Partnership to Develop an Integrated, Advanced Travel Demand Model and a Fine-Grained, Time-Sensitive Network in the Sacramento Region

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Introduction

This paper describes the work plan for Project C10 of the Strategic Highway Research Program (SHRP2) titled "Partnership to Develop an Integrated, Advanced Travel Demand Model and a Fine-Grained, Time-Sensitive Network." Project C10 consists of two projects: one which includes both highway and non-highway modes, and one in which choices of non-highway modes are limited. This paper discusses the former project, which focuses on the Sacramento, California region.

Project C10 is an important step in the evolution of travel modeling from an aggregate, trip-based approach to a completely dynamic, disaggregate methodology. At the same time that travel demand models have been evolving, traffic simulation models, which simulate the movements of vehicles through a highway network, have become more sophisticated due to improvements in computing. The product of project C10 will be a true integrated model that simulates individuals' activity patterns and travel and their vehicle and transit trips as the move on a real time basis through the transportation system. It will produce a true regional simulation of the travel within a region, for the first time using individually simulated travel patterns as input rather than aggregate trip tables to which temporal and spatial distributions have been applied to create synthetic patterns. The product is intended to be a model that can be used in any urban area with a significant amount of multimodal travel and will be implemented in an open source software framework. The progress of this project will therefore be of great interest to planners in such urban areas.

The goals of C10 are to improve the travel modeling process to address key transportation policy and investment questions, to facilitate further development, deployment, and application of the procedures, and to make operational an advanced travel demand model integrated with a fine-grained, time-dependent network. Secondary objectives include:

- Production of a portable, transferable product
- Incorporation of products from other SHRP projects
- Incorporation of travel time reliability into the modeling capabilities
- Demonstration of the application of outputs of the integrated model to estimate greenhouse gas emissions using MOVES, the new EPA air quality analysis model

- Demonstration of the dynamic integrated model set in a real-world environment on selected policies

The objectives of SHRP C10 include developing tools to accurately analyze the effects of policy and investment questions that are critical to planning in urban areas today. These questions require a model that:

- Reflects the sensitivity of travel choices to the continuous changes in traffic characteristics throughout the day;

- Considers the full range of choices that each traveler encounters, including whether to travel, activity location, mode, route, and departure time, and their effects on other activity decisions the person makes;

- Is fully disaggregate to properly consider the effects of individual choices and to provide results at any relevant level of aggregation; and

- Is sensitive to the important variables affecting travel decisions, including transportation level of service, reliability of travel time, traveler and household demographics, and land use.

The Integrated Model

The structure of the integrated model is shown in Figure 1. The project team is implementing this approach by integrating an activity based model (SACSIM) with a traffic microsimulation model, DynusT. The integrated model will link individual person records with vehicle and transit trips in the microsimulation, and transit tours will be simulated. Software development professionals will perform the programming of the integrated model.

SACSIM is the travel demand model used by the Sacramento Area Council of Governments, the metropolitan planning organization (MPO) for the Sacramento region. It is one of only four activity based models currently in use by MPOs in the U.S. although several others are currently developing such models. Internal person trips are modeled using a complete activity based approach that simulates each person's set of daily activities by purpose, expressed as tours, and their sequence, locations, and times, as well as the modes used to travel between activity based locations.

DynusT lends itself well to the integration with both SACSIM and MOVES. DynusT is a true disaggregate simulation model that can track individual vehicles and transit travelers through the network—consistent with tracking traveler activities in a travel demand model. Furthermore, DynusT is a true dynamic traffic assignment (DTA) model that takes into account both the spatial and temporal effects of congestion. DynusT has been shown to be able to simulate and assign traffic over a 24-hour period.

The Motor Vehicle Emission Simulator (MOVES) is the next generation mobile source emission model being developed by the U.S. Environmental Protection Agency (EPA). Ultimately, upon formal adoption by the EPA, MOVES will serve as a single comprehensive system for estimating emissions from both on- and non-road mobile sources for state implementation plans (SIP) and regional or project-level transportation conformity analyses. MOVES is designed to estimate emissions at scales ranging from individual roads and intersections to large regions.

An item of critical concern for C10 is the consideration of the effects of travel-time reliability on travel choices. Both anecdotal and technical studies indicate that average congestion levels have grown—and are continuing to grow—in our cities. Therefore, travel-time reliability has come to be recognized as a major component of transportation system performance. It has been observed from SHRP Project L03 research that congestion is highly dynamic and interactive: an event influences—and is influenced by--other events.

Software Approach

The proposed software architecture for the new model will allow users to access the modeling software using any web browser, with the major model components running on one or more shared servers. This allows for the much more efficient sharing of large data files, alleviates the need for every modeler to have a powerful desktop computer, and enables the research team to use parallel processing or other techniques as necessary to ensure adequate performance. We propose to design, document, and implement clean boundaries and interfaces between the model components, leveraging our experience in software system integration and in developing transportation data exchange standards. The resulting software architecture will be efficient, modular, and maintainable and will reduce the risk of changes to one model component affecting the operation of the model as a whole.

The software will be developed using an iterative, incremental methodology that reduces risk, ensures continuous testing, and makes progress more transparent and predictable. Under this approach, an initial software release will be delivered in early 2010, with updated releases with additional features and capabilities on roughly two-month cycles until the model integration is complete. The methodology also outlines rigorous quality assurance and testing procedures and high standards and specifications for documenting the software design.

