective transportation planning solutions require consensus/buy-in

Context: Technical Motivation

- Dynamic Traffic Assignments are needed for analyzing pricing strategies, capacity improvements, and ITS
- Congested travel times form the basis for crucial planning model estimation and application
- Static assignments produce biased travel times and biased models and forecasts
- These compromises are no longer necessary or justifiable
- …

Context: Technical Motivation (cont.)

- …
- Operational fidelity needed for traffic engineering work
- Many projects and traffic management measures have impacts that cannot be estimated with planning models
- These require detailed microsimulation in which lane level behavior is captured

Context: Practical Motivation

- Effective deployment hinges on usability, robustness
- DTAs lend themselves better to dynamic visualization and animation
- A more compelling tool for engaging stakeholders and the public

Context: Background

- Early experiments with macro DTA
- TRANSIMS & MITSIM
- Meso models-Integration, Dynasmart, & DYNAMIT
- Microsimulation thought to be impossible at the regional scale
- The TransModeler hybrid approach: Macro, Meso, and Micro in any combination on the same network
- 4-D lane level GIS for efficiency in simulation development

Context: Wide Area Micro DTA Successes

- Eureka, CA
- Burlington, VT
- Phoenix, AZ
- Lake County, CA
- Jacksonville, FL
- Virginia Beach, VA
- Ukiah, CA
- Practical, calibrated, validated, and deployed Microscopic DTA models
- Hybrid models neither needed nor warranted for any reason

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Context: Corridor Microscopic DTA Successes

- 495 Express Lanes (Northern VA)
- 95 Express Lanes (Miami)
- 95 Express Lanes (Northern VA)
- I-4 (Orlando)
- C-470 (Denver)
- I-70 Mountain Corridor (West of Denver)
- Purposes varied: from practical applications to T&R to research
- Dynamic pricing a theme

Approach: Key DTA Elements

- Dynamic shortest paths based upon departure times
- Realistic route choice incorporating VOT, willingness to pay
- Queue build-up and dissipation
- Short time intervals for travel time measurement
- Dynamic User Equilibrium condition- Temporal extension of Wardrop's principle that all used paths between each OD pair, have the same minimum cost for a given departure time interval and that there are no lower cost routes
- Iterative computation to achieve convergence

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Direct tie-in with activity-based models (ABM)

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- Iterative computation to achieve **<u>convergence</u>**

While rooted in familiar trip-based model theory

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Key advantages

Approach: 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

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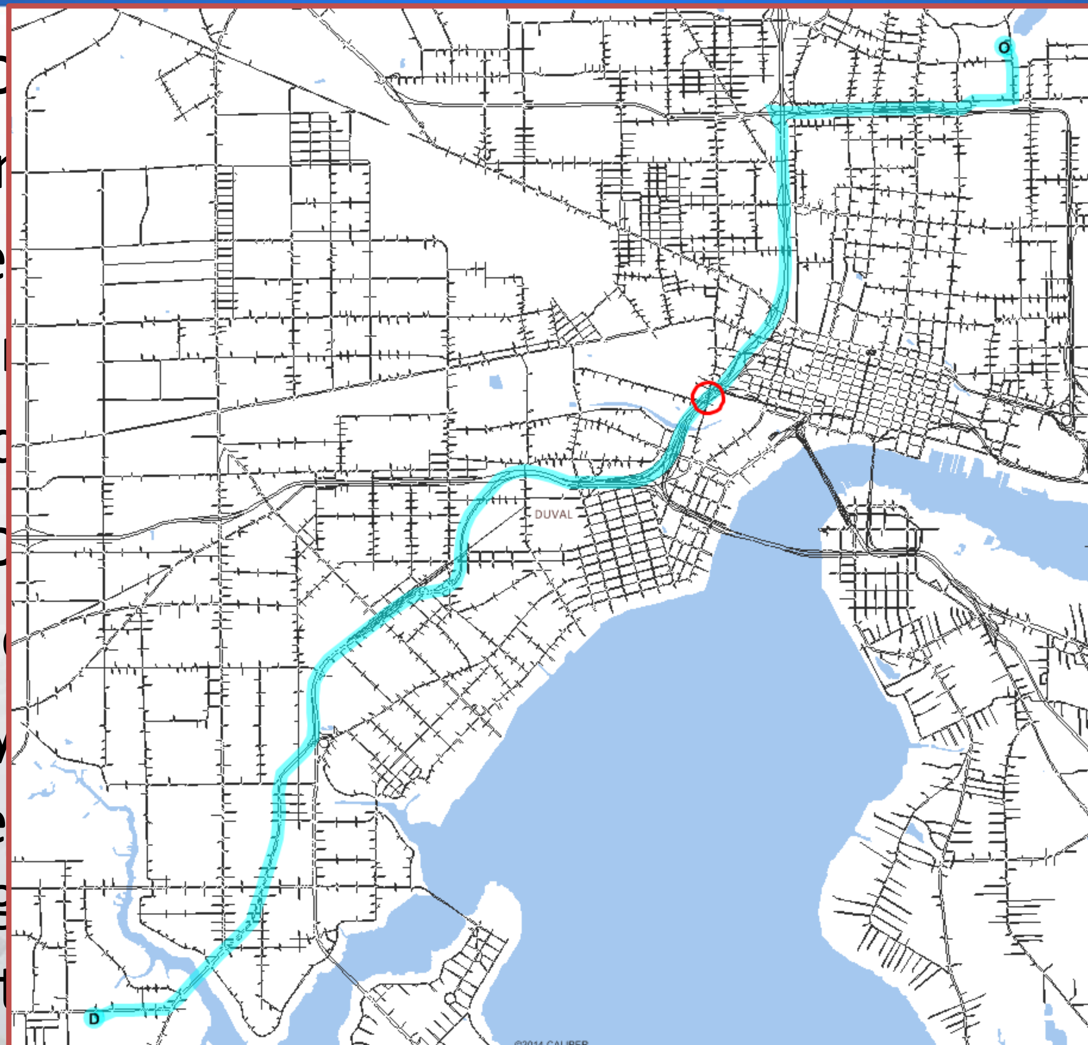
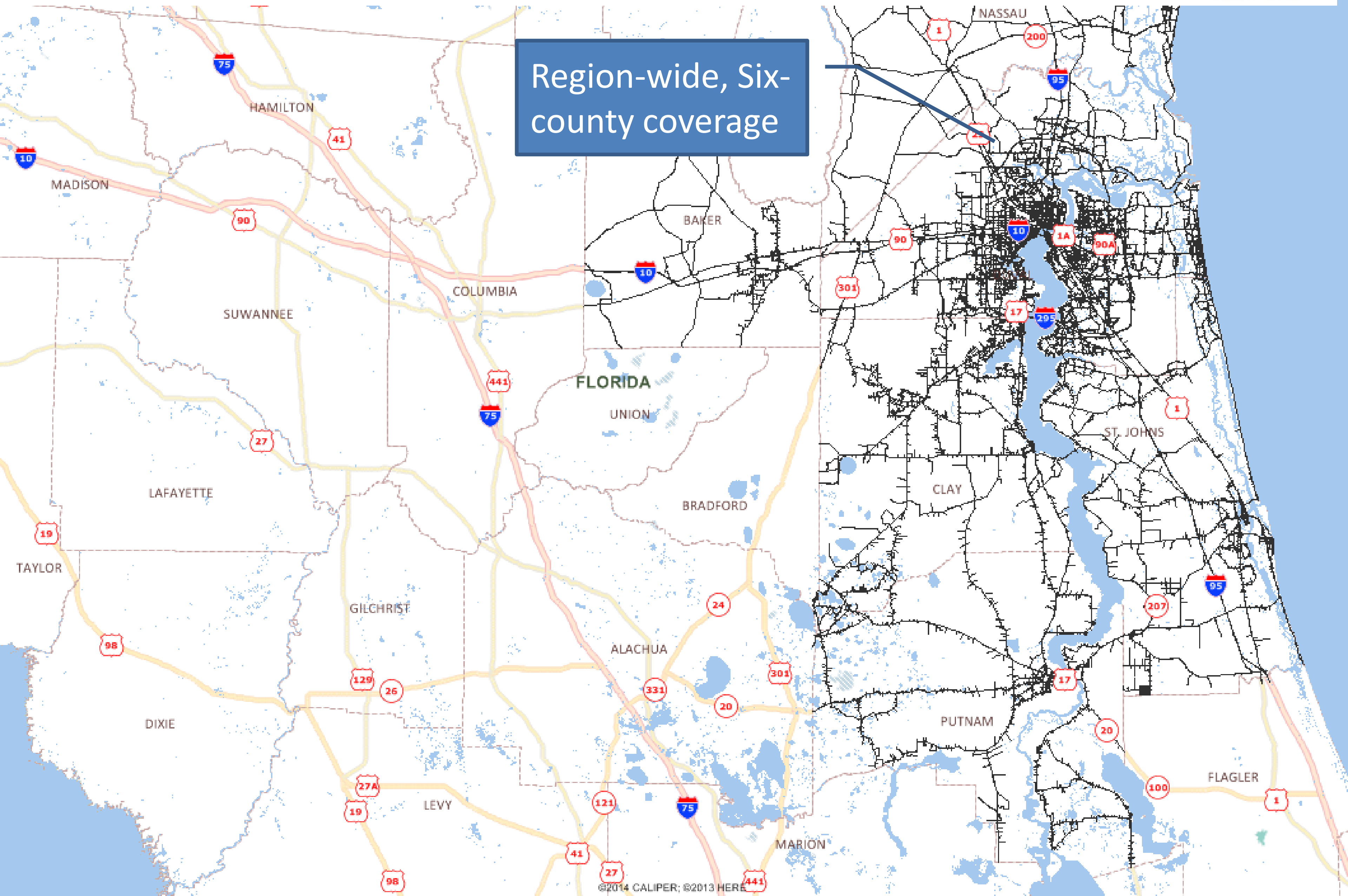


