Early Deployment of

TRANSIMS

Issue Paper

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TABLE OF CONTENTS

TABLE OF CONTENTS, CONTINUED

TRANSIMS is coming! The Early Deployment Program (EDP) described in this document is designed to help move this new integrated travel demand forecasting and air quality analysis tool from research to application. This document describes the Transportation Analysis Simulation System (TRANSIMS) EDP, TRANSIMS capabilities and status, and how transportation planning agencies can be involved in the EDP.

INTRODUCTION

The EDP will build on the multi-year effort to develop TRANSIMS, a suite of advanced travel forecasting procedures. The EDP will support selected transportation planning organizations across the country in implementing these new procedures. TRANSIMS offers advanced analysis capability, but the implementation of this new package will require a greater level of data collection, advanced computers, and extensive training of both agency and consultant staff.   To accomplish these tasks, the U.S. Department of Transportation (USDOT) will commit both financial and staff support for the planning organizations ready to take this major step.

This *Issue Paper* is the first in a series of papers that will describe the EDP and TRANSIMS. The purpose of this paper is to introduce TRANSIMS to technical, management, and transportation policy professionals. Addressing such a broad audience requires a fairly general description of the modeling details and technical specifications. Subsequent documents will provide more detail. *Getting Ready for TRANSIMS*, the next document in this series, will include more information on data, computer, and training requirements. Transportation planning agencies interested in using TRANSIMS will find that document useful in designing a program to improve their current models, both to improve the sensitivity of existing models and to position themselves for a smoother implementation of TRANSIMS in the future. The Environmental Protection Agency (EPA), a partner in TRANSIMS development, is preparing an *Air Quality Conformity White Paper,* which will describe how air quality regulations affecting transportation planning will be addressed in the EDP. A final document, *TRANSIMS Description*, will provide a detailed description of every aspect of TRANSIMS, its data requirements, and its operation.

2

TRANSIMS is still in the development stage, and the EDP is being fine tuned. Therefore readers will frequently be given the "most recent thinking" concerning particular issues or topics. However, with the growing interest in TRANSIMS and the EDP and the possible effects on transportation planning in the future, these important issues and topics need to be introduced as soon as possible. The final section of this report will describe how to keep current on this program.

This paper begins with a description of the EDP and the TRANSIMS software, followed by the selection process and program funding. Finally, there are instructions on obtaining more information regarding the Travel Model Improvement Program (TMIP), TRANSIMS, and the EDP and remaining involved in the process.

TRANSIMS ROLE IN TMIP

TMIP is a multi-year, multi-agency program designed to improve both the analytical tools and the integration of those tools into the transportation planning process. Specifically TMIP has the following objectives:

  1.   to increase the ability of existing travel forecasting procedures to respond to emerging policy and technology issues;
  2.   to redesign the travel forecasting process to reflect changes in behavior, to respond to greater information needs placed on the forecasting process, and to take advantage of changes in data collection technology; and
  3.   to integrate the forecasting techniques into the decision making process, providing better understanding of effects of transportation decisions.

TMIP has focused on both short and long term improvements to the models and planning procedures. The short-term improvements concentrated on changes to the existing 4-step modeling process. TRANSIMS is the long-term effort to redesign the modeling process from the ground up.

HOW DOES EDP FIT IN WITH TRANSIMS AND TMIP?

The previous text box describes how the TRANSIMS program fits under the TMIP umbrella. The EDP will fall under that same umbrella, but will cut across several tracks. The EDP's connection to TRANSIMS is fairly obvious: the EDP will bring the research program through the software refinement process and help several local transportation planning agencies implement the software. In addition, the EDP will have connections to the other TMIP tracks, as is described in the following paragraphs.

Track A – Outreach and Technical Assistance
This track will grow to include TRANSIMS. Developing and implementing the training program, establishing communication systems for EDP participants (using web and e-mail technology), and holding meetings and conferences for participants are examples of the future work in this track.

Track B – Short Term Travel Model Improvement
This work will continue but will begin to focus on changes to help position the LTPAs for the transition to TRANSIMS. For example, this work will provide advice on improvements to highway and transit networks which will both improve the operation of the existing model and help develop more advanced networks.

Track C – TRANSIMS

Track D – Data
This track will continue to look at advanced, automated techniques for data collection. The projects will increasingly focus on the collection of data needed by TRANSIMS.

Track E – Land Use
Availability of disaggregate land use data and forecasts (parcel based) will be critical for the use of TRANSIMS. Few local transportation planning agencies have this type of land use data. Track E and Track D will develop expedient techniques for preparing this type of data.

Track F – Freight
Freight trips can be included in TRANSIMS travel forecasting models, but only if there is information on the types and amount of freight in a region, and the origins and destinations of that freight. Again, most local transportation planning agencies face a major effort to collect freight movement information if they want to use TRANSIMS for freight forecasting.

EARLY DEPLOYMENT PROGRAM

Throughout the development of TRANSIMS, the sponsors have considered the deployment process a necessity for making TRANSIMS available to transportation planning organizations. As the completion of TRANSIMS drew near, the USDOT was given a legislative mandate providing financial support for the deployment of TRANSIMS. That mandate was included in the Transportation Equity Act for the 21st Century (TEA-21.)

The description of the EDP begins with the initial legislative intent and issues in TRANSIMS deployment. Following that background, the program will be described in detail.

