Dynamic Traffic Assignment for Transportation Planning and Operations

Agenda

- Need for Analytical Tools
- Key Properties of Dynamic Traffic Assignment Methods
- Integrated Model Linkages with DTA
- Closing Thoughts

Law

Linking Planning and Operations

- **SAFETEA-LU Requires Plans to…**

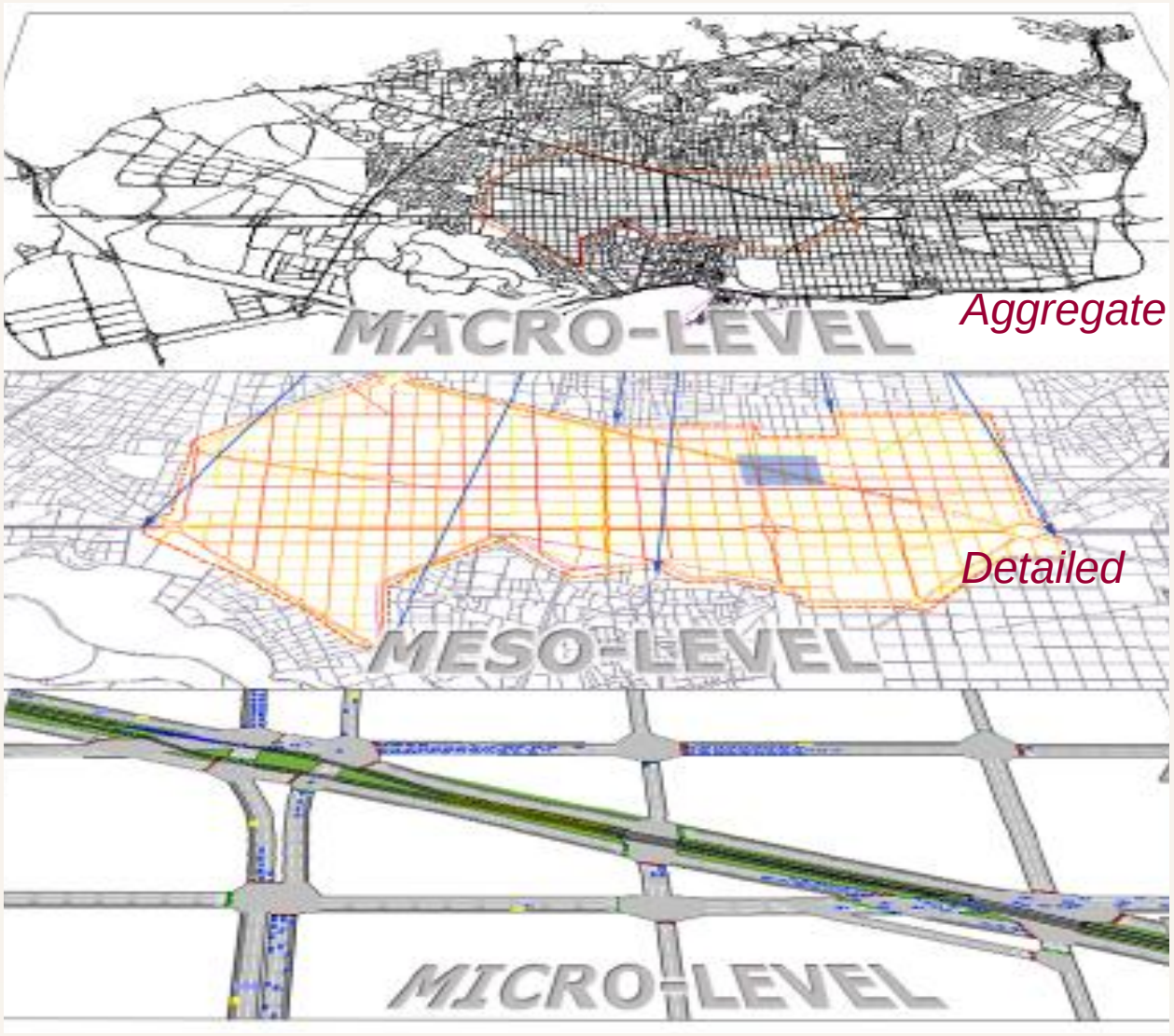
  – .. “Include Operational & Management Strategies to Improve Performance of Existing Transportation facilities, Relieve Vehicular Congestion & Maximize the Safety & Mobility of people & goods.” [1]

  – *[1] Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy forUsers (SAFETEA-LU) Section 6001(i), 2005.*

