Large Area Transport Simulations: Climbing the Mountain – Near Term Research Challenges

"Multi-Resolution Modeling: Incorporating Dynamic Traffic Assignment into Operational Planning Projects"

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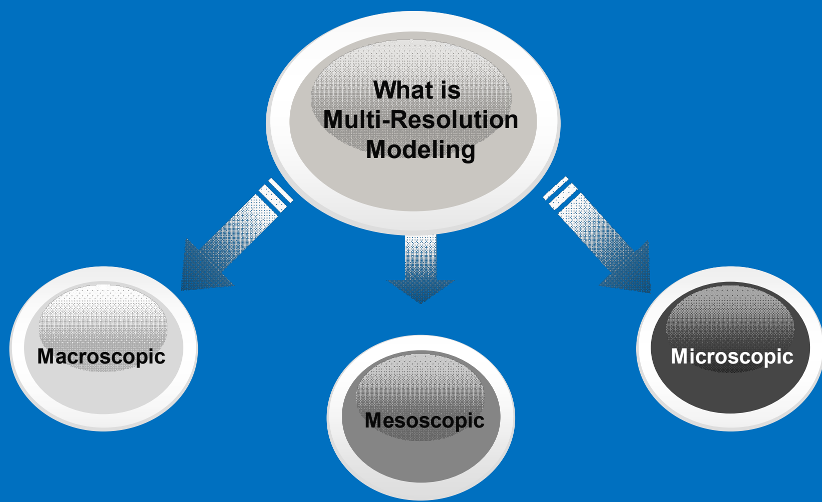
Outline

1. Multi-Resolution Modeling - Concept
2. Conversion, Calibration & Consistency
3. Challenges in Operational Planning Projects
4. Case Studies

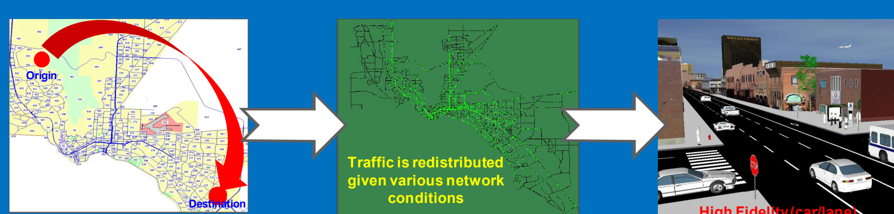
Multi-Resolution Modeling-Concept



Integrating macro, meso and micro model to achieve a specific goal

Multi-Resolution Modeling-Concept

- Model integration takes the strengths of all models
  - **TDM gives blueprint of network and provides O/D**
  - **DTA model provides region-wide estimation of traffic redistribution**
  - **Micro- local operational analysis**



Regional Travel Demand Model

Simulation-Based DTA Model

Sub-area Microscopic Model

Multi-Resolution Modeling-Concept

- Why is multi-resolution modeling so important?
  - **Models are not mutually exclusive**
  - **They are complimentary to one another and can accomplish optimal modeling capabilities.**
  - **Retain the best characteristics**
    - Realistic representation of regional traffic
    - Detailed interactions
  - **Challenges remain in model translation and interface**
    - Calibration
    - Consistency