Legislative Intent

Section 1210 of TEA-21, passed in May 1998, calls for an Advanced Travel Forecasting Procedures Program. Recognizing the progress made in the development of TRANSIMS, this legislation directs the USDOT to move onto implementation. Funding was allocated for four specific tasks:

1. complete TRANSIMS,
2. develop user-friendly software and graphics,
3. provide training and technical assistance on the use of TRANSIMS, and
4. provide financial support for converting to TRANSIMS in up to 12 urban areas in the United States.

The full text of the TEA-21 TRANSIMS mandate is reproduced in Appendix A.

Issues in TRANSIMS Deployment

With the nearing completion of TRANSIMS, the program sponsors have identified the following issues as critical for satisfactory deployment of TRANSIMS:

New Underlying Theories of Microsimulation
Simulation models are based on very different assumptions, require different statistical analysis tools, and develop very different answers. Retraining of transportation planners will be necessary, as will rethinking of the questions and legislation which drive travel demand forecasting models.

Computer Hardware

TRANSIMS hardware requirements are expected to exceed the current computer hardware capacities in most planning organizations. The package will require multi-processor, UNIX-based computers with considerable memory. Existing transportation staff will typically require extra training.

Initially in Critical Areas

Initial TRANSIMS applications will likely concentrate on areas with the most severe traffic congestion and air quality problems. Those areas are considered most likely to be capable of providing experienced staff and funding for necessary data collection.

Development of New Analysis Techniques

Analysis techniques must be developed in the early applications. For example, when comparing corridor improvements using a 4-step model, fairly standard modeling techniques have been developed over the years to compare the effect of alternative improvements on travel time, different populations, cost and benefit calculations, and air quality. These standard techniques have spread throughout the transportation planning profession through conferences, journal reports, and staff movement. This process will begin again with the introduction of TRANSIMS.

Demands and Expectations Will be Great

With earlier transportation planning software, the analytical expectations were limited to planning for new highways or major transit investments. There were no expectations for detailed air quality analyses, estimates of the effects of land use design, or predicting the effects of policy initiatives such as congestion pricing or parking cost. The 4-step modeling techniques developed gradually over the years to "answer" such questions to some extent. The transportation planning environment now faces these and other questions, and the techniques for analyzing and answering them with TRANSIMS need to be developed quickly.

The EDP is designed to work through these issues to move TRANSIMS from its current research stage, through software refinement, to application in the first few Metropolitian Planning Organizations (MPOs).

Program Goals and Objectives

USDOT and EPA have made a large financial commitment to the development of TRANSIMS. Now that the TRANSIMS package is nearing completion, the focus is on deployment of the technology to agencies responsible for transportation planning.

The program sponsors and others involved in TRANSIMS realize that this multi-year process will be expensive and difficult. The EDP has been designed to aid in this process with the following specific goals:

1. help planning organizations willing to "go first",
2. encourage and accelerate the implementation process,
3. begin training transportation professionals, and
4. develop examples of the analysis, data collection techniques, etc.

Program Description

The EDP is an ambitious effort to complete development and initial implementation of TRANSIMS. Following are descriptions of the major tasks to be accomplished in the EDP.

Complete Model Development

Los Alamos National Laboratory (LANL) will complete the TRANSIMS software. "TRANSIMS – LANL," the version LANL will pass to a software contractor team for software refinement, will contain completely functional modules, one or more viewers, a basic user interface, and examples of implementation or application.

Hire a Software Contractor Team

LANL will select, contract with, and manage a software contractor team to further prepare the TRANSIMS computer code for use by staff at state and local transportation planning agencies. The software contractor team will create "shells" around the several TRANSIMS modules to make the model operation "user-friendly." Those shells will include standard analytical techniques, graphic tools, and other features to be defined by LANL. The contractor will also prepare user operating and training manuals and will work with LANL and Texas Transportation Institute (TTI) staffs to provide training and technical assistance. The product of the software contractor team's efforts will be known as "TRANSIMS-DOT."

Complete Portland Case Study

LANL and Portland Metro (the regional planning organization for Portland, Oregon) staffs will build a regional travel forecasting model for Portland to test the TRANSIMS software. The findings from that application will be used to refine the software and conduct sensitivity tests. That case study will provide a "real world" environment for demonstrating and improving TRANSIMS, and for developing and documenting procedures for implementing TRANSIMS.

Select Local Transportation Planning Agencies (LTPAs)

USDOT will select several LTPAs to develop regional models using TRANSIMS-DOT. The LTPAs will all be selected at one time, but will not all be developed simultaneously. This staging will be necessary to assure that adequate technical support is provided as each agency

starts working with TRANSIMS. Staging will also permit taking advantage of the experience gained with each successive implementation. USDOT will provide funds to assist each of the selected LTPAs with implementation of TRANSIMS. That funding could be used for computer purchase, data collection, or hiring a consulting firm to assist with implementing TRANSIMS.

Train LTPA Staff and Consultants

LANL, the software contractor team, and TTI will design and offer training courses. Training will be provided in stages, beginning with data collection and manipulation, and will begin soon after the selection of the LTPAs.

Data Collection for TRANSIMS

TRANSIMS will require more data, of different types and more detail than the traditional 4-step models. Data collection is expected to take a year or more in each selected region. The LTPA staff, consultants, and staff from other agencies in the region will probably be involved in this data collection effort.