Role of Analysis Tools for Planning and Operations

- Analytical Support for Improved decision making
  - Set priorities among competing projects
  - Consistent approach for comparing alternatives
    - "Balanced" comparison for programming projects
    - Impacts, benefits, and costs of construction & operations strategies considered
  - Provides data to support planning needs
  - Forecasts future operations resource needs
  - Provides benefit information that can be communicated to agency management, politicians, and the traveling public

Spatial Resolution



Simulation Methods

- **Macroscopic**
  - Simulation of flow, speed, and density made on a segment-by-segment basis
  - Examples: FREQ, PASSER, Transyt-7F, VISTA
- **Mesoscopic**
  - Hybrid model where dynamic estimation of individual vehicles based on average segment speeds
  - Examples: DYNASMART-P/DynusT, DynaMIT-P, TransModeler, TRANSIMS
- **Microscopic**
  - Simulates detailed movement of individual vehicles throughout the network
  - Examples: CORSIM, Paramics, VISSIM, AIMSUN, TransModeler

Simulation Methods: Strengths, Limitations

Advantages

- Network-based
- Detailed results, particularly microsimulation
- Dynamic analysis of incidents and real-time diversion patterns
- Visual presentation opportunities
- Reuse for future analyses

Challenges

- Demanding data and computing requirements, particularly microsimulation
- Calibration may be time consuming for larger, more complex, or congested networks

Dynamic Traffic Assignment

- What is Dynamic Traffic Assignment (DTA)?
  - A **method** to describe the process and outcomes of how motorists with **different departure time** find their respective **experienced shortest (minimal-cost) path** from origin to destination in response to roadway **connectivity**, **capacity, or travel demand** changes
  - Or in laymen term "A capability to describe how tripmakers may take alternative routes when the roadway condition is different from normal condition"
- DTA model can be used to:
  - Evaluate individual travel time and cost
  - Represent traffic
  - Represent dynamic conditions of the transportation system
  - Represent resulting behavior

Dynamic Traffic Assignment

- DTA is emerging as a practical tool for numerous planning and operational applications
  - Addresses both the short- and long-term impact of operation plans and strategies at the investment and regional/systems level
  - Capable of reflecting true capacity constraints on upstream and downstream system performance over time
    - Better equipped (than) macroscopic models to evaluate the effectiveness of operations alternatives
  - Can interface with signal optimization, macro, and microscopic models
    - Ideal analysis scale for small regional/corridor studies
  - Most cost effective for corridor+ size analysis than micro models

Modeling Demand/Supply Interactions in DTA

- Four fundamental elements for a transportation System
  - **Infrastructure**
    - Geometries

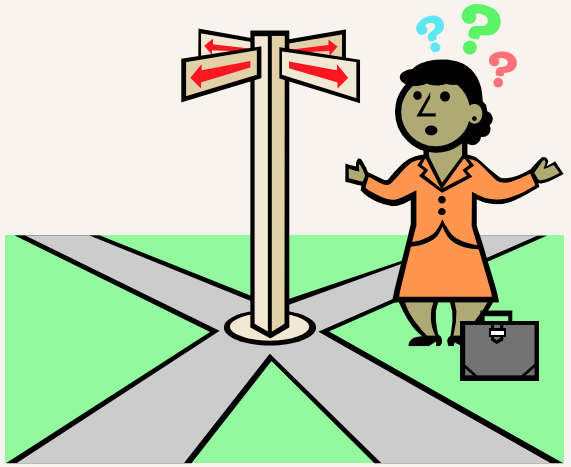
  - **Traffic flows**
    - Speed, density, flow, shockwaves, queue

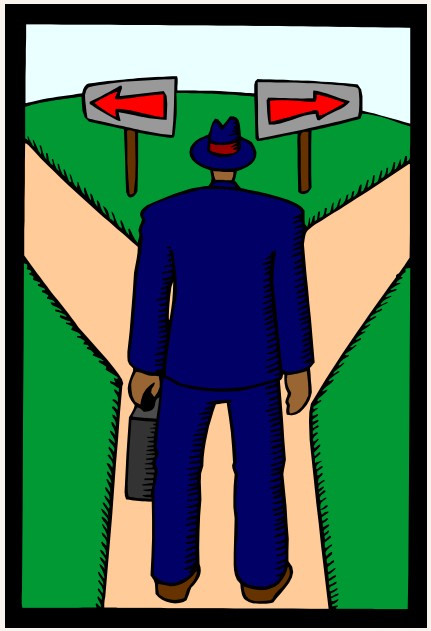
  - **Control systems**
    - Signals, ramp meters