Implementation: Jacksonville, FL

Region-wide, Six-county coverage



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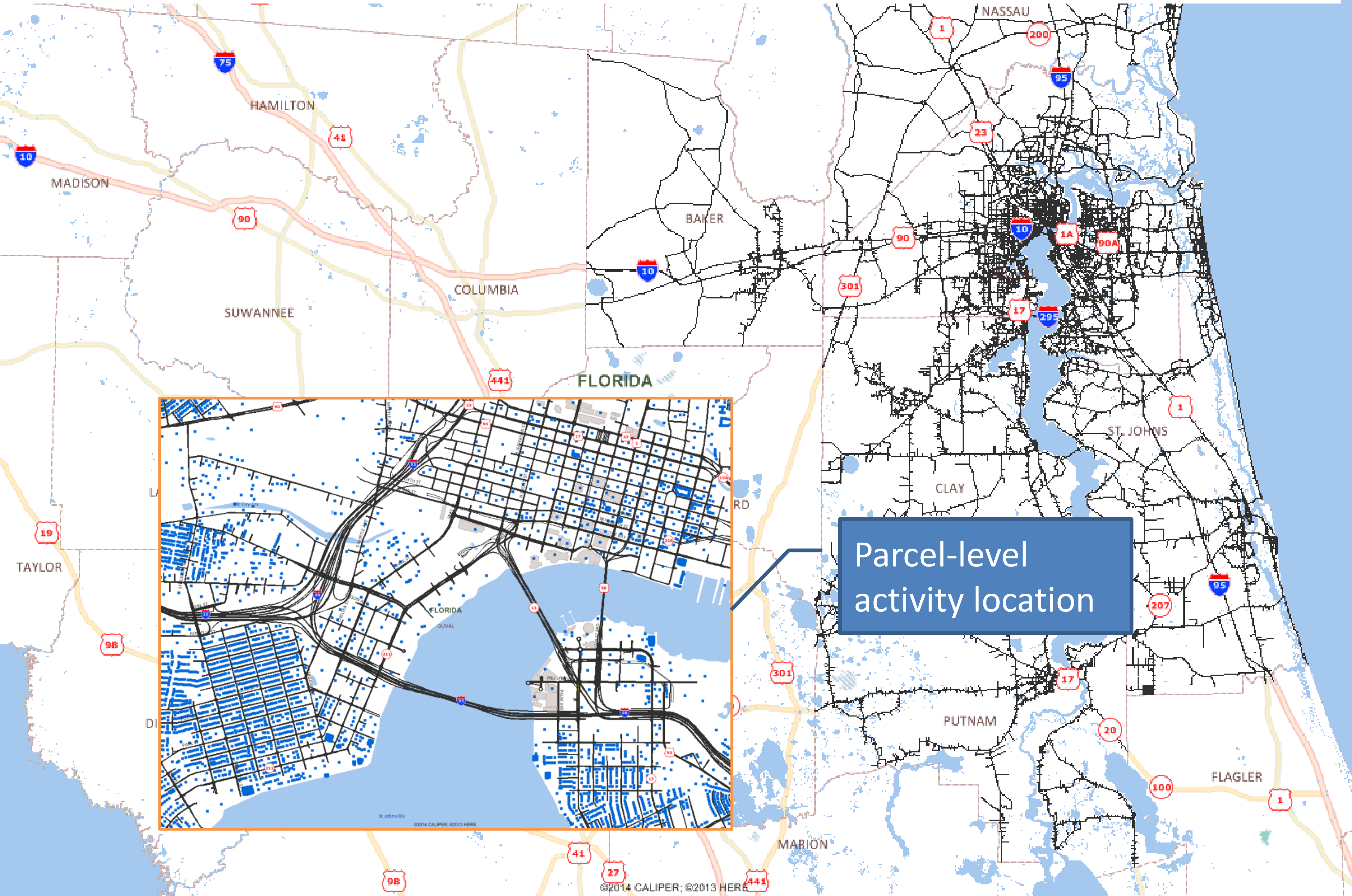