Application

Calibrating, validating, and applying TRANSIMS in each region is expected to take a year or more. Each LTPA should initially apply the TRANSIMS model to one specific question, study, or corridor.

Reporting on the Program

Critical for the long-term success of TRANISMS will be the LTPA reports to the transportation community about their experiences. Reporting will include data collection strategies, software problems and solutions, and analysis graphical and reporting techniques developed by the LTPAs and the software contractor team.

Who Will Participate?

There will be several groups working on the TRANSIMS EDP. USDOT staff from the Federal Highway Administration, Federal Transit Administration, and Assistant Secretary for Transportation Policy will participate. EPA staff participating will be from the Office of Mobile Sources and the Office of Air Quality Planning and Standards. The sponsors are guiding the design of the EDP, and they will select the local transportation planning agencies.

The TRANSIMS development team at LANL will complete the development of the TRANSIMS core early in the EDP. They will participate in all aspects of the deployment process. Their assistance in the training program, technical assistance and support of the software refinement will be critical.

TTI, currently responsible for Track A in the TMIP Program, will be similarly involved in the training and technical assistance program for TRANSIMS. In addition, TTI will be responsible for facilitating the sharing of information among local transportation planning agencies and reporting on the process and results of the EDP.

The software contractor team will be responsible for refining TRANSIMS software to improve its usability by transportation planners. They will also prepare user manuals and training material, help in the training program, and assist with installing software at each local transportation planning agency.

The agencies and firms described above are all prepared to help the main player in the EDP - the local transportation planning agencies (LTPAs). The sponsors have specified a preference that the LTPAs selected be responsible for developing the regional transportation plan in their regions. MPOs are the most likely organizations; however, the possibility of other types of organizations, such as transit providers, has been left open to not preclude particularly strong or innovative proposals.

Consultants may be chosen by the LTPAs to help with the development of the TRANSIMS model in their region, but there is no obligation to hire such a firm.

The selected LTPAs will be encouraged to work with local universities when possible. This collaboration would serve several purposes. Staff and students could provide some of the computing and other expertise to assist the LTPA staff. In addition, the collaboration would begin to introduce TRANSIMS into the academic environment.

WHAT IS TRANSIMS?

TRANSIMS is a series of simulation and other related models being developed at LANL. The following is a very abbreviated description of the multi-year, multi-million dollar project. Readers are encouraged to obtain the additional references listed in Appendix B to learn more about TRANSIMS.

Background
TRANSIMS design has been driven by the often noted concern that the Intermodal Surface Transportation Efficiency Act (ISTEA) and the Clean Air Act Amendments (CAAA) generated analytical requirements that exceed the capabilities of current models and methodologies. State departments of transportation and MPOs are trying to forecast travel demand that is sensitive to transportation system conditions and congestion and more precise and quantitative than needed in the past.

Who Is Working on It?

The LANL team has incorporated work from researchers across the country into the TRANSIMS modules. The team has also received invaluable assistance from two MPOs, the North Central Texas Council of Governments (NCTCOG) and Portland Metro. Those two MPOs have provided the planning environments, data, and experience necessary to develop TRANSIMS.

Who Is Funding the Development of TRANSIMS?

The Federal Highway Administration and the Federal Transit Administration have provided most of the funding for the development of TRANSIMS. Additional funding has come from the EPA.

Description

TRANSIMS is a series of integrated transportation and air quality analysis models. The principal components of TRANSIMS are an *activity based travel generator*, an *intermodal trip planner, traffic microsimulation, feedback selector,* and *air quality analysis.* Using those components, TRANSIMS estimates activities for individual households and residents, and then plans trips to satisfy those activities. Those trips are then assigned to an initial path (using the intermodal route planner), and then a regional microsimulation simulates the performance of all individual vehicles (both personal vehicles and transit vehicles) and operation of the transportation system. Feedback between these first three steps is fundamental to the TRANSIMS concept and is handled by the selector. Finally vehicle emissions are estimated using the vehicle operating information generated by the microsimulation. Those modules are shown in Figure 1 and described in more detail in the following sections.

TRANSIMS Four Modules

The *Activity-Based Travel Demand Module* estimates the number, characteristics, and locations of activities in which individuals will participate during the forecast period. Activities include work, shopping, and recreation. Those activity estimates are based on the characteristics of individuals, their households, and available vehicles as determined by a synthetic population generator.

The *Intermodal Trip Planning Module* computes combined route and mode trip plans to accomplish the desired activities. The planner tries to accommodate all the desired activities, scheduling secondary activities such as shopping during the routing of a principal trip such as work. TRANSIMS maintains the identities and characteristics of individual travelers, as well as personal or transit vehicles used throughout their trips. Activity locations (for example home, work, or shopping) are identified by specific geographic points of origin and destination, in contrast to the zonal aggregations used in the 4-step travel models.