  - **Information**
    - Traveler information, message signs

Rich Travel Behavior Representation

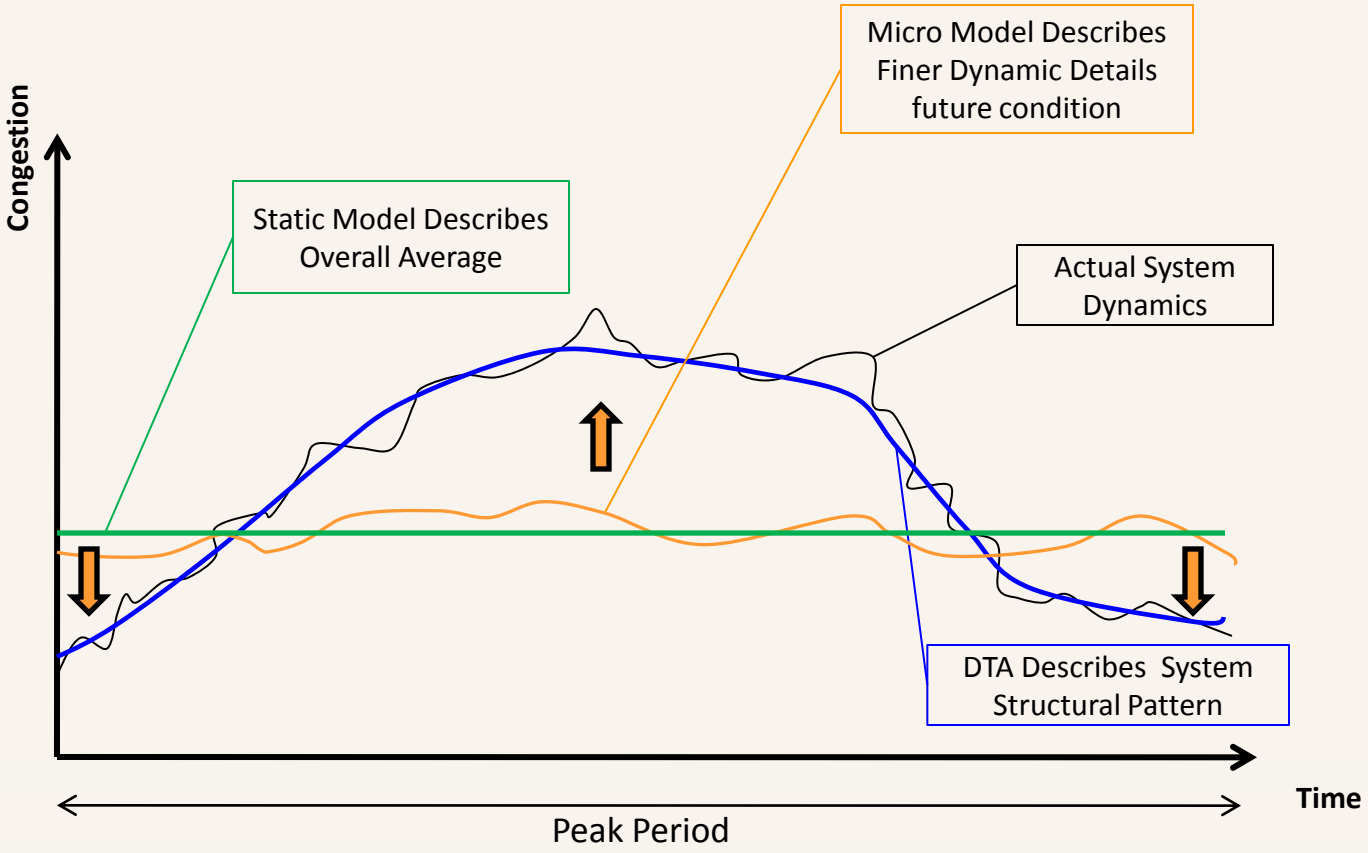
- Driving behavior
  - Car following
  - Lane changing
- Travel choice behavior
  - When to leave
  - Which route to take
  - Diversion or not
  - Reaction to
    - Work zone
    - Congestion
    - Information
    - Pricing
    - Evacuation scenarios