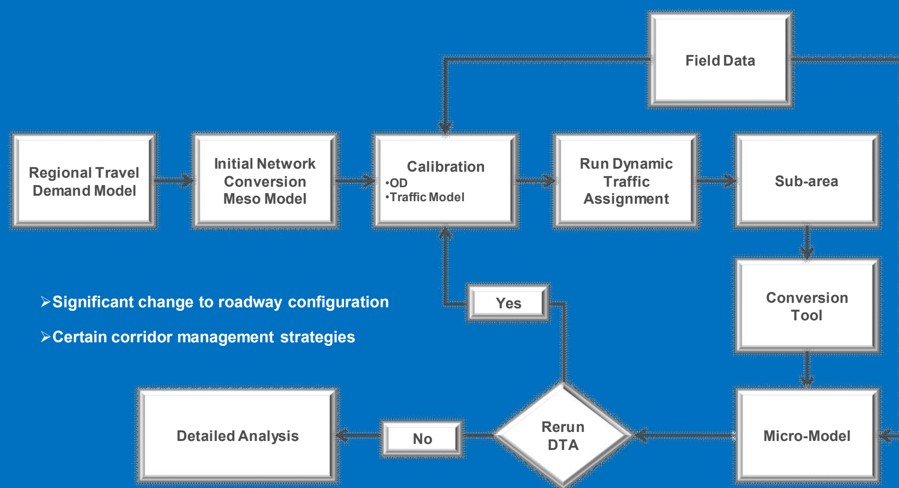
Multi-Resolution Modeling-Concept

Understanding what you are trying to model }

- Use DTA for travel demand modeling to understand the spatial and temporal distribution of traffic during peak periods
- Sub – area analysis for detailed operations studies

Which model resolution integration suits situation best?

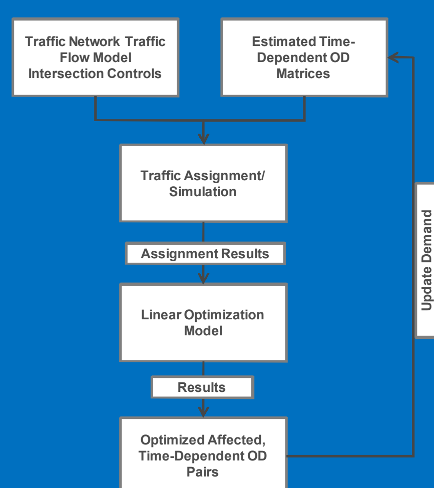
Model Conversion Process



Macro → Meso → Micro

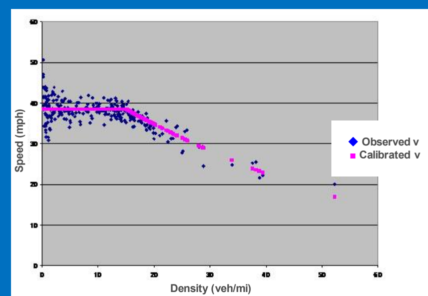
Calibration

- Time-dependent OD
  - **Minimize the deviation between simulated and actual screen line counts & speed profile**
  - **Iterative process**
  - **Program solves linearized quadratic minimization problem**
  - **Results in updated OD matrices**



Calibration

- Traffic flow model
  - Traffic simulation in DynusT is based upon the Anisotropic Mesoscopic Simulation (AMS) model
  - Moves vehicle based upon speed-density (v-k) relationship
  - v-k relationship is derived from Greenshield's equation



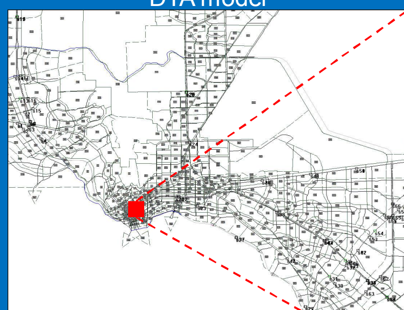
Consistency

- Network
  - Lane configuration
  - Geometric design
- Paths and flows
  - Verify same origin/destination paths
  - Verify number of vehicles generated
- Speed profile
  - Perform field data collection to determine speed and vehicle counts
  - Obtain v-k curve from simulation output
  - Calibrate models with field data

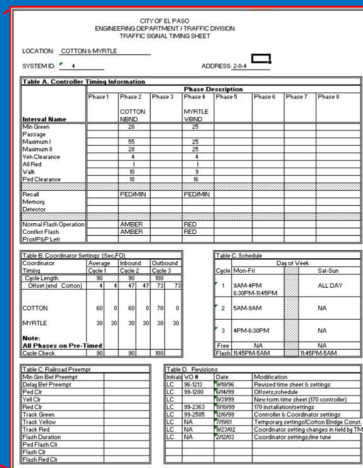
Challenges in Operational Planning

- How do you incorporate realistic traffic control into future year models?