The *Traffic Microsimulation Module* uses the intermodal paths developed in the trip planning module in a microsimulation of vehicle interactions. The microsimulation continuously computes the operating status of all vehicles and engines, second by second, throughout the simulation period, including locations, speeds, acceleration, or deceleration. Every motor vehicle in the study area is monitored in this manner to identify traffic congestion and emissions concentrations.
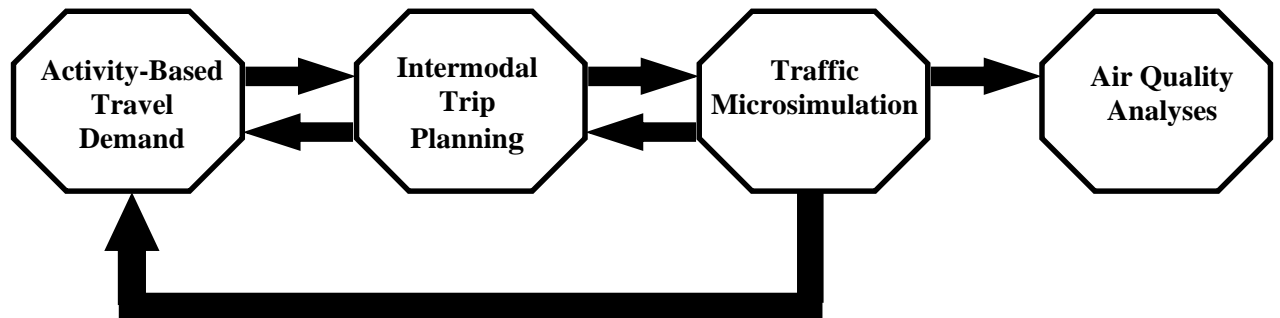
Figure 1

The *Emissions Module* forecasts the nature, amount, and location of motor vehicle emissions using the vehicle information generated in the microsimulation module. The emissions information is then used in urban air shed models to predict urban air quality. TRANSIMS does not contain an air shed model; however, data from the emissions module will be compatible with the EPA=s MODELS3 air shed model.

Finally the *Selector* manages the feedback of information among the first three modules of TRANSIMS. "Manages" in this instance refers to decisions, such as, what percent of the

regional trips should be fed back between modules, which trips should be fed back, how far back should the trips go for replanning, and when to stop iterating.

The modules developed for TRANSIMS contain many significant advances beyond 4-step models. In addition to those advances, there are underlying conceptual and structural differences which, although more subtle, will result in major changes in travel demand forecasting. Some of these are described below.

Dissagregate Models

TRANSIMS tracks individuals, households, and vehicles, not zonal aggregations of households and employment. TRANSIMS also estimates travel second-by-second throughout the simulation period rather than total travel for various periods.

Simulation

To produce operating speeds, intersection operations, and vehicle operating conditions for each vehicle in the system, the regional microsimulation uses vehicle interactions instead of relying on deterministic equations such as the "BPR curve" and the Highway Capacity Manual equations.

Integrated System

Underlying the development of the TRANSIMS modules has been the effort to tightly couple the functions and data flow among the four modules. That and the feedback described next are the most significant advances realized in the development of TRANSIMS. By integrating all these capabilities in one model, TRANSIMS overcomes limitations transportation professionals currently experience with 4-step models.

Built-in Feedback

Feedback in TRANSIMS is automatic and selective. Not all trips are replanned, and replanning is accomplished internally by the Selector. One example of replanning occurs between the trip route planner and the microsimulation. Initially the planner uses estimates of speeds for highway and transit trips. The microsimulation then moves vehicles across the transportation networks, simulating congestion that changes travel times. The resulting travel times are fed back to the planner, which reroutes selected trips according to the new travel times. This process represents changes in route choice due to congestion.

Highly Detailed Vehicle Emissions Estimates

Current emissions models use average speed estimates from the 4-step models. The speeds are based on deterministic relationships such as the BPR curve relating volume: capacity ratios to speed. Those deterministic techniques are a generalization of how the interaction of vehicles affects speed. The resulting emissions estimates are insensitive to traffic conditions and lack precision. In contrast, the TRANSIMS emissions estimates are based on the operation of individual vehicles as they move and interact in roadway traffic. With TRANSIMS, data on the speed, engine condition, and driver behavior for all vehicles, and where and how they are operating, will be produced by the microsimulation of traffic movement.

Microsimulation Provides Operational Tools

The microsimulation will permit planning level analyses of operational changes in the transportation network. Operational changes which could be evaluated include traffic signal plans and ramp metering.

Who Will Use TRANSIMS?

There has been much discussion in the transportation profession concerning how widely adopted TRANSIMS will be, producing several schools of thought. Skeptics believe the large data requirements, computer requirements, and training requirements will limit use of TRANSIMS to a handful of the largest MPOs. A second school of thought is that regulatory requirements will quickly force the use of TRANSIMS in **many** regions. This accelerated adoption of TRANSIMS might exceed the capability of project staff to support the affected regions. A final school of thought is that in the beginning, TRANSIMS will indeed be used mainly by larger MPOs with particularly sophisticated transportation planning questions. Subsequently, TRANSIMS would evolve into versions which would be more appropriate for MPOs with smaller staffs and different analysis needs. Experience with the earlier software suggests that this last scenario is most likely. It is also the most promising scenario for bringing new technology to the broadest audience in a less painful manner.

TRANSIMS Development Status

LANL has been working on TRANSIMS since the spring of 1994. In that time, the underlying data structures, microsimulation module, graphic interfaces, and the emissions module have been developed. Preliminary activity generation, route planning techniques, and an application of TRANSIMS in Dallas have also been completed. The Dallas case study involved a large scale demonstration of the microsimulation module; details of that case study are given below.