Macro-Meso-Micro

- Bridge macro and micro for a wide range of applications



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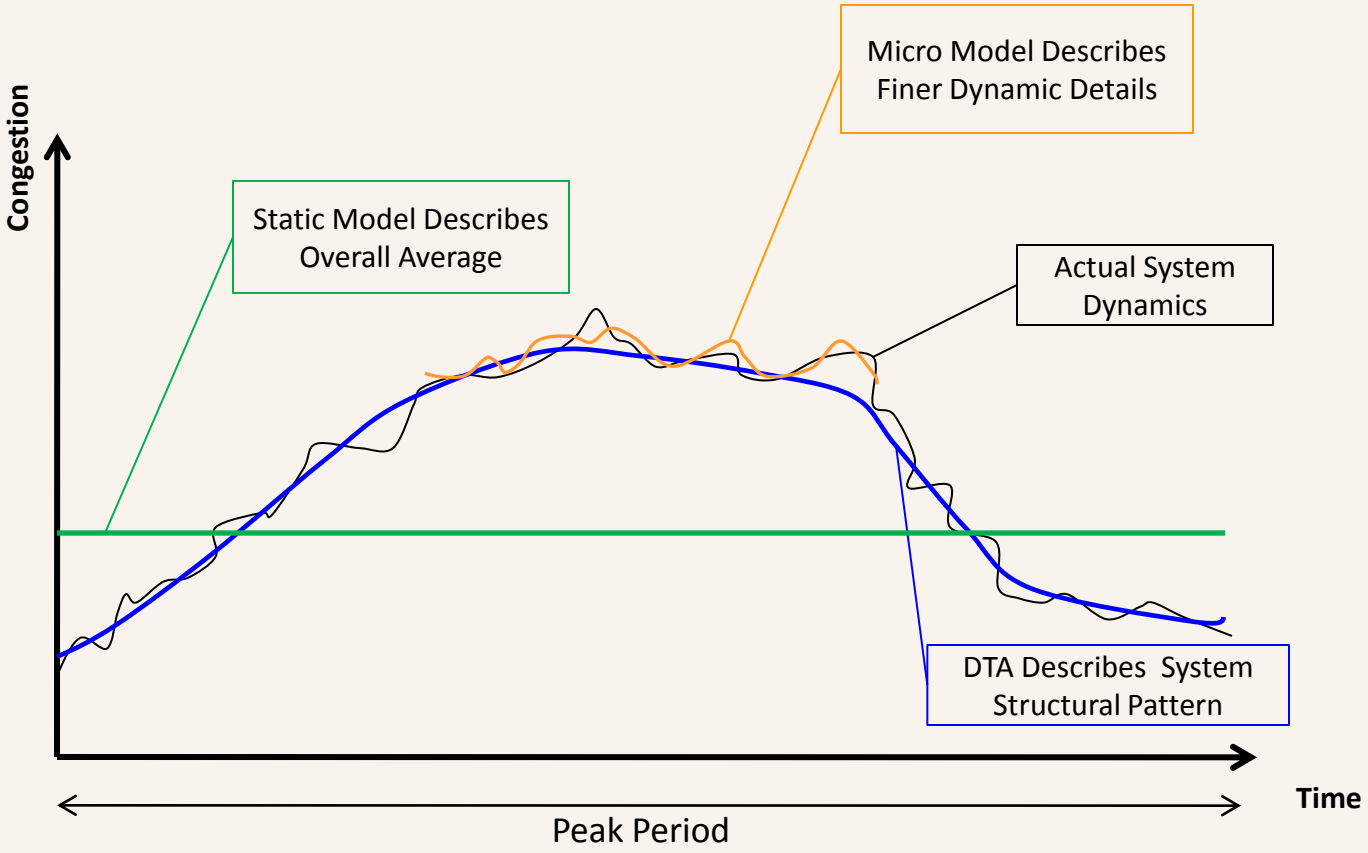
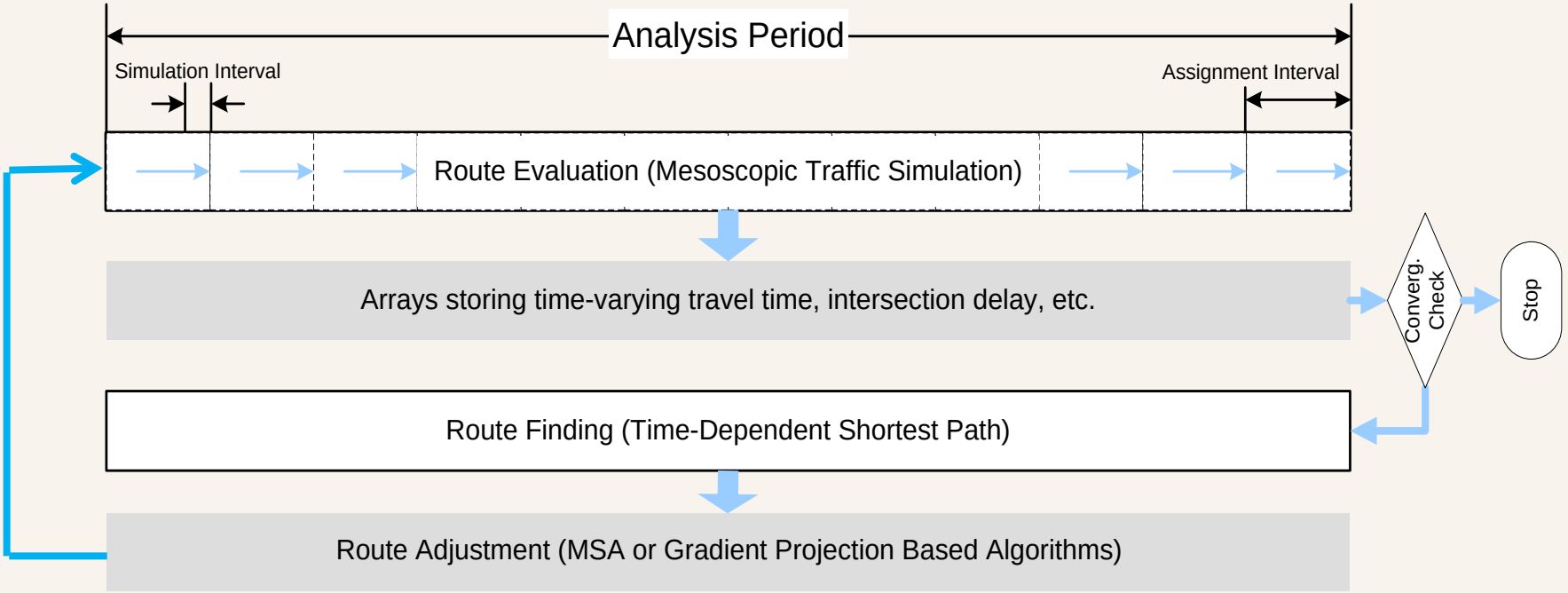
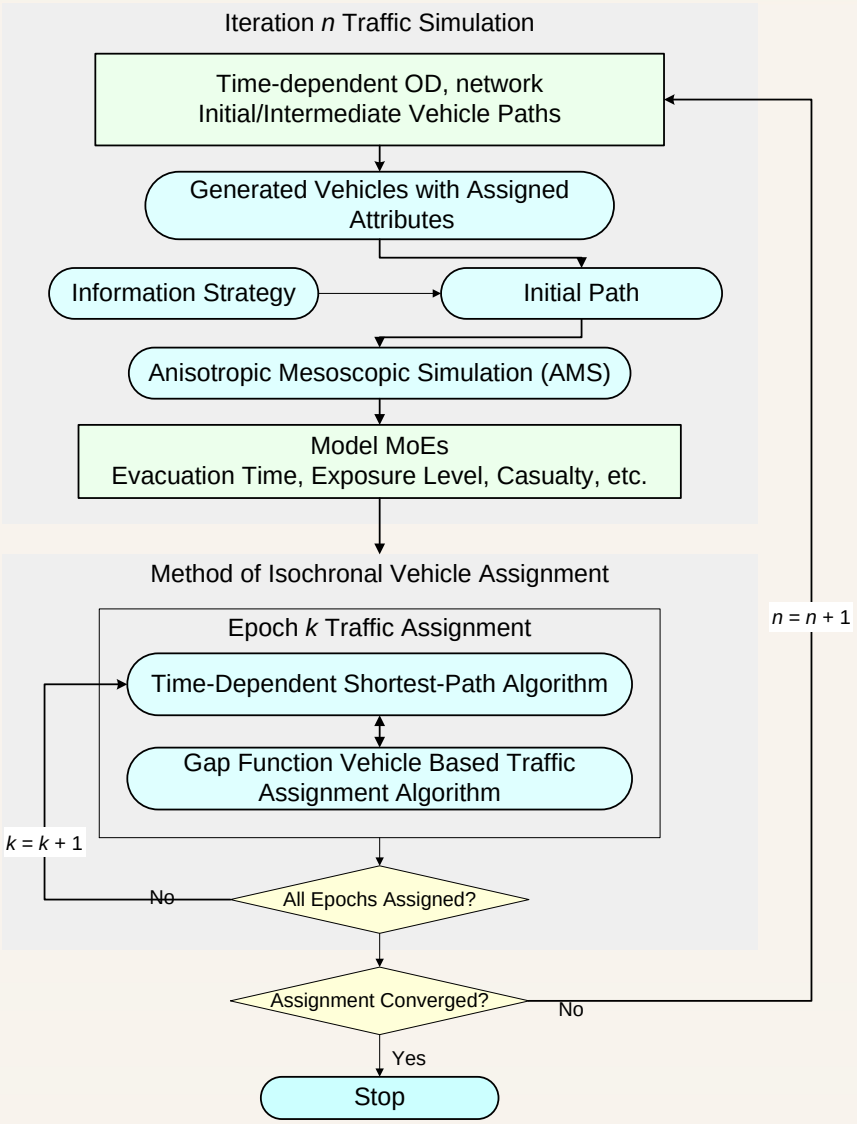