DTA model



Input all exiting signal control data into regional model



CITY OF EL PASO
ENGINEERING DEPARTMENT / TRAFFIC DIVISION
TRAFFIC SIGNAL TIMING SHEET

LOCATION: COTTON & MYRTLE

SYSTEM ID: 4 ADDRESS: 2-0-4

Table A. Controller Timing Information

Interval Name	Phase 1	Phase 2 COTTON NBND	Phase 3	Phase 4 MYRTLE WBND	Phase 5	Phase 6	Phase 7	Phase 8
Min Green		28		25				
Passage								
Maximum I		55		25				
Maximum II		28		25				
Veh Clearance		4		4				
All Red		1		1				
Walk		10		9				
Ped Clearance		18		16				
Recall		PED/MIN		PED/MIN				
Memory								
Detector								
Normal Flash Operation		AMBER		RED				
Conflict Flash		AMBER		RED				
Prot/P&P Left								

Table B. Coordinator Settings (Sec,FO)

Coordinator Timing	Average Cycle 1		Inbound Cycle 2		Outbound Cycle 3	
Cycle Length	90		90		100	
Offset (end Cotton)	4	4	47	47	73	73
COTTON	60	0	60	0	70	0
MYRTLE	30	30	30	30	30	30
Note: All Phases on Pre-Timed						
Cycle Check	90		90		100	

Table C. Schedule

Cycle	Day of Week Mon-Fri	Sat-Sun
1	9AM-4PM 6:30PM-11:45PM	ALL DAY
2	5AM-9AM	NA
3	4PM-6:30PM	NA
Free	NA	NA
Flash	11:45PM-5AM	11:45PM-5AM

Table C. Railroad Preempt

Min Grn Bef Preempt	
Delay Bef Preempt	
Ped Clr	
Yell Clr	
Red Clr	
Track Green	
Track Yellow	
Track Red	
Flash Duration	
Ped Flash Clr	
Flash Clr	
Flash Red Clr	

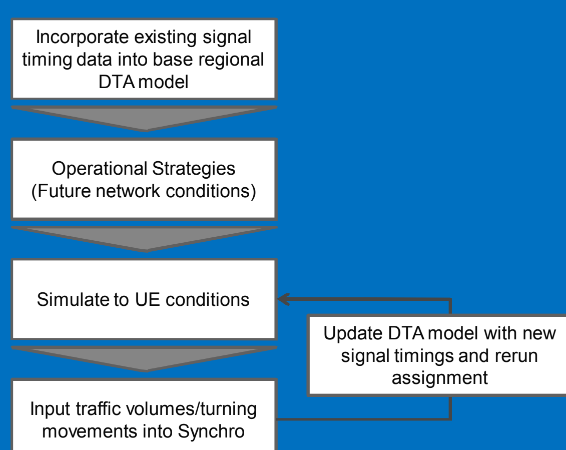
Table D. Revisions

Initials	WO #	Date	Modification
LC	96-1213	9/18/96	Revised time sheet & settings
LC	99-1200	6/14/99	Offsets;schedule
LC		8/31/99	New form time sheet (170 controller)
LC	99-2363	11/10/99	170 installation/settings
LC	99-2585	12/6/99	Controller & Coordinator settings
LC	NA	7/11/01	Temporary settings/Cotton Bridge Const.
LC	NA	9/23/02	Coordinator setting changes in field by TMC
LC	NA	2/12/03	Coordinator settings;fine tune

Challenges in Operational Planning

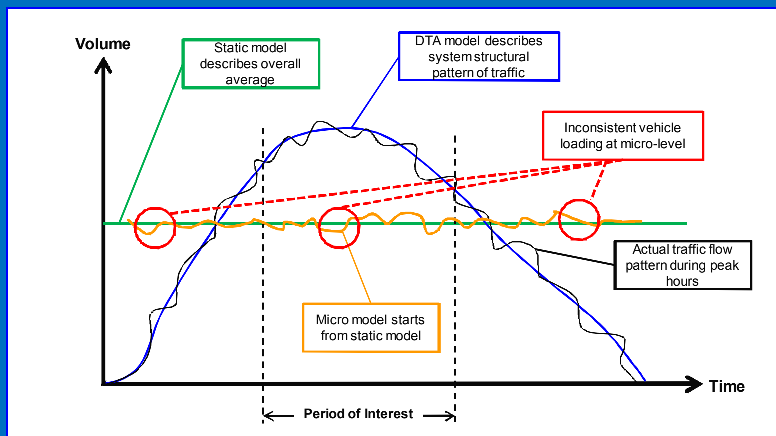
- How do you incorporate realistic traffic control into future year models?