TRANSIMS is still being developed. The LANL team is now working with the Portland Metro staff and Portland data to develop the remaining modules. The main focus now is on developing the activity generator, intermodal trip planner, and feedback mechanisms in the selector. Once the TRANSIMS core capabilities are complete, the Portland case study will explore the sensitivity of TRANSIMS software to different types of data. At the completion of that case study, TRANSIMS will be given to the software contractor team. The LANL team will continue to work on the emissions module and the Intelligent Transportation Systems (ITS) application of TRANSIMS.

The following paragraphs describe in more detail the completed and future work on TRANSIMS. It is important to keep in mind that, although considerable progress has been made, the work in Portland will greatly affect and define the "final" TRANSIMS software.

Dallas Case Study

Early in the TRANSIMS development process, LANL and the project sponsors agreed that developing and testing the modules with "real" data was critical to the eventual success of the software. This decision has slowed the development process but has yielded great returns. The development process has been broken into two phases: an Interim Operational Capability (IOC) and a case study. In the IOC phase a portion of the software was developed, including any special data structures. The subsequent case study was an application of that portion of the software to a typical problem addressed by transportation planning organizations. This process has been used in Dallas and is currently underway in Portland.

The IOC in the Dallas area focused on development of a microsimulation which would be robust enough to execute the travel itinerary of each individual in an urban region. This portion of TRANSIMS was chosen for the first IOC because developing a region-wide microsimulation was considered the most critical and difficult step in determining sufficiency of computer storage and speed as well as accurately simulating driving behavior. For this first IOC, the microsimulation was limited to automobile trips, and methods were developed

14

to use existing NCTCOG's zonal production/attraction information as the source of traveler demand on the system. The microsimulation executed approximately 200,000 trips (between 5:00 A.M. and 10:00 A.M.) in and through the 25 square mile study area. The microsimulation ran in real time on five SUN SPARC workstations ("real time" meaning a five-hour period took five hours).

After the microsimulation software was developed in the IOC, the Dallas case study used the microsimulation to compare two highway improvements in the study area encompassing the Galleria Mall, the Valley View Mall, and the intersection of the Lyndon B. Johnson Freeway and the Dallas North Tollway. Two alternatives were designed to improve travel conditions in this very congested area. The first alternative added two lanes to the Lyndon B. Johnson Freeway, and the second alternative included additional lanes on four major arterials, additional frontage roads to improve continuity and access, a grade-separated intersection, and additional turn bays at several intersections. The two alternatives were compared using both traditional and new measures of effectiveness made possible with TRANSIMS technology. A full report on The Dallas case study is available from the TMIP clearinghouse (ordering information is in Appendix B.)

Portland Case Study

The Portland IOC is focusing on development of the Activity Demand, Intermodal Route Planner, Microsimulation, and Selector modules. The work in Portland involves a number of very difficult technical issues. For example, the route planner and microsimulation capability developed for Dallas must be expanded to include large vehicles, transit vehicles, and transit passengers. This includes the complicated tasks of incorporating into the data base all transit vehicle schedules, the different operating characteristics of rail and buses, and simulating the interaction of transit vehicles and private vehicles. The Portland data collection and IOC work began in June 1998. The IOC is expected to be complete in January 2000.

In contrast to the "real world" planning question explored in Dallas, the Portland case study will explore the effects of different types of data on the results and sensitivity of TRANSIMS. Although the final work program for the case study is not complete, two sensitivity tests are under consideration. The first would test the effect of generating synthetic local streets instead of realistically coding every single street in the region. The second test would explore the effect of synthesizing traffic signal plans. Both of these data collection and coding efforts have been very time consuming and difficult. To test these and other model sensitivities, the Portland staff assembled the actual local street and traffic signal plans to compare with the results of the synthesis. These tests could determine the effect of the data synthesis on the sensitivity of the TRANSIMS models. Details of the case study work plan will be released as soon as they are available. The case study will be complete in September 2000.

Steps Yet to Come

The core TRANSIMS software (TRANSIMS-LANL) will be handed off to the software contractor team at the conclusion of the Portland case study. After that, two additional applications of the TRANSIMS software will be developed using the Portland data and model. The first of these, vehicle emissions modeling, will not require new software capability. This application will be a demonstration of the use of TRANSIMS to test the relationship between vehicle emissions and policy actions such as parking pricing measures. This demonstration will mainly produce examples of how to test the policies, how to represent the alternatives within the TRANSIMS networks, and statistical techniques to assess the impacts on vehicle emissions estimates. The particular policies to be tested have not been decided. The LANL staff is currently working with the EPA to develop the work plan for those tests.

The second application, an evaluation of effectiveness of Intelligent Transportation Systems (ITS), will be a more substantial undertaking. The ITS evaluation will require changes and additions to the core software. Following the software changes, an application similar to the air quality application will take place. For a limited number of ITS tools, the LANL staff will show how to design the tests, represent the ITS tools, and assess the impacts on congestion and other measures of effectiveness. Representing the ITS tools will be a critical design and model operation issue.

Being an Early Deployment Site

What We Know

Having provided a general description of the EDP and a brief description of TRANSIMS, what does it all mean to LTPAs – those interested in the EDP as well as those who may be interested in later versions of TRANSIMS? First, the known conditions for conversion to TRANSIMS will be described, followed by the uncertainties, and finally the LTPA selection process and funding.

