AMPO Travel Modeling Working Group Meeting on Dynamic Traffic Assignment

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Technical Report Documentation Page

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16. Abstract On December 17-18, 2015, the Association of Metropolitan Planning Organizations (AMPO) convened a travel modeling working group meeting for the purpose of discussing Dynamic Traffic Assignment (DTA). Participants discussed the uses of DTA, challenges in using DTA and research needs. Challenges that were discussed included the modeling of transportation supply (the network, including traffic controls), making the appropriate translations from trip-based transportation demand, convergence, calibration and validation.		
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1.0 Introduction

1.1 Disclaimer

The views expressed in this document do not represent the opinions of FHWA and do not constitute an endorsement, recommendation or specification by FHWA. The document is based solely on the discussions that took place during and after the AMPO travel modeling working group meeting.

1.2 Acknowledgements

The FHWA acknowledges AMPO's efforts in organizing and facilitating the meeting, and is grateful for the time and thoughtful comments of the participants.

1.3 Report Introduction and Organization

On December 17-18, 2015, the Association of Metropolitan Planning Organizations (AMPO) convened a travel modeling working group meeting for the purpose of discussing Dynamic Traffic Assignment (DTA). The meeting was held at the Atlanta Regional Commission (ARC) and by web conference. This report presents findings from the following components of the meeting:

- Experiences with DTA – Roundtable Discussion covering:
    - Success stories and lessons learned from current DTA work;
    - General DTA modeling procedures and modeling issues;
    - Policy issues and transportation applications agencies address using DTA;
    - Transportation applications where DTA could be useful;
    - Agencies planning to undertake DTA in the near future; and
    - Other issues.
- Facilitated Discussion - Development of DTA Research Needs Statements.

In person participants included:

- Charles Baber, Baltimore Metropolitan Council
- Carlos Carrion, University of Maryland (December 18th only)
- Hamideh Etemadnia, Denver Regional Council of Governments
- Liyang Feng, Southeast Michigan Council of Governments
- Bill Keyrouse, AMPO
- Guy Rousseau, ARC
- Steve Lewandoski, ARC (December 18th only)
- Lubna Shoaib, East-West Gateway Council of Governments
- Scott Smith, Volpe Center, US DOT

Telephone/web participants included:

- Denise Bunnewith, North Florida Transportation Planning Organization
- Rick Curry, San Diego Association of Governments
- Rich Denbow, Cambridge Systematics
- Craig Heither, Chicago Metropolitan Agency for Planning

- Ron Milone, Metropolitan Washington Council of Governments (MWCOG)
- Mark Moran, MWCOG
- Dzung Ngo, MWCOG
- Arash Mirzaei, North Central Texas Council of Governments
- David Ory, Metropolitan Transportation Commission
- Sarah Sun, FHWA

Peter Bosa of Portland Metro and Vladmir Livshits of the Maricopa Association of Governments provided additional comments on an initial draft of this report. This report considers their comments as well as those of the participants. The remainder of the report is in three sections: the uses of DTA, challenges with using DTA, and research needs going forward.

2.0 Uses of DTA

DTA provides a way to examine the interaction between network performance and demand on a transportation system, at a much more fine-grained temporal and spatial resolution than is typically available in static four-step models. Participants discussed their experiences with DTA, and agreed that DTA is useful for assessing traffic management actions. It is also useful in situations where either supply or demand tend to be highly time dependent, and in situations where it is necessary to report on congestion and queuing in greater spatial and temporal detail than is possible with static models.

Traffic management actions that were mentioned include shoulder running (either for buses or general traffic) and any number of Intelligent Transportation System (ITS) improvements including dynamic pricing, ramp meters, transit signal priority, and signal coordination. Although tolls can be handled to some extent in a static model, a time-sensitive model is needed to handle dynamic pricing, especially on a managed lane with a target speed. Similarly, the treatment of signals in an arterial system is inadequate in static assignment.