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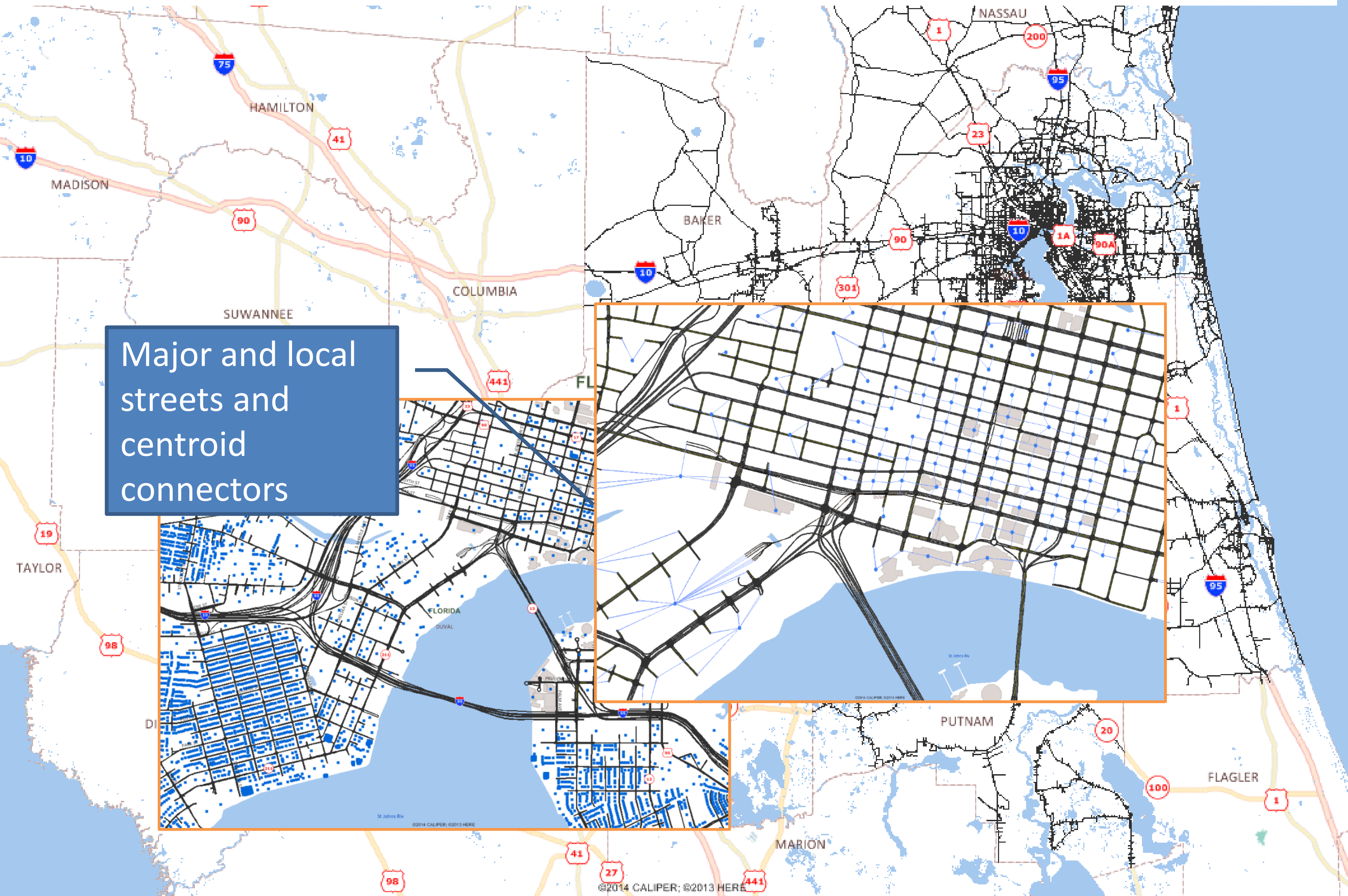

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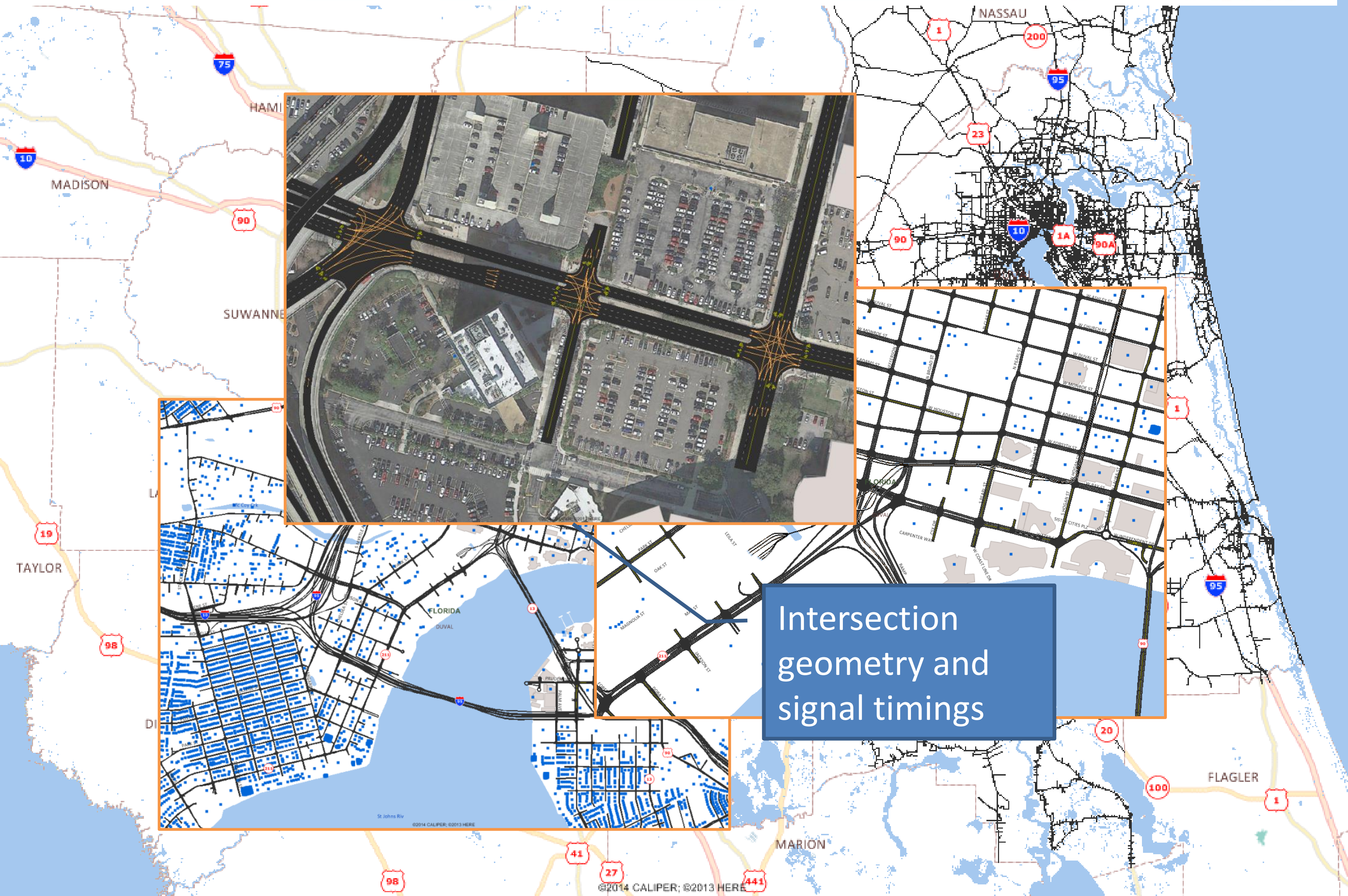

Implementation: Framework

- Parcel-level origins and destinations
  - 492,684 parcels
  - Point-to-point route choice
  - Trips produced by DAYSIM
- Zonal truck and external traffic
  - 2,578 TAZs
  - Zone-to-zone route choice
  - Matrices produced by CUBE
- Integration/Linkage
  - DAYSIM
  - CUBE