We know that using TRANSIMS will require increased data collection, additional computer capability, and staff training. Being an EDP site will not eliminate any of those conditions. However, there will be advantages to being selected to participate in the EDP. The first agencies to convert to TRANSIMS will receive several types of support offered by the USDOT. The LANL staff, TTI staff, and the software contractor team will provide training, technical assistance, and on-site support. In addition, financial support will be provided by the USDOT. The following sections briefly describe the major conditions for eligibility to participate in early deployment.

16

Data

This discussion of the future data collection effort is limited by unresolved data issues described earlier. The Portland case study will focus on identifying the data needed to address the questions for which TRANSIMS was designed. More data collection information will be available in the upcoming document, *Getting Ready for TRANSIMS*.

Regardless of the findings in the Portland case study, the local transportation planning agencies selected for the EDP will need to undertake a major data collection effort. The needed data will come from many agencies and organizations which might not have been traditionally involved in transportation modeling, such as the public works departments, transit agencies, and tax assessors. The data needs list below will seem overwhelming to many LTPAs. For LTPAs not involved in the EDP, the data and other needs can be addressed gradually. The Portland and Dallas MPOs found that the data needed for TRANSIMS has also led to improvements in their existing 4-step models.

Roadway Network
1. Include all freeways, interstate, ramps, frontage roads, and principal and major arterials, may need to include minor arterials, collectors, and local streets
2. Locate turn pockets, including the number of lanes and the storage length
3. Represent interchanges and underpasses/overpasses in detail; accurately represent ramps, including length, number of lanes, and configuration, code underpasses and overpasses to show the eventual difference in elevation
4. All nodes will need elevations – mainly for the air quality analysis

Transit Network
1. A complete database of the operating schedule for all transit <u>vehicles</u>, in contrast to the 4-step representation of transit service, which focuses on routes; details on individual bus departures, layovers, etc.
2. Details on transit stop locations and design for the more complex stops, such as transit stations with bus transfer accessibility and bus transfer station

Traffic Operations
1. An inventory of all intersection controls, with signs (stop and yield) and signal plans including timing, phasing, and whether the signal is actuated or pre-timed; the Portland case study may find that synthetic intersection controls could be developed with minimum reduction in sensitivity
2. Ramp metering and/or other freeway operation control

Land Use
1. Parcel-based data for household and commercial land uses
2. Detailed employment data at the parcel level
3. Orthophotos for land use, networks, etc., will not be necessary but would be helpful

Other Data
1. Regional activity surveys will be needed for the activity generation module
2. Traffic counts on roadway segments and turning movements at critical intersections; aggregation to an hourly level will be inadequate, to validate and calibrate a microsimulation, 15 minute intervals will likely be the maximum acceptable level of aggregation
3. A GIS-based database to centralize all the information described in this list
4. A freight survey to model freight movements within a region
5. A parking inventory, including both on-street and off-street lots or garages, including cost of the parking

Hardware

Most transportation planning software and resulting models are developed for DOS-based personal computers. TRANSIMS is designed to run on UNIX-based computers. UNIX machines are currently used by many MPOs to run GIS software. Although it is theoretically possible to run a regional TRANSIMS model on one UNIX machine, to achieve reasonable run times several machines (five were used in Dallas, six in Portland) can be linked together and the necessary calculations distributed among the machines. The other alternative is to buy a "multi-processor" machine, basically several computers in one box, to run the TRANSIMS models. The prices and operating characteristics of these machines are changing so quickly that potential EDP participants are advised not to buy or lease hardware to run TRANSIMS until closer to the time when they will acquire the programs.

Training and Staff Expertise

Many existing and future transportation planning professionals using TRANSIMS will need additional training. Most areas of training are not new to the transportation profession but are taking on a new importance with TRANSIMS. Training may be necessary in the following areas.

Geographic Information Systems (GIS)

GIS will be critical for managing the large databases needed for TRANSIMS. A GIS software package is integrated into the network editing, results viewer, and other aspects of TRANSIMS.

The UNIX Operating System

UNIX is familiar to many, although most current transportation software is written for either a DOS or WINDOWS operating environment. TRANSIMS, and presumably its derivative software, will run only in a UNIX-based environment.

Logit Models

These models are currently used in several aspects of travel demand forecasting – particularly in forecasting mode choice. In TRANSIMS, the activity generation module will be based on a logit model and an activity survey.

Simulation Modeling

These models may present the most difficult training hurdle. Current travel demand forecasting models are largely deterministic. TRANSIMS and other simulation models are probabilistic. They function according to behavioral rules that govern but do not determine the interactions among relevant entities. The simulation results are then based on behavior and interactions of the vehicles. The assumptions, analysis techniques, and statistical analysis tools that are part of TRANSIMS will require additional training for most transportation professionals.

Training in all these areas will be provided to agencies participating in the EDP. Similar training will be available to LTPAs that later convert to TRANSIMS after the EDP. In the meantime, LTPAs are encouraged to establish relationships with universities in their area. Those relationships can provide access to training for agency staff, bring the research power of the university to the agency, and bring students into the agencies for the benefit of all involved.