This process makes virtually the entire suite of research products available to the transportation community, making all pre-existing model components available (along with any modifications) under open source licenses, and making the National Academy of Sciences (NAS) the owner of all new software. The plan also yields an integrated model that does not depend on any commercial travel demand modeling or simulation software. The entire modeling system—both executable programs and source code—will be readily available to the broadest possible set of constituents, enabling public agencies to use and customize the software to meet their needs; enabling researchers to modify or enhance the system, or even create new modeling system components that interact with the proposed framework; and encouraging commercial software developers and transportation planning firms to leverage the framework in a way that benefits the industry and provides them with appropriate commercial opportunities.

Project Status

By spring 2010, the project team will have begun the development of the integrated model. The detailed model plan will be presented, the iterative approach to software development laid out, and the necessary data collected and assembled. The presentation for this paper will provide the specifics of the model plan, including details of how SACSIM, DynusT, and MOVES will be integrated, and initial results of the model development and the software iteration process.

The project team will be making presentations throughout the course of the project, at venues where MPO planners and modelers can obtain progress updates and provide feedback to the project team. The project is scheduled to be completed in the spring of 2012, at which time the integrated model will be made available to the public.

Figure 1. Model Structure

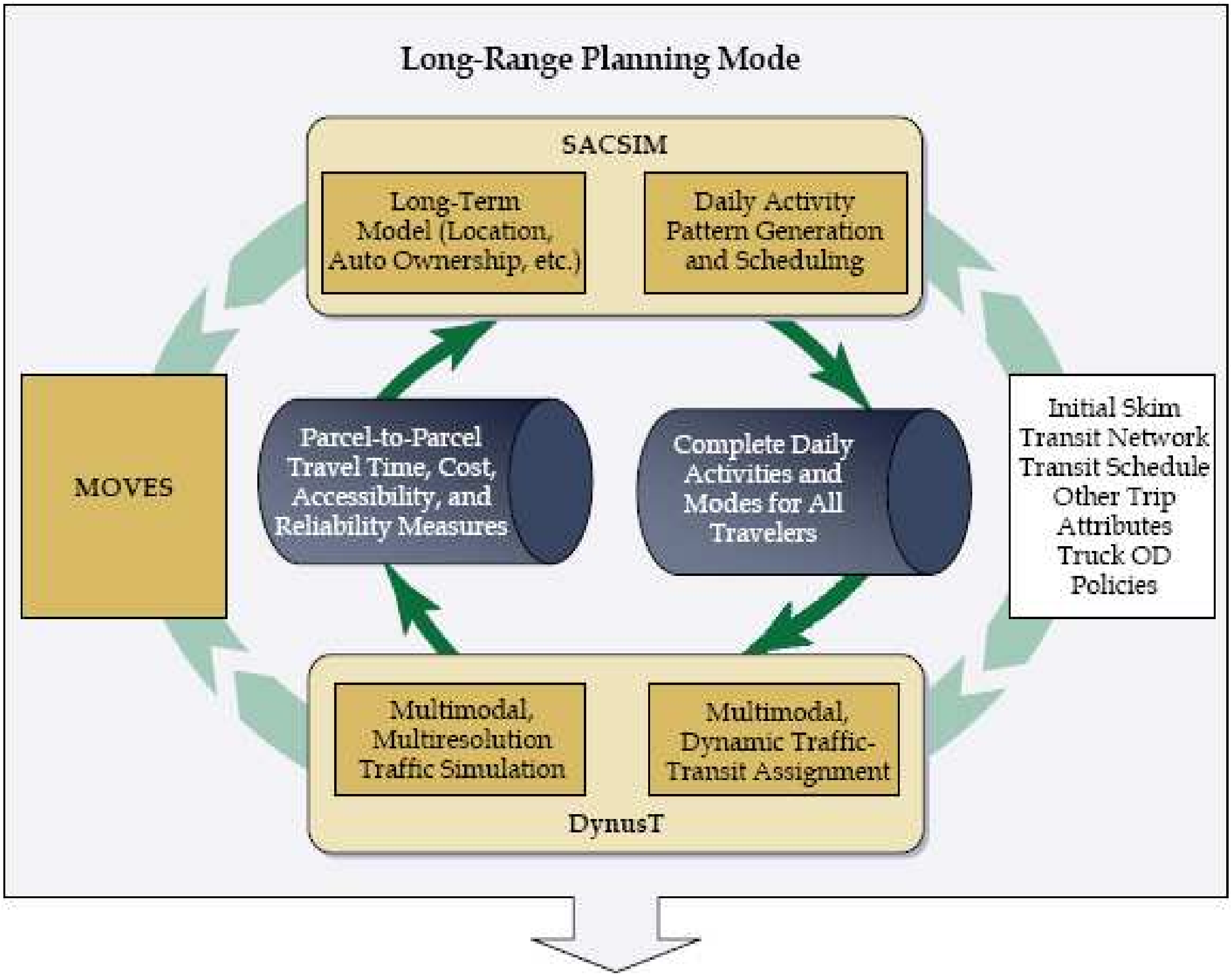

Figure 1. Model Structure (continued)