May be tedious and time-consuming but necessary



Challenges in Operational Planning

- Proper vehicle loading in future network conditions is critical



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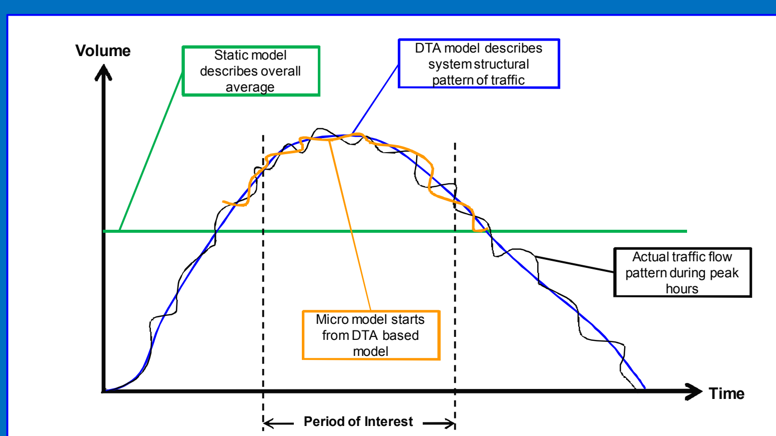
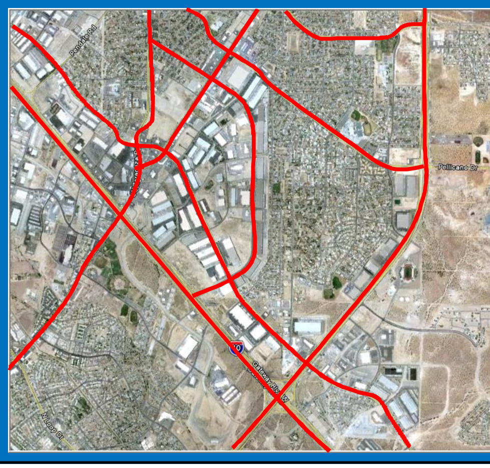


Challenges in Operational Planning

- Regional travel demand models usually do not represent the entire network – only major arterials.



Challenges in Operational Planning

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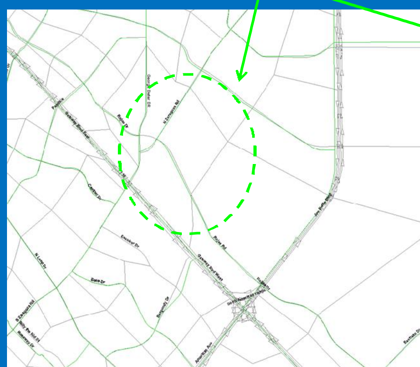
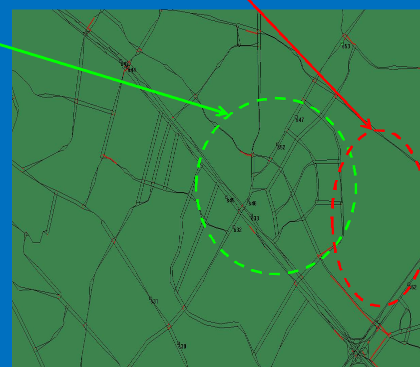
- How detailed is enough to give realistic results?
- How difficult is it to include smaller localized streets in regional models?