Model Program Implications

The goal of the EDP, as stated before, is to help several LTPAs make the initial conversions to TRANSIMS. However, the project sponsors understand that **no** LTPA can drop an existing modeling program in favor of a new model until it has been developed and the planning and political communities in the region are satisfied with its operation. LTPAs should maintain and use their existing model program while preparing to adopt the TRANSIMS models. This has major implications for the allocation of staff and other resources.

Beyond resource constraints, the potential "dueling model" problem may make the transition to TRANSIMS difficult. For a period there will be two operational models and two sets of forecasts. Transportation planners will have to decide which results to use and how to use them. This problem in the air quality conformity area will be discussed below, but in the many other applications of travel forecasting models, each LTPA will need to decide how to handle the "dueling models"

Planning and Policy Implications

TRANSIMS opens up a whole new world of analysis capability. The new capabilities have been mentioned elsewhere in this document and are discussed in detail in other TRANSIMS documents. Examples of these capabilities include:

1. *equity analysis*, which examines transportation effects on populations with similar income or racial characteristics, populations that work or live in particular geographic areas, or populations using certain transportation facilities*, and*
2. comparison of *emissions reducing strategies* such as parking pricing, sophisticated signal timing plans, and changes in *roadway network design* (grid vs. cul-de-sac) or land development designs (mixed use sites vs. segregated land use patterns) and their effects on travel behavior, vehicle miles traveled, etc.

These and other analytical capabilities will add new power and complexity to the planning process. Transportation planning organizations may have to reexamine project criteria, and their responses to both land use and transportation policies. They may also have to educate decision makers in both the new capabilities of TRANSIMS and the different types of results the models will produce.

Institutional Implications

Due to its disaggregate and more integrated nature, TRANSIMS will require close collaboration with other regional agencies. For example, the signal data collection requirements will encourage close cooperation with the public works or equivalent agencies of each jurisdiction. Data from transit agencies, assessor's offices, building or land development permitting offices, and roadway design offices of state and local transportation departments will also be necessary.

Beyond the closer ties formed by cooperating on data collection, TRANSIMS additional capabilities will enable LTPAs to provide new analytical services for other agencies. For example, a state DOT considering new ramp configuration on a segment of freeway could use a preliminary analysis with TRANSIMS.

Air Quality/Conformity Implications

The implications of TRANSIMS for air quality analysis and conformity determinations are yet to be understood and applied. The EPA is currently preparing a white paper addressing both technical and policy matters in that regard. Exactly when that paper will be available is not known at this time. Questions concerning this matter should be referred to the EPA.

What We Don't Know

In the interest of full disclosure, this section will describe the uncertainties that early deployment sites will face. Although the LANL staff has made excellent progress on TRANSIMS, it is still a research project. As such, there are a number of uncertainties. While considering all of the "known" items described previously, LTPAs should also consider the implications of participating in an ongoing research effort. The uncertainties could include late product delivery, software coding errors, and high learning curves for both TRANSIMS project staff and LTPA staff. The TRANSIMS staff is working hard to overcome or minimize these potential problems, but they will inevitably occur. Aside from general areas of concern, three specific uncertainties are described below.

Data

What to Collect

As was described under Portland case study above, it is not clear how much transportation supply detail must be collected and how much can be synthetically generated. This information must be available before the LTPAs begin work. The working assumption has been that the roadway network must include all the roads in the region – including local streets, collectors, and circulation roads. This data could be simplified with the synthesis of subdivision streets and other minor roads. There are other types of data which could be synthesized, and the Portland case study will explore the effects of data synthesis.

How Long to Collect the Data

The experience with collecting a full TRANSIMS data set is quite limited; only the Portland Metro staff has successfully collected the needed data for an entire region. The Portland Metro data collection process, well before the work with TRANSIMS, had national recognition as an exemplary, inter-agency process. However even beginning with their excellent data sets, collecting the TRANSIMS data took five full-time person years. Simplifications of the necessary data or streamlined techniques for collecting data may reduce the amount of time needed to collect TRANSIMS data.

Validation and Calibration

Although still a difficult effort, validating and calibrating a travel forecasting model is a fairly standard process. The data needed is generally available and "rules of thumb" exist. TRANSIMS will require a completely new process to validate and calibrate models. The new process will require calibration of the activity-based travel demand module, the intermodal route planner, and the microsimulation of vehicle interactions. Validating a microsimulation model that generates minute-by-minute link volumes and turning movements will be challenging. The first problem will be obtaining an adequate number of intersection turning movements and link volumes for small time increments from across the region. These turning movements and link volumes must then be compared to model results, and statistical techniques used to evaluate the comparison must be conducted. The Portland and Dallas case studies will provide examples of the validation and calibration process.

Analysis Tools

After LANL finishes the Portland case study, they will prepare the final version of the software and the case study report. The software and report will include examples of analysis techniques. Subsequent work by LANL in the areas of air quality and ITS will add to the library of analysis techniques. The software contractor team responsible for refining the software will likely add additional techniques to their version of TRANSIMS. However, this work has <u>not</u> been done, so considerable uncertainty exists about what will be available for the LTPAs participating in the EDP.

PROGRAM SCHEDULE

Selection of all LTPAs to participate in the EDP will occur at the same time in March 2000. The LTPAs' work with TRANSIMS will be staggered, with two LTPAs starting each year. This arrangement is intended to provide the LTPAs with sufficient time to include the EDP in their work programs, staffing plans, and long term data collection plans. The staggered starting dates will help the project staff provide adequate support to each LTPA and to improve the training, technical support, and software for each successive LTPA. The following schedule includes the major milestones in the EDP.