Implementation: Challenges

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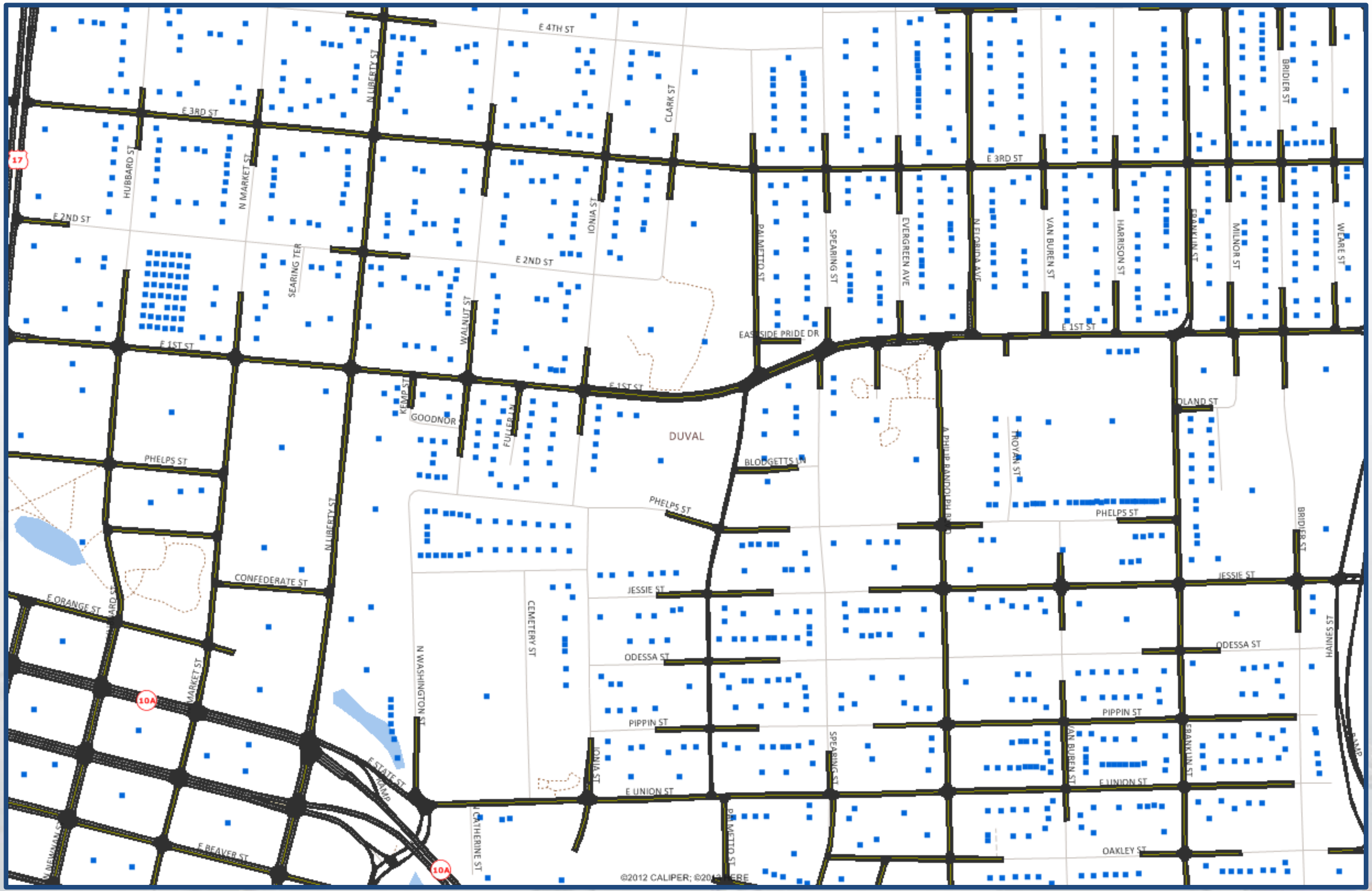
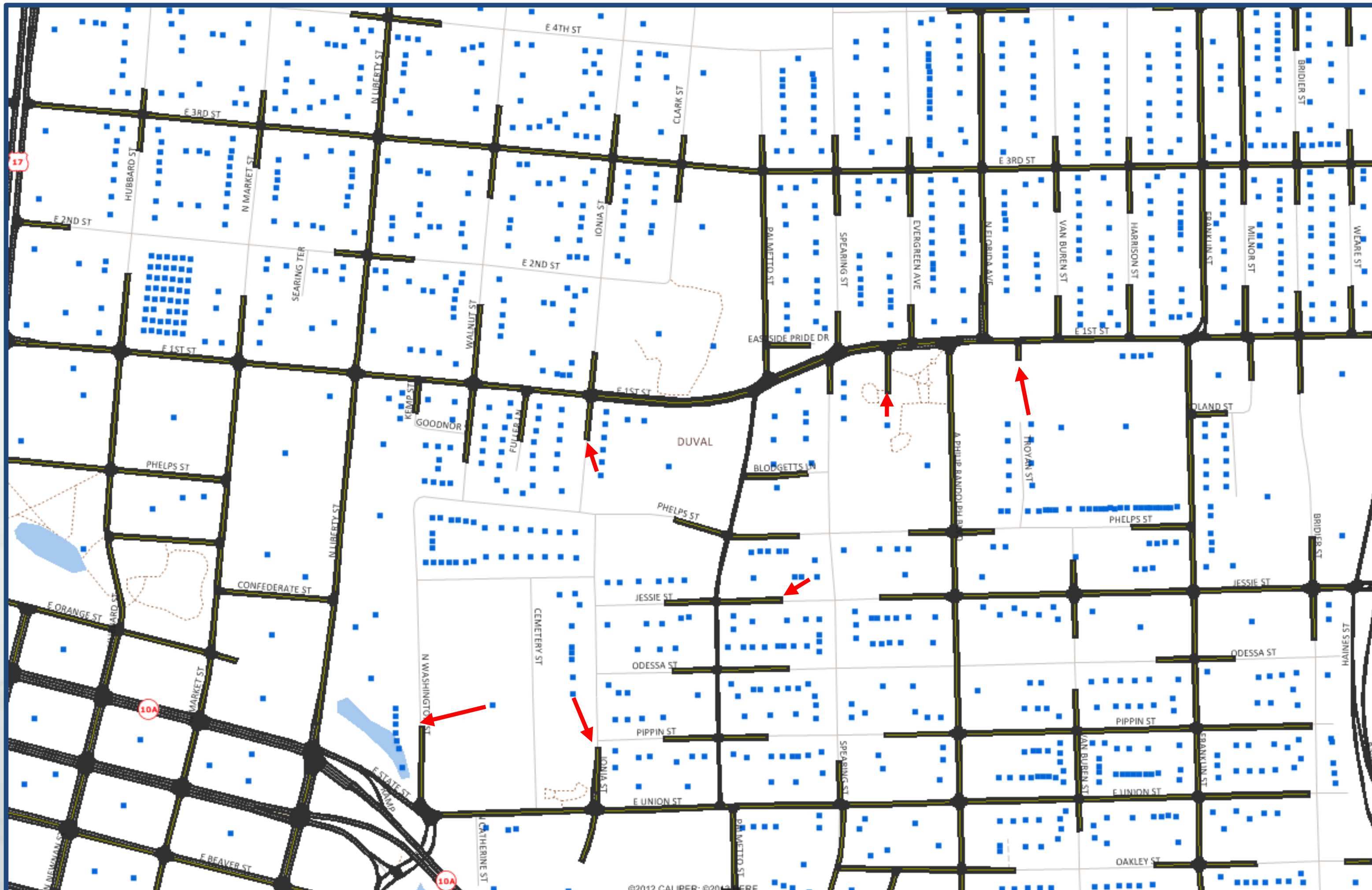