Simulation-Based Dynamic Traffic Assignment

- Typical algorithmic structure

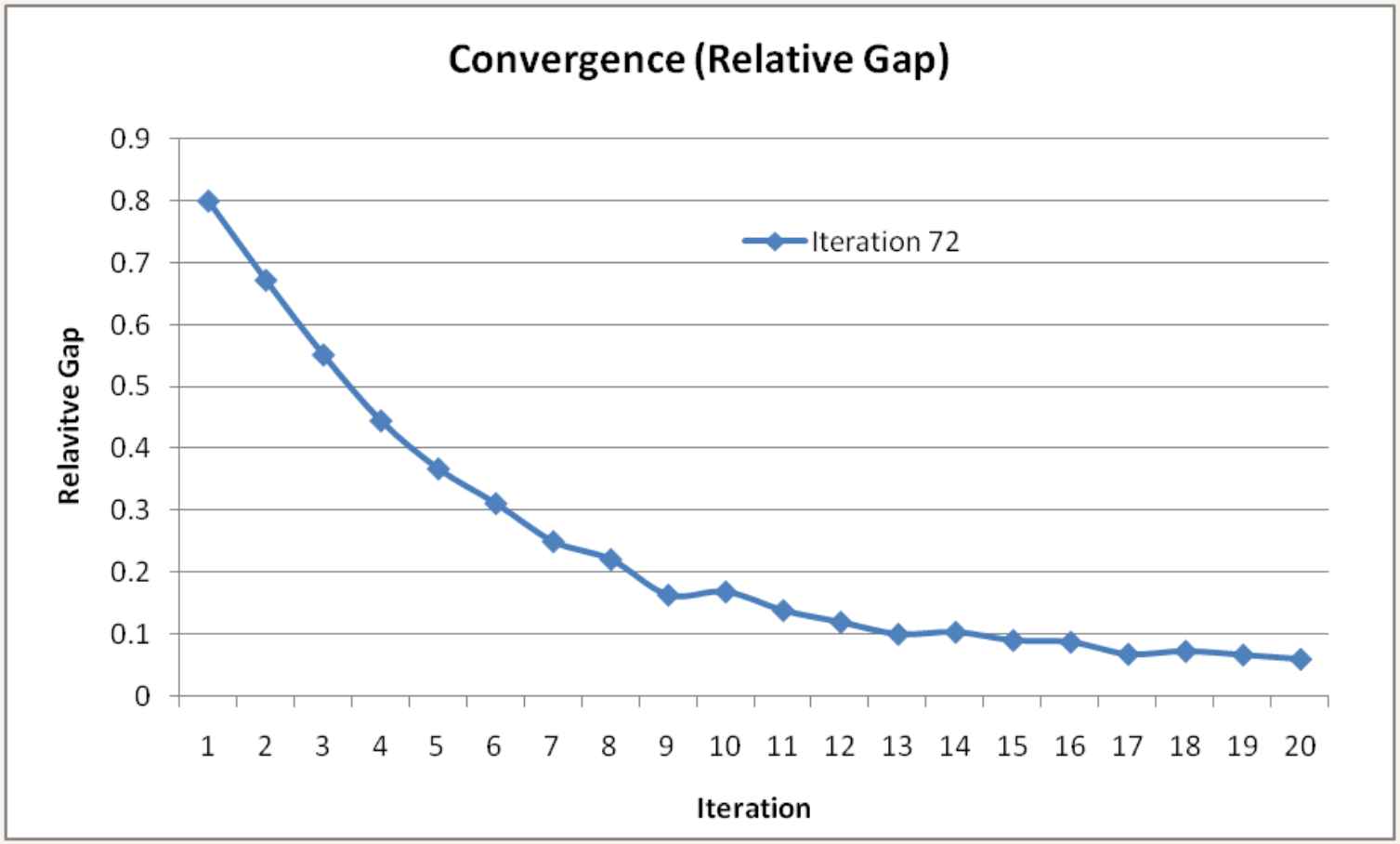


Simulation Assignment Framework



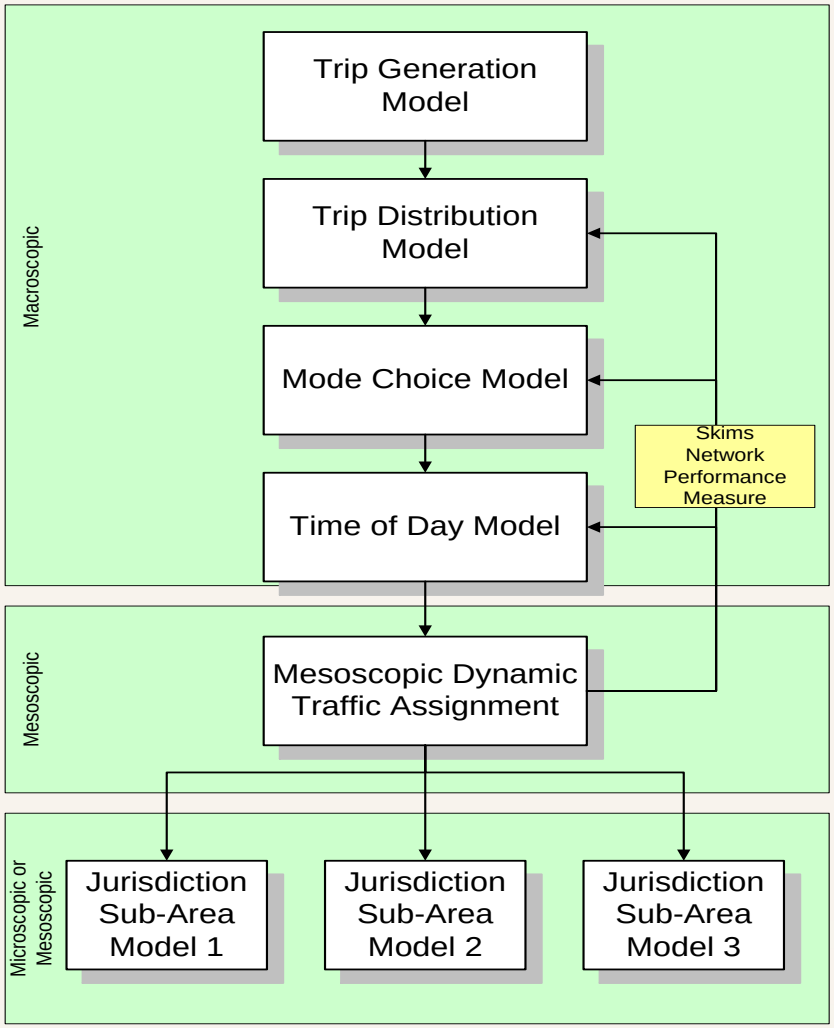
Gap-Function Vehicle Based Assignment

- Driven by Gap Function



Compatibility with Existing Modeling Framework

- Trip-based framework