Challenges in Operational Planning

Additional links were added

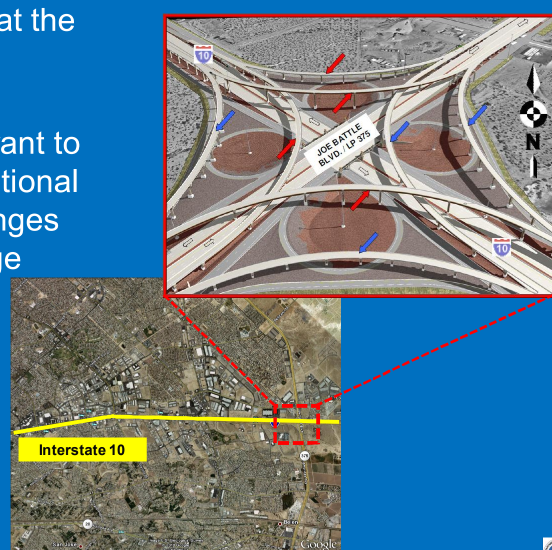
Street network still not detailed enough





Case Study I

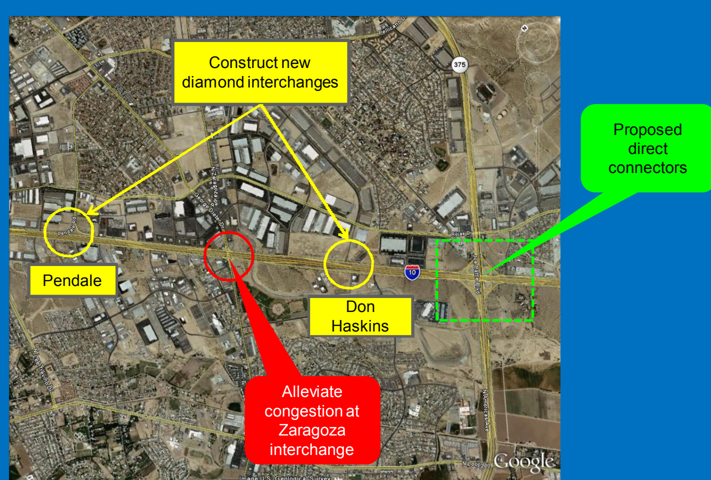
- TxDOT is constructing direct connectors at the I-10/Loop 375 interchange
- In addition, they want to construct two additional diamond interchanges west of interchange



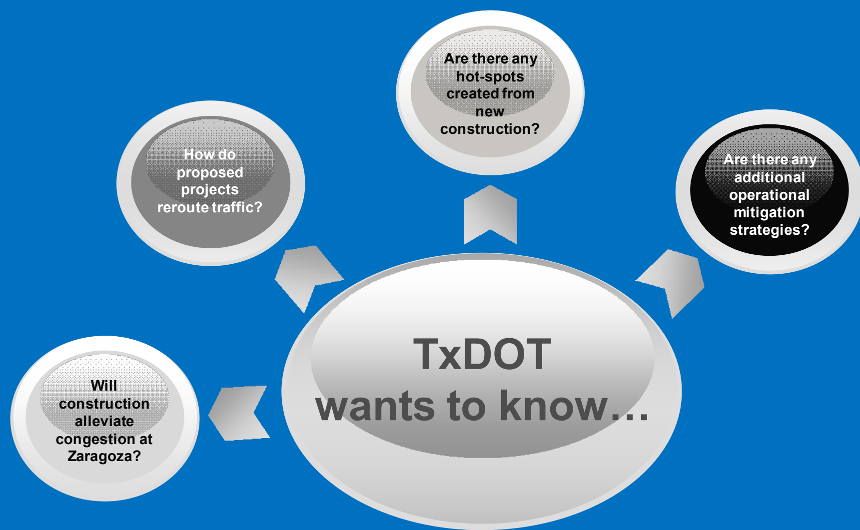
Case Study I

- TxDOT wants to reduce the severe congestion at the Zaragoza/I-10 diamond interchange
  - **Propose two additional diamond interchanges up and downstream of Zaragoza**
  - **Reverse/braided ramps upstream of proposed interchanges**
  - **Possible diverging diamond interchange**