DTA is useful on congested corridors, where time-of-day choices, queue spill back and response to incidents need to be considered. In such an environment, static assignment is not detailed enough, but microsimulation may be more detailed than is necessary. A windowing approach may be helpful, with a regional DTA and increased refinement in a subarea.

Finally, DTA is useful where demand is highly time-dependent. This includes special event and evacuation planning.

With increasing computer capabilities and data availability, models are increasing in fidelity. The modeling of dynamic traffic phenomena is one example of this increase in fidelity. However, DTA is not the only approach. Microsimulation is another approach and some have argued that in a dynamic environment, it may not be necessary to run a model to equilibrium.

3.0 Challenges in Using DTA

Challenges in using DTA include:

- Ensuring that users understand the assumptions about travel and driver behavior, and traffic flow theory underlying a particular DTA model;
- The representation of transportation supply (the network and traffic controls);
- Representation of demand;
- Run times;
- Convergence; and
- Data needs for calibration and validation.

3.1 Transportation Supply

A DTA network and its associated traffic controls typically require more detail than the network used in static assignment models. For example, in its Second Strategic Highway Research Program (SHRP2) Integrated Dynamic Travel Model (C10) project that includes a DTA component, Atlanta Regional Commission (ARC) has allowed one year for network development. They conflated an existing stick network with a NAVTEQ (now part of HERE) centerline file to obtain geometries, and also used NAVTEQ to add most of the signals. A variety of sources (Google maps, local jurisdictions, Georgia Department of Transportation) were needed to get to 100%; this involved substantial manual work.

Obtaining sufficiently detailed traffic signal information can be time consuming. Although the locations of traffic signals are often available, the challenge is in obtaining phasing, timing and progression information. This information is available from Synchro files, and DynusT has some defaults. ARC's model has more than 5,000 signalized intersections, and found coding the signals to be a four-month effort involving staff and three interns. Given this high level of effort to code the signals in a large network, a reasonable approach might be to focus detailed modeling efforts on the regionally significant corridors, and accept approximations and defaults elsewhere. Without reasonably good signal plans, the DTA can struggle with convergence and networks can become overloaded with congestion. The degree of detail needed for the modeling of signals also depends on the model package being used, with a microsimulation model typically requiring more detail than a DTA model.

Networks that are used in static models may not have the detailed road geometries (turn pockets, multiple turning lanes) that are sometimes required in DTA models. Finally, although it was not discussed at this meeting, detailed information on transit services and access may not be readily available.

Future-year conditions can also be an issue. Heuristics based on population and employment forecasts may be used to synthesize traffic controls at future year intersections. In a 30-year horizon, potential technological and social changes (for example, shared autonomous vehicles), may make it impossible to simply extrapolate from existing conditions. A related question is that of updating the network from year to year. An MPO might be using a base map from a third party provider with annual updates. How does one merge the changes from a new base map into an existing network?

3.2 Transportation Demand

In a static model, the demand for transportation is typically represented in a zone-to-zone trip table for a particular time period that may last several hours. In trip-based static (four-step) models, entries in the trip table may be fractional, and often less than one. Dynamic models may be expecting integer trips, from one location to another location at a particular time. Three areas require attention:

- Translation of origins and destinations to the level of spatial detail required by the intended use of the DTA. For example, if a corridor analysis on an arterial is being performed, and the DTA can use locations on a street to introduce flow to the network, the zonal flow may need to be distributed among the locations on the streets in the zone.

- Assignment of departure times. If there is a certain number of trips during a particular time period (e.g., the AM peak 7 – 10 AM), these trips may need to be distributed to specific departure times.
- Creation of integer trips. Trip table entries often have fractional values. Techniques, such as bucket rounding, exist for making reasonable conversions from fractional to integer trips.

3.3 Convergence

Combined dynamic traffic assignment / activity based model (DTA/ABM) systems can have significant central processing unit (CPU), memory and disk requirements, resulting in long run times when multiple iterations are executed in an effort to reach convergence. It may be helpful for DTA users to share their experiences, so that the appropriate hardware can be acquired at the beginning of a project.