Implementation: Challenges



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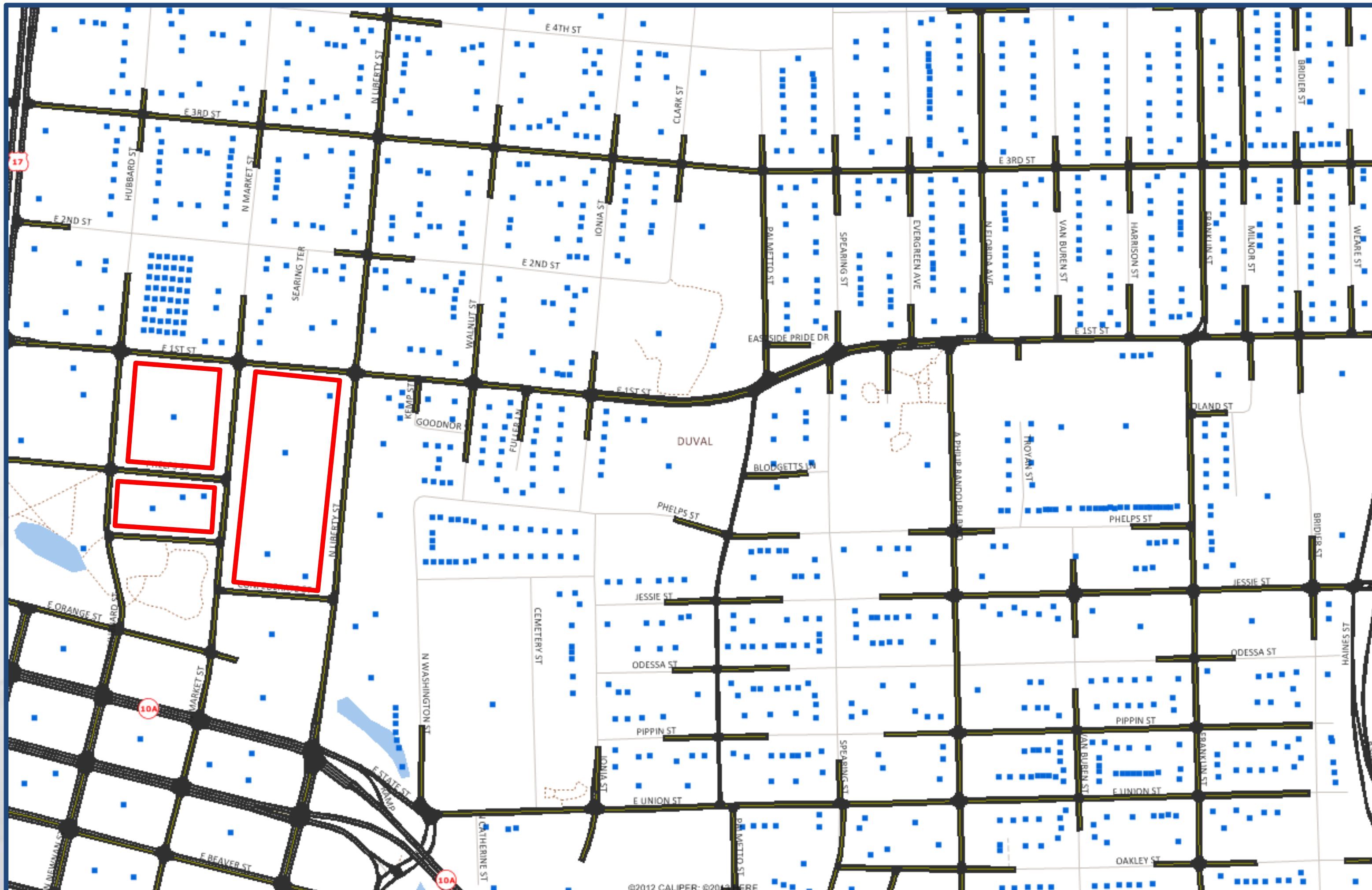

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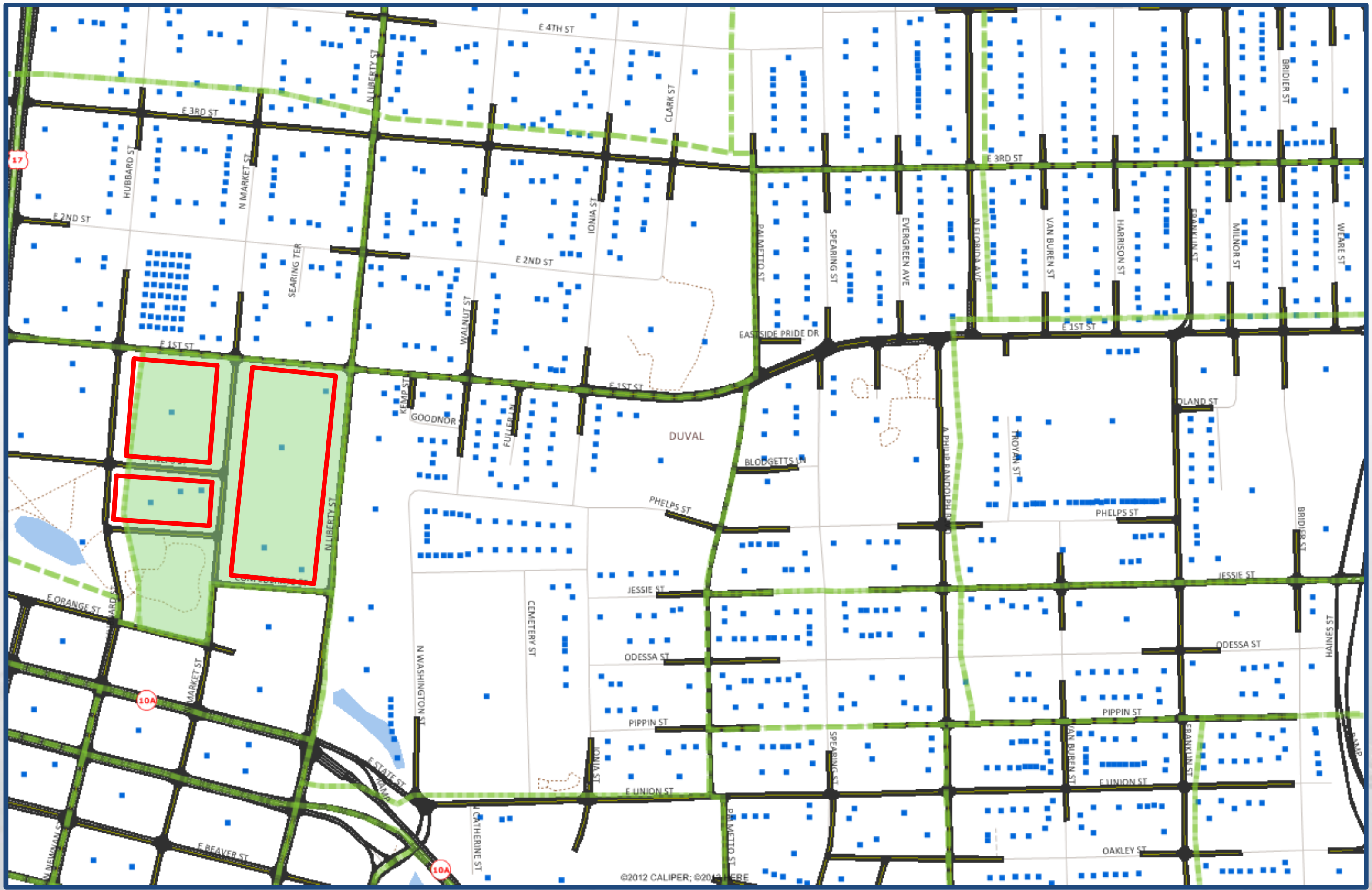