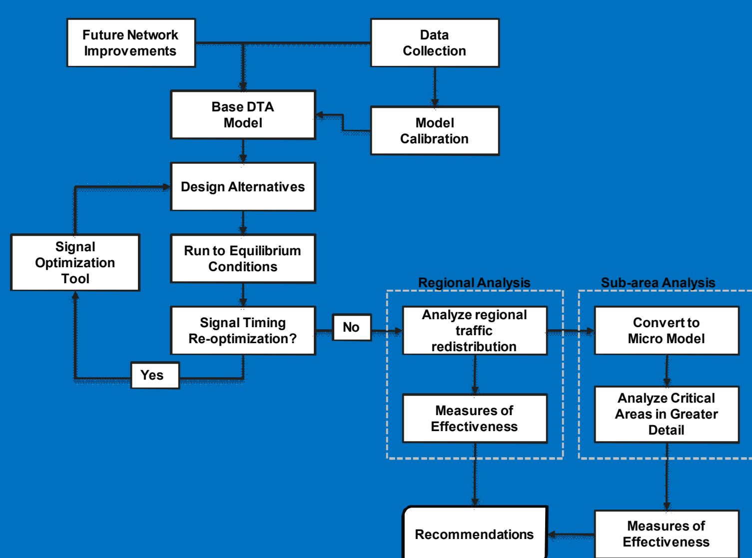
Case Study I



Case Study I



Case Study I

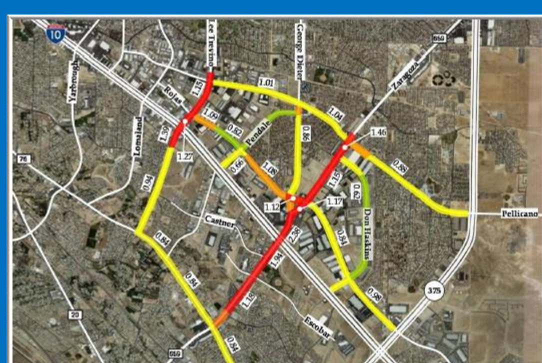


Case Study I

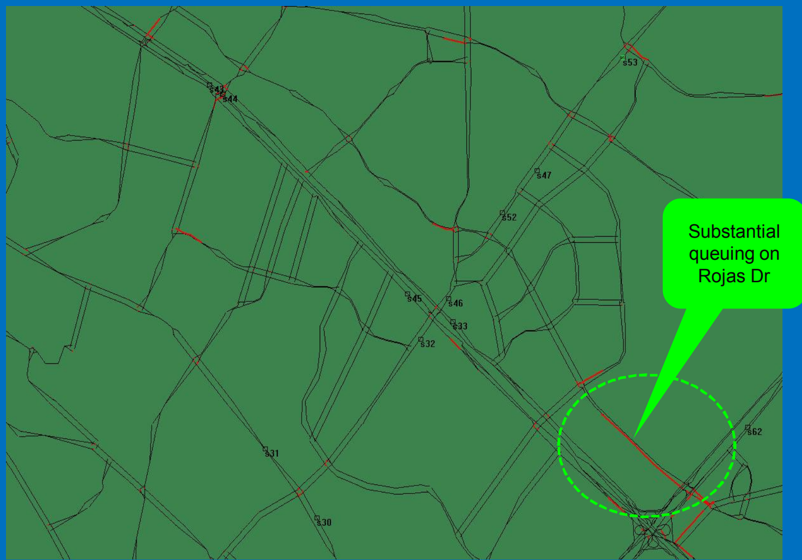
- Network loading and unloading of vehicles became a challenge.
  - **Mesoscopic DTA model showed severe queuing westbound on Rojas Dr/Loop 375**
  - **Private consultant conducted independent study and came to same conclusion**

"Rojas Dr will operate at a LOS E - F during peak periods of the day with substantial queuing"