Convergence of DTA models raises a number of other questions[1]. Although static models may be reasonably expected to reach a 0.0001 or lower relative gap[2], it may not be possible to reach this point with a DTA model. With integer flows and no splitting of trips[3], too much oscillation might occur. With this oscillation, there may be significant "noise" in the model, as total vehicles hours traveled (VHT) and other performance measures change from one iteration to the next. Dynamic tolls will also affect convergence, as the toll prices may change from one iteration to the next as the use of the facility changes. When DTA is used to assess a small project, the expected improvement in VHT might be small enough to be masked by this noise.

More fundamentally, we should be asking what level of convergence is needed, and what types of convergence we should be measuring. The answers may change depending on how the model is used. For example, aggregate numbers are fine when considering air quality attainment. On the other hand, more detail is needed when a ramp or specific road is being analyzed.

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[1] A 2015 report prepared by Caliper Corporation for the Federal Transit Administration provides a discussion of convergence and its importance. See http://www.caliper.com/PDFs/traffic-assignment-and-feedback-research-to-support-improved-travel-forecasting.pdf

[2] Relative gap measures the sum of the flow-weighted differences between the generalized cost (travel time) on the route used for an O-D pair, and the generalized cost on the least cost (fastest) route for that O-D pair. In a true user equilibrium condition, the relative gap is 0.

[3] There may be two routes between an origin and destination with similar travel times. In an all-or-nothing assignment, all of trips are assigned to the shortest route, while in reality they may be split between the routes. Furthermore, as iterations proceed in the assignment process, these trips may toggle back and forth between one route and the other.

3.4 Calibration and Validation

How much data are needed to calibrate and validate a DTA model? A large region may need more than 5,000 traffic counts, which will come from a variety of sources: local, county and state DOTs. For example, the SEMCOG static assignment model uses about 7,000 daily traffic counts.

A number of agencies are looking at INRIX and AirSage data. AirSage is mostly used for origins and destinations, while INRIX provides speed and some volume information. One participant remarked that in the Washington DC region, the INRIX data covers nearly all of the freeways and many arterials. It is good at showing congested areas, but may not provide reliable free flow speed information.

4.0 Research Needs

Research needs fall into the following areas:

- Helping users to understand how DTA fits into a modeling environment, and why DTA is valuable
- Input data
- Convergence, calibration and validation
- Software and hardware

4.1 User Understanding of DTA

A potential user of DTA may be a Metropolitan Planning Organization (MPO), State Department of Transportation (DOT), municipality, or other agency. They need to make the case for DTA by bringing well-documented applications and case studies to senior management. Case studies can help in demonstrating the potential benefit of DTA to regional planning.

Users also need to understand how DTA will fit into their modeling environment. An agency may have both static and dynamic models for different uses. For example, the static model may be used for air quality assessments while a dynamic model is used for corridor analysis. Finally, an agency needs to understand what level of staff resources will be required to develop a DTA model.

4.2 Input Data

What is the minimum amount of data needed to support a DTA model, at the corridor or subarea level? The answer to this question will depend on the planned use of the model, but for most models, the following data types should be considered:

1. Supply (network) data. Starting from a line network of roads, what additional data are needed? Do signal locations (without phasing, timing, and coordination) provide a

reasonable starting point, or are detailed signal data needed? What network fidelity is needed (e.g., pocket lanes)? Is there value in providing a standardized representation of a routable network, to include links, nodes, intersection connectivity, pocket lanes and traffic controls? What tools would be most useful for converting supply data into a form usable by DTA?

2. Demand data. How detailed does demand data need to be in time and space. Many are now using a 15-minute temporal resolution for time-dependent trip tables and time-dependent shortest path. What are the implications of using 15, 30, or 5 minutes? What are the implications of using zone versus parcel data? How do we ensure consistency with existing trip tables?
3. Calibration data. How much count and speed data are needed to calibrate and validate a DTA model, and at what level of temporal resolution?