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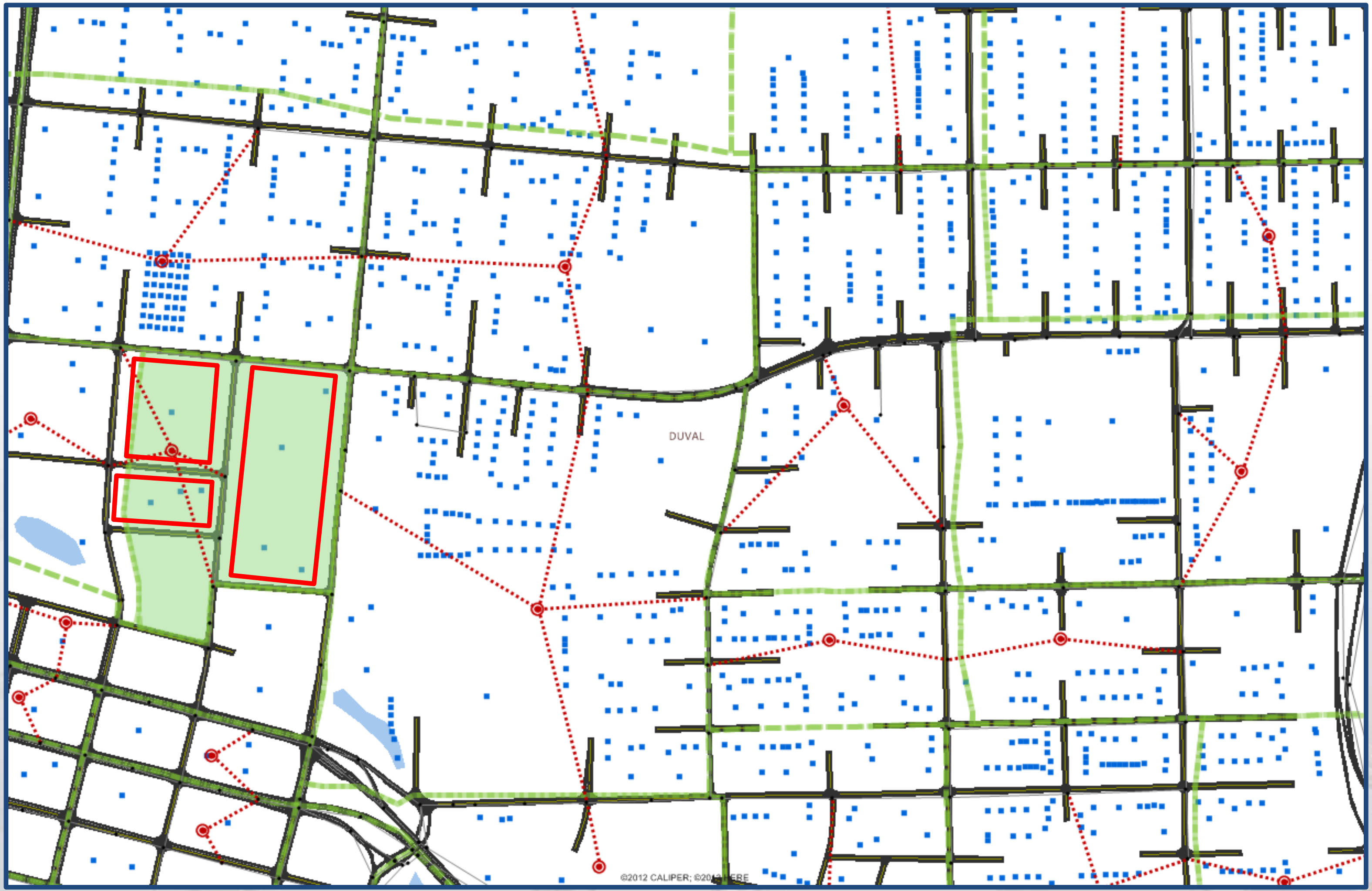

Caliper

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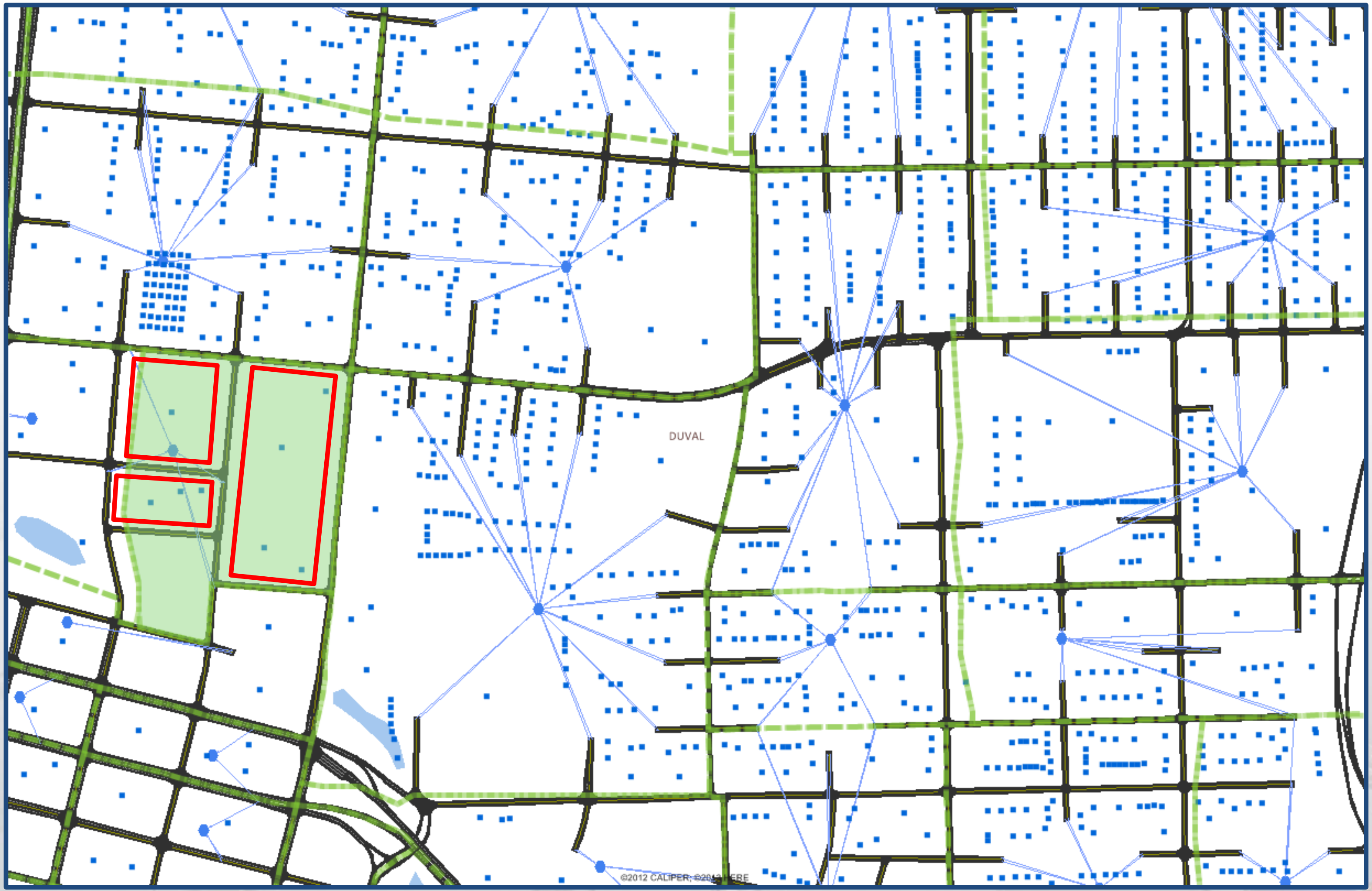