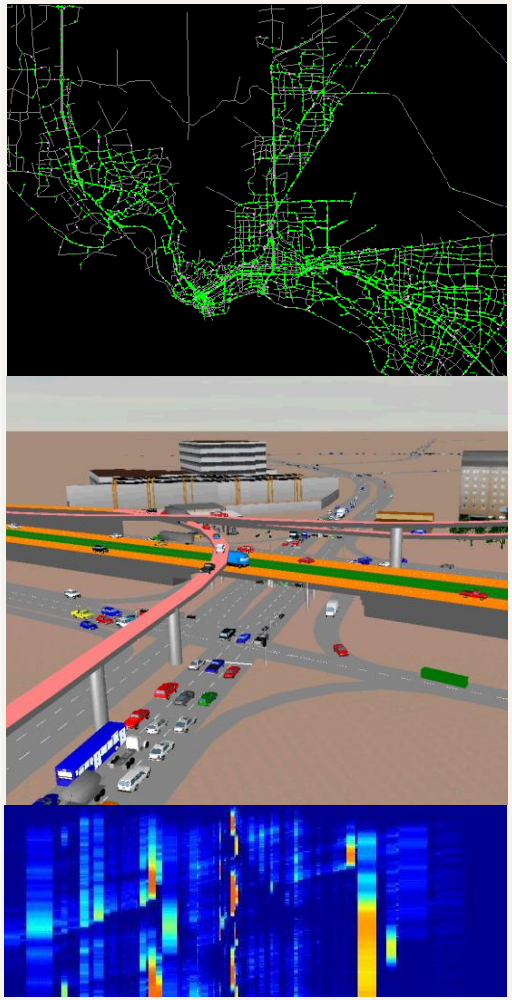
DTA Applications

- Linking Planning and Operation
- Planning project prioritization
- Construction project sequencing
- Incident Management
- Work zone impact analysis
- Tolls operations
- ITS/Operation analysis
  - DMS / Traveler information
- Evacuation planning

Who Using DTA (Federal)?