The treatment of traffic signals is particularly challenging in a large network, where there are insufficient staff resources to optimize individual signals and sets of signals on corridors. DTA models would become significantly more useful if they included the capability to synthesize good signal timing, phasing and coordination plans, based on inputs including projected traffic volumes, road functional classification, and policies (e.g., we will optimize flow on XYZ corridor).

Research is also needed on the treatment of traffic controls in future year models. It may be necessary to link travel forecasts to land use forecasts. In a long term (20-30 year) forecast, not only do we need to forecast future travel patterns and the resulting traffic volumes, we need to forecast what traffic controls will be put in place in response to the changed traffic patterns. We may also need to consider major technological changes, such as automated vehicles. One idea is to treat the control as an agent, with a predictive model of what it will do (e.g., if volume exceeds X, the stop sign becomes a signal). Perhaps such a model can be tied to traffic signal warrants.

4.3 Convergence, Calibration and Validation

In a static model, the number of trips on a particular route between an origin and destination is typically fractional, with travel time being calculated via a set of volume-delay functions. The travel time is an average over an entire time period, which is typically several hours. On the other hand, a DTA model will provide trajectories for individual vehicles (especially if it is a simulation-based DTA), with an integer number of trips. In such an environment, what is the best convergence that can realistically be achieved?

Related to this question is that of the stability of the solution from a DTA model. Will performance measures, such as VHT, remain the same from one run to the next, given identical inputs? Or will they vary enough to mask any improvement created by the project under consideration?

In an environment where both volumes and speeds vary with time, how is calibration done? The traditional count-based methods for static models still apply, but what about the newer data sources? How does one effectively use thousands of 15-minute counts or speed observations? What are the calibration criteria?

4.4 Software and Hardware

Participants mentioned a number of DTA products, including DTALite, DynusT, Aimsun, Dynameq, Cube Avenue DTA, TransModeler, TransDNA, DynaMIT, VISTA, DynaSmart and DIRECT. Although obtaining details from the vendors of proprietary software can be challenging, it may be helpful to compare DTA platforms to identify strengths and weaknesses, including technical support and data needs.

Given the run time issues that sometimes occur, participants would like more support from DTA providers on what equipment to acquire, and how to set it up.

Finally, it was noted that a mix of open source and commercial DTA software products are available. Which business models for DTA software support can most effectively meet user needs going forward?

Appendix 1: Attendees

Organization	Name	Email
ARC	Guy Rousseau	grousseau@atlantaregional.com
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For AMPO	Janet Oakley	janetoak@aol.com

Appendix 2: Agenda

This report focuses on those portions of the agenda that were outlined in the introduction.

AMPO Travel Modeling Work Group Meeting - Final Agenda
December 17-18, 2015
Atlanta Regional Commission
40 Courtland Street, NE
Atlanta, GA

December 17: Harry West Room "B" – Main "C" Level

2:00 pm — Welcome and Introductions

Opening Discussion – Meeting purpose and desired outcome

Status of Activity-Based Models and Dynamic Traffic Assignment at Peer MPOs – Mark Moran, MWCOG-NCRTPB

Experiences with DTA – Roundtable Discussion

- Success stories and lessons learned from current DTA work
- General DTA modeling procedures and modeling issues
- Policy issues and transportation application agencies address using DTA
- Transportation applications that DTA could be useful for
- Agencies planning to undertake DTA in the near future
- Other issues

Comments on TMIP draft report – *How to Calibrate and Validate a Regional DTA Model for Planning Applications* (draft report to be emailed to participants prior to the meeting)

AMPO Research Foundation Common Modeling Platform Development Status – Guy Rousseau, ARC

5:30 pm — Adjourn

December 18: Chattahoochee Room, Level 2

9:00 am — SHRP2 ABM/DTA Integration

- Maryland Integrated Travel Analysis Modeling System (MITAMS) – Carlos Carrion, University of Maryland
- Atlanta Regional Commission – Guy Rousseau, ARC

Facilitated Discussion - Development of DTA Research Needs Statements

- Detailed research recommendations

Modeling Updates – Roundtable

- Current and planned modeling initiatives

Future Meetings

12:00 pm — Adjourn

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