Implementation: Features

- Read DAYSIM trips without temporal aggregation
- Handle parcel locations without spatial aggregation
- Use dense street network
  - Realistic accessibility, connectivity
- Simulate multiple travel modes
- Possess practical running times

Implementation: Input

- Demand: Disaggregate trip tables
  - Detailed demographic and trip information
  - Approximately 650K trips in 3-hour AM peak [6:00-9:00]

TransModeler (Licensed to Caliper Corporation)

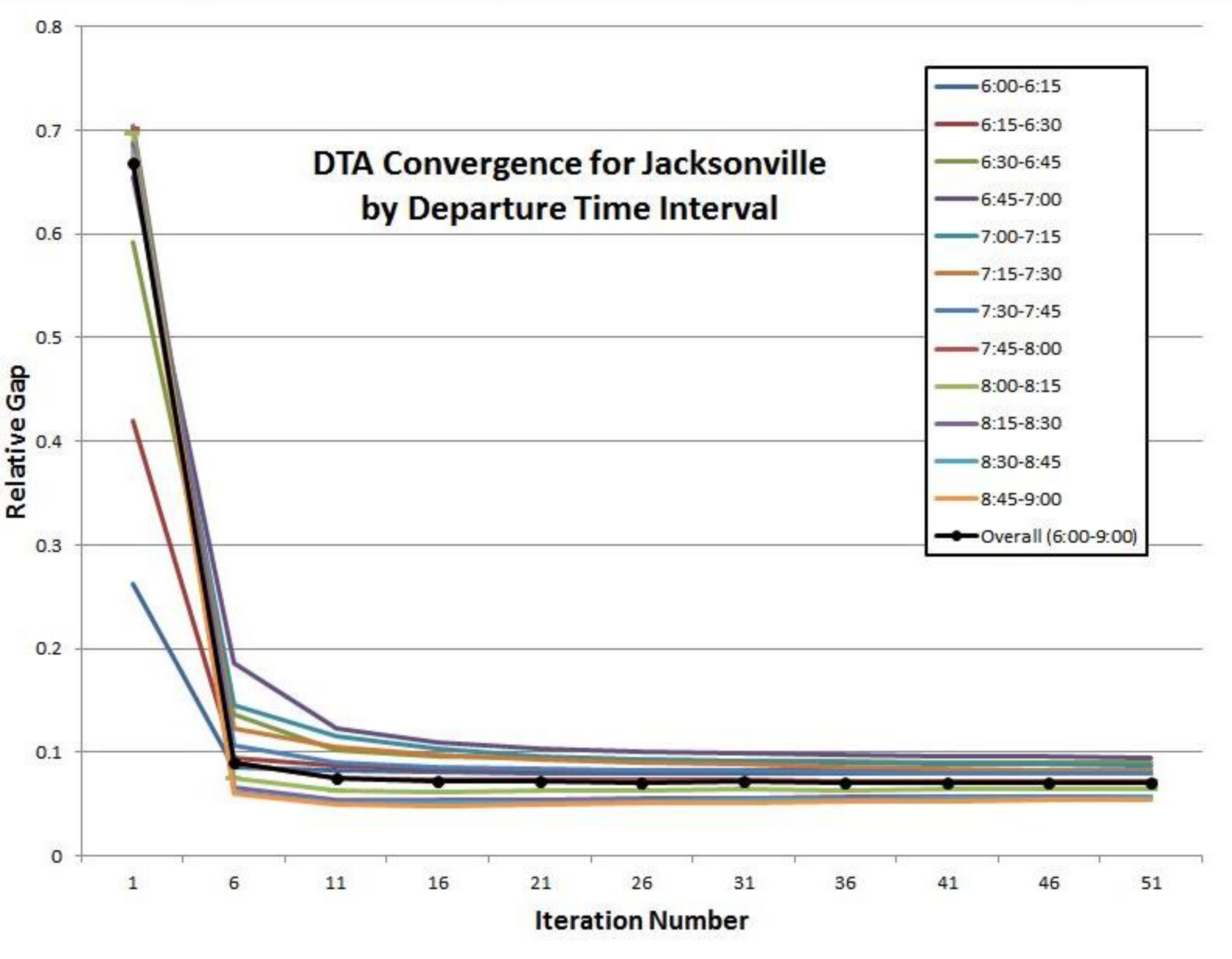
File Edit Dataview Selection Project Demand Route Systems Parameters Simulation 3D Tools Window Help