- FHWA - Integrated Corridor Management
  - 2 out of 3 pioneering sites (Minneapolis and Dallas)
- FHWA – Exploratory Advanced Research Program
  - Integrating land-use, activity-based model and DTA
- FHWA – Real-Time Traffic Estimation and Prediction
  - TrEPS – for real-time ITS based active traffic management

Who Using DTA (States)?



- IH corridor improvement (North Carolina)
- IH work zone planning (ELP, TX-2004)
- Evacuation operational Planning (Houston, TX, 2007, Baltimore, MD, 2005, Knoxville, TN, 2003)
- Florida turnpike system traffic and evacuation analysis (FDOT Turnpike)
- Downtown improvement (ELP, TX, 2004)
- ICM AMS modeling (Bay Area, CA, 2007)

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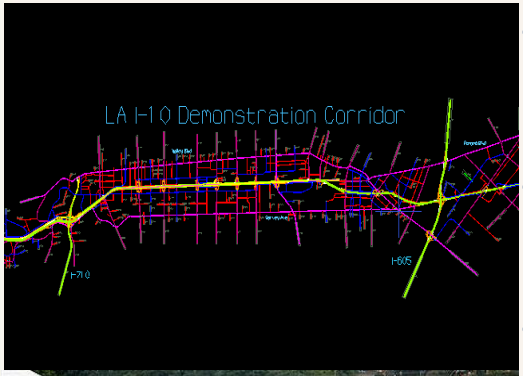

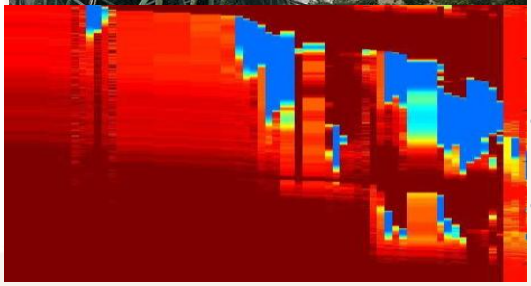

- **Military deployment transportation improvement in Guam** (PB, **FHWA**)
- **Interstate highway corridor improvement** (TTI, **TxDOT**, **ELPMPO,** Kittelson**, ADOT**)
- **Value pricing** (ORNL, **FHWA**; SRF, **Mn/DOT**, TTI, **TxDOT**, UA, **CDOT/DRCOG**)
- **Evacuation operational planning** (TTI, **TxDOT**, UA, **ADOT**; LSU, **LDOT**; Noblis, **FHWA**; Univ. of Toronto, Cornell Univ. Jackson State Univ., **MDOT**, Univ. of Missouri, **MDOT**)
- **Integrated Corridor Management modeling** (CS, **FHWA**, **MAG**, NCSU, **NCDOT**)
- **Pilot studies** (Portland Metro, DRCOG)
- **Activity-based model integration** (UA/CS, **SHRP2 C10**, **FHWA EARP**)
- **Work zone impact management** (**SHRP2 R11**)

Closing Thoughts

- Limitations of traditional Network-Based Models amplified when evaluating operations alternatives
  - Trip assignment is a ‘weak link’ of network models
    - Poor representation of speeds and congestions
- Meso methods (including DTA) provide a suitable level of fidelity for the effective evaluation of operations-based alternatives
  - Ideal temporal and geographic detail for corridor level analysis
  - Also applicable for regional analysis in large-scale networks
  - Retain some important properties of microsimulation methods
  - Can improve existing 4-step models and help enhance the effectiveness of microsimulation models
- Not “just” another tool, but a valuable addition to existing regional models

Conclusions

- DTA as a dynamic view of system
  - Regional/Corridor
  - Linking planning and operations
- Protecting/enhancing existing model investments
  - Interoperability with macro and micro models
- Plan ahead and make it a priority
  - Budget, data, man hours
  - Intellectual capability building
    - Agency staff
    - Consultants
- Work closely with developers

What is Next

FHWA is working on a One Day overview course:

- Expected to be completed by 1 April, 2011
- Looking for a locations to present the materials:
  - Expected to present it 5 to 6 location in FY 2011