Challenges in Operational Planning



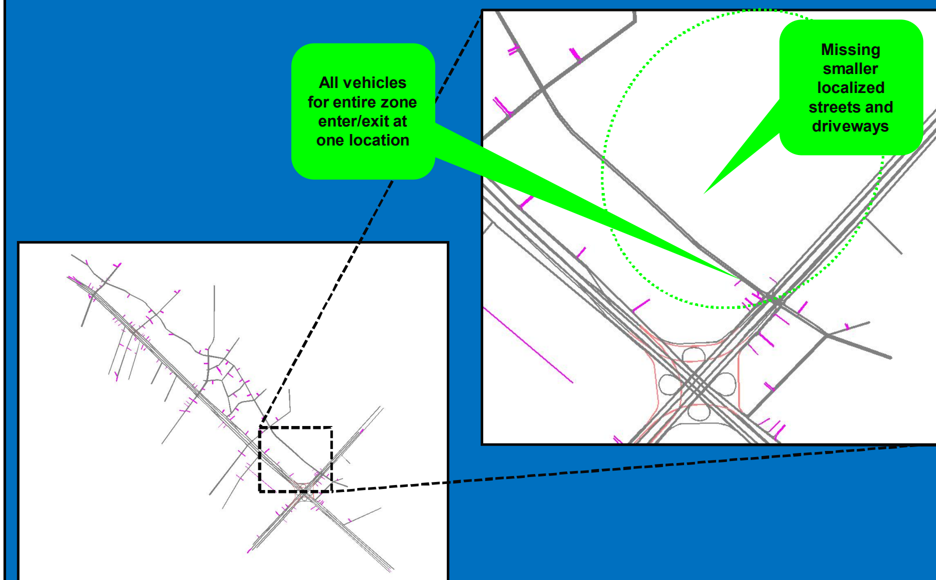
Case Study I



Case Study I

- Once we converted sub-area to micro-level, it was clear that the network was loading/unloading vehicles only in one specific spot on Rojas.

Case Study I



Case Study I

- Presented results to TxDOT and informed them of the limitations in using a regional model for operational planning projects
- TxDOT wants us to simulate the network again and include all smaller localized streets.

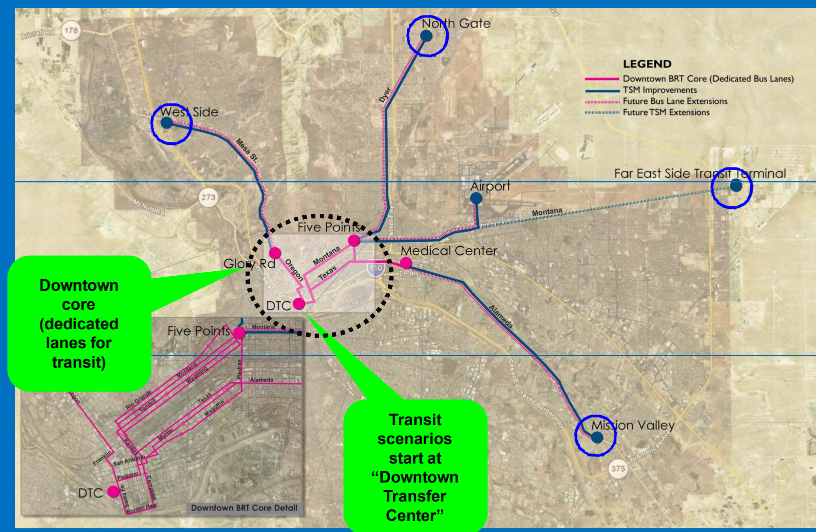
The more detailed the network, the more realistic the results will be

Case Study I

Case Study II

- The City of El Paso to conduct a transit corridor feasibility study
  - **Adopt four alternative corridors**
  - **Different alternatives include**
    - Bus Rapid Transit
    - Transit signal priority
    - Combination (BRT in core & signal priority on extensions)
  - **What is the effect on traffic?**