All Records

Dataview1 - Micro trips

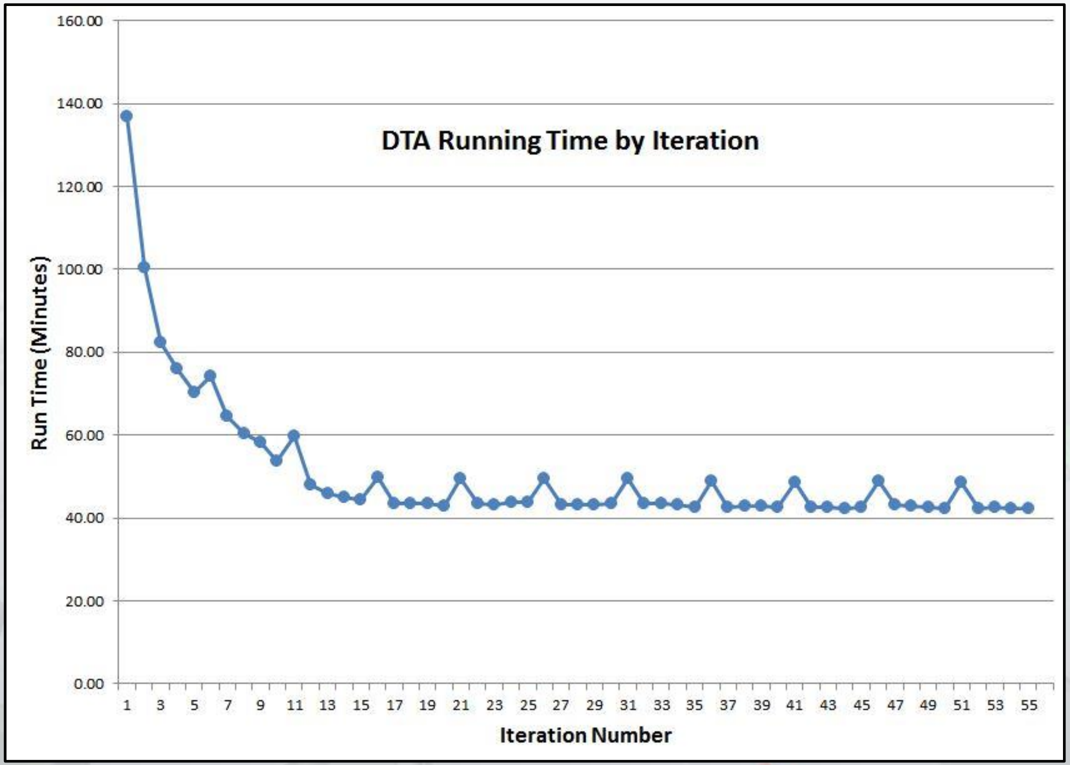
ID	OriID	DesID	OriType	DesType	OriPos	DesPos	Class	Group	Preemption	PathFixed	Occupants	VOT	ETC	Transit	Truck	UserA	UserB	Probe	Status	OriLink	Path	EndLink	DepTime	ExpArrT
1	1465	50498	Node	Link	0	75	PU	Informed	None	0	1	15.00	No	No	No	No	No	No	En route	13190	5	50498	21600.0	
2	-13958	13965	Link	Link	73	77	PC2	Uninformed	None	0	1	7.50	No	No	No	No	No	No	En route	-13958	53	13965	21600.0	
3	-13958	-10024	Link	Link	73	29	PC2	Informed	None	0	1	15.00	No	No	No	No	No	No	En route	-13958	94	-10024	21600.0	
4	13576	6561	Link	Node	80	100	PC2	Informed	None	0	1	15.00	No	No	No	No	No	No	En route	13576	135	13553	21600.0	
5	57995	50800	Link	Link	92	76	PC1	Informed	None	0	1	15.00	Ye	No	No	No	No	No	En route	57995	212	50800	21600.0	
6	13482	7408	Link	Link	93	70	PC2	Informed	None	0	1	15.00	No	No	No	No	No	No	En route	13482	276	7408	21600.0	
7	57995	10220	Link	Link	92	90	PC2	Uninformed	None	0	1	7.50	No	No	No	No	No	No	En route	57995	313	10220	21600.0	
8	-57995	13386	Link	Link	8	36	PC2	Informed	None	0	1	15.00	No	No	No	No	No	No	En route	-57995	361	13386	21600.0	
9	13482	13469	Link	Link	93	19	PC3	Uninformed	None	0	1	7.50	No	No	No	No	No	No	En route	13482	382	13469	21600.0	
10	10633	10897	Link	Link	64	0	PU	Informed	None	0	1	15.00	No	No	No	No	No	No	En route	10633	415	10897	21600.0	
11	13957	13482	Link	Link	72	93	PC2	Uninformed	None	0	1	7.50	No	No	No	No	No	No	En route	13957	438	13482	21600.0	
12	-57995	13575	Link	Link	8	45	PC1	Uninformed	None	0	1	7.50	No	No	No	No	No	No	En route	-57995	465	13575	21600.0	
13	50504	1557	Link	Link	51	89	PC2	Informed	None	0	1	15.00	Ye	No	No	No	No	No	En route	50504	490	1557	21600.0	
14	57964	431	Link	Link	62	34	PC1	Uninformed	None	0	1	7.50	No	No	No	No	No	No	En route	57964	511	431	21600.0	
15	13951	-50390	Link	Link	20	44	PU	Uninformed	None	0	1	7.50	No	No	No	No	No	No	En route	13951	539	-50390	21600.0	
16	-57995	-50390	Link	Link	8	44	PC2	Informed	None	0	1	15.00	No	No	No	No	No	No	En route	-57995	576	-50390	21600.0	
17	57966	9201	Link	Link	94	92	PC3	Uninformed	None	0	1	7.50	No	No	No	No	No	No	En route	57966	625	9201	21600.0	
18	-57995	57985	Link	Link	8	25	PC2	Uninformed	None	0	1	7.50	No	No	No	No	No	No	En route	-57995	663	57985	21600.0	
19	8887	12359	Node	Link	0	0	PC3	Uninformed	None	0	1	7.50	No	No	No	No	No	No	En route	10456	694	12359	21600.0	
20	9891	9902	Link	Link	24	11	PC1	Uninformed	None	0	1	7.50	Ye	No	No	No	No	No	En route	9891	720	9902	21600.0	
23	50390	47069	Link	Link	14	97	PC1	Informed	None	0	1	15.00	No	No	No	No	No	No	6	-48420	692883	47069	19799.9	227
24	50494	57985	Link	Link	75	25	PC2	Uninformed	None	0	1	7.50	No	No	No	No	No	No	En route	50494	800	57985	21600.0	
25	57993	9557	Link	Link	90	93	PC3	Uninformed	None	0	1	7.50	No	No	No	No	No	No	En route	57993	856	9557	21600.0	
26	50498	1888	Link	Link	75	91	PC2	Informed	None	0	1	15.00	No	No	No	No	No	No	6	1763	671150	1888	19799.9	221
27	50498	-57993	Link	Link	75	54	PC3	Informed	None	0	1	15.00	Ye	No	No	No	No	No	En route	50498	987	-57993	21600.0	
28	-57993	57963	Link	Link	54	22	PC1	Uninformed	None	0	1	7.50	No	No	No	No	No	No	En route	-57993	1084	57963	21600.0	
29	50498	10645	Link	Link	75	31	PC1	Uninformed	None	0	1	7.50	No	No	No	No	No	No	En route	50498	1203	10645	21600.0	
30	-50536	10220	Link	Link	12	90	PC2	Informed	None	0	1	15.00	No	No	No	No	No	No	En route	-50536	1284	10220	21600.0	
31	-50498	46297	Link	Link	25	78	PC1	Uninformed	None	0	1	7.50	No	No	No	No	No	No	En route	-50498	1329	46297	21600.0	
32	50430	57985	Link	Link	43	25	PC2	Uninformed	None	0	1	7.50	Ye	No	No	No	No	No	En route	50430	1377	57985	21600.0	
33	58000	57989	Link	Link	67	84	PC2	Uninformed	None	0	1	7.50	No	No	No	No	No	No	En route	58000	1396	57989	21600.0	
34	50494	7616	Link	Link	50	27	PC1	Informed	None	0	1	15.00	No	No	No	No	No	No	En route	50494	1446	7616	21600.0	
35	50430	13450	Link	Link	43	85	PC2	Uninformed	None	0	1	7.50	No	No	No	No	No	No	En route	50430	1483	13450	21600.0	
36	-50498	9807	Link	Link	25	39	PC1	Uninformed	None	0	1	7.50	No	No	No	No	No	No	En route	-50498	1531	9807	21600.0	
37	-50498	310	Link	Link	25	61	PC1	Informed	None	0	1	15.00	No	No	No	No	No	No	En route	-50498	1632	310	21600.0	

Implementation: Convergence



Implementation: Running Time

- DTA running time per iteration
  - Approx. 50 minutes overall
  - 3.1 GHz Intel Xeon Dual-Core 64-Bit CPU, 64 GB RAM



Implementation: Next Steps

- Model Development Review
  - Testing
  - Signal timings validation
  - Running time performance evaluation
- Model Calibration
  - Compare DTA volumes with counts
- Software integration/linkage
  - Refine
  - Deliver
  - Support