Case Study II



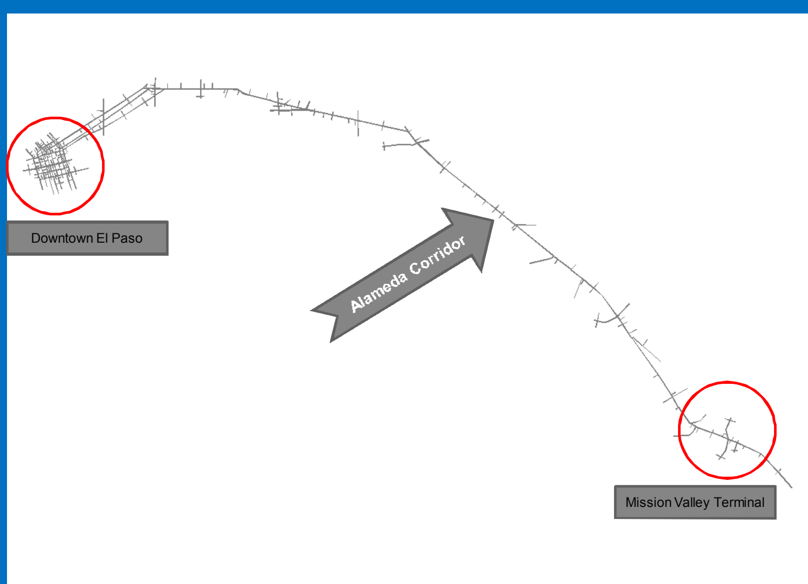
Case Study II

- Same methodology used as in case study I
  - **Developed base year model**
  - **Run DTA model to equilibrium conditions**
  - **Extract sub-area and convert to micro-level**
  - **Run micro model with different transit management strategies**

Case Study II

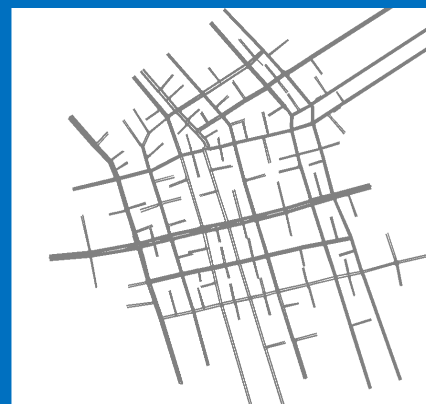
- Very large microscopic models
  - **Alameda corridor**
    - Over 10,800 links and connectors
    - 60 signals
    - 80,000 vehicles generated
    - Over 6,400 routes generated
    - Simulated for 4 hours
    - Paths updated every 15 minutes
    - All four transit corridors include all of downtown El Paso

Case Study II

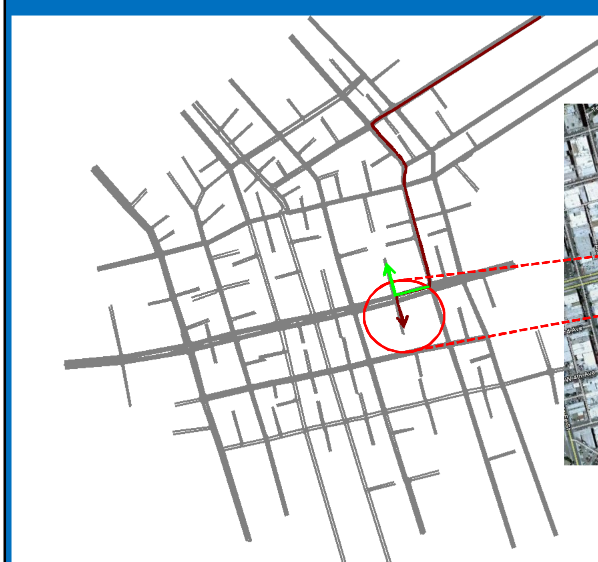


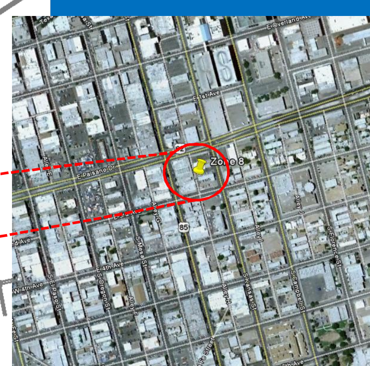
Case Study II

- Several weeks of calibration was needed for each model
- Downtown was difficult to calibrate due to size and number of zones
- Manual adjustment of vehicle destinations needed



Case Study II





Manually move some routes to alternate destination

Case Study II

- Simulation results were able to show impact of dedicated transit lane on traffic congestion
- Dedicated lane actually increased travel time for bus routes on Alameda
- Full BRT to extension terminals not feasible
- City has since reconsidered BRT and opted for BRT in core and signal priority to extensions

Recap

- Signal timing in future years needs to be optimized
- Care must be taken when translating vehicle loading between different levels of resolution
- Sufficient representation of roadway (links) in network
- Large micro-models require tremendous amount of calibration
- Sometimes using "best engineering judgment" is needed to further calibrate models.

Thank You!

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