LTPA Selection
1. EDP and TRANSIMS Briefing at TMIP IV Conference (Spring 1999)
2. Letter Solicitation to LTPAs (Fall 1999)
3. Selection of All LTPAs (Spring 2000)

Software Contractor Team Selection
1. TRANSIMS Opportunities Conference (Summer 1999)
2. Software Request For Proposal Issued (Fall 1999)
3. Software Pre-bid Meeting (Fall 1999)
4. Software Contractor Team Selected (Spring 2000)

TRANSIMS Implementation for the First Two LTPAs
1. Funding Begins (Summer 2000)
2. Training Begins (Summer 2000)
3. Complete Data Collection (Summer 2001)
4. Complete Calibration, Validation, and Application of TRANSIMS (Summer 2002)

The subsequent LTPAs will begin working with TRANSIMS in one to two years after the schedule shown above.

LTPA Selection Process and Criteria

USDOT will convene a committee to establish the final LTPA selection criteria and select the LTPA participants. Although the selection criteria are yet to be decided, there are goals, criteria, and data that the federal sponsors have identified as important in choosing the LTPAs to participate in the EDP.

The federal sponsors want to select a group of LTPAs that achieve the following goals:
1. the LTPAs should be distributed across the country;
2. the regional population sizes should range from large to medium;
3. the regional transit system should vary in type and size; and
4. the proposed initial applications of TRANSIMS should vary.

The criteria guiding the selection of the particular sites would include:
1. data availability and quality;
2. regional political and policy group support;
3. technical qualification of staff; and
4. local match funding commitment.

The federal sponsors and the selection committee will need the following information:
1. what type of network description is available (level of detail and type of data);
2. what traffic counts are available (for calibration and validation);
3. what travel survey information is available;
4. computer hardware available and staff experience with that hardware; and
5. LTPA technical staff experience with travel forecasting.
The proposal process will occur in two stages. The first step will be a solicitation for a

simple letter of interest. The LTPAs interested in participating in the EDP will submit <u>brief</u> letters outlining their capabilities, proposed application of TRANISMS, and regional characteristics. A smaller group of LTPAs will be asked to prepare a more detailed proposal. The final LTPAs will be selected based on those longer proposals.

As part of this second stage, the LTPAs will need to solicit support from the other planning and transportation agencies and committees in their regions. Support from other agencies and oversight committees within the region will be important for several reasons. Because much of this data will come from other agencies, their support will be critical. A less obvious, but more profound reason for requiring this support will be the changes in the planning process that will result from the new analyses available with TRANSIMS. It is important to remember that because TRANSIMS spans operations analysis, planning, and air quality analysis, many more agencies will take an interest in its application. TRANSIMS, by its very nature, will also produce very different results. The "answer" to a given question will not be a single number but a set of numbers setting confidence intervals and based on a very explicit set of assumptions. Before embarking on the conversion to TRANSIMS, those involved in regional transportation planning should understand the implications of this conversion and agree upon the direction.

FUNDING

The funding provided by TEA-21 limits the number of LTPAs that can be partially funded for participation in the TRANSIMS EDP. The amount of funding for selected LTPAs will depend on characteristics of the sites and on the level of effort they are able to provide to convert to TRANSIMS. The limited federal funding will be available for any expense required to convert to TRANSIMS. The expenses could include hardware, software, data collection, in-house staff, consultants' fees, etc.
The legislation calls for 20 percent local funding. This local match may be provided through in-kind services, such as in-house staff time, etc. It is likely that the conversion to TRANSIMS will need a larger local contribution than 20 percent. The experience in the case studies indicates that the cost of data collection and manipulation can be quite high. LTPAs interested in participating in the EDP should evaluate the level of local funding available.

WHAT TO DO

This issue paper has outlined the preliminary plans for the EDP, briefly described TRANSIMS, and explained the role the LTPAs will play in these two efforts. Over the next year, the EDP plans will be firmed up, TRANSIMS will near completion, and LTPAs will be selected. We strongly urge those interested in the EDP and TRANSIMS to keep in contact with the TMIP and its staff. You may do this by:

1. visiting our web site – http://tmip.tamu.edu,
2. subscribe to our mail list by going to http://tmip.tamu.edu and clicking on TMIP E-Mail List and following the instructions,
3. call the project staff (phone numbers and e-mail addresses are on the web site),
4. attend TRANSIMS, TMIP, or EDP sessions at the various transportation conferences, held around the country, or
5. call or e-mail Kim Fisher at 202-366-4054 – kim.fisher@fhwa.dot.gov

APPENDIX A - FULL TEXT LEGISLATION

SEC. 1210. ADVANCED TRAVEL FORECASTING PROCEDURES PROGRAM.

(a) Establishment – The Secretary shall establish an advanced travel forecasting procedures program –

> (1) to provide for completion of the advanced transportation model developed under the Transportation Analysis Simulation System (referred to in this section as "TRANSIMS"); and
> (2) to provide support for early deployment of the advanced transportation modeling computer software and graphics package developed under TRANSIMS and the program established under this section to States, local governments, and metropolitan planning organizations with responsibility for travel modeling.

(b) Eligible Activities – The Secretary shall use funds made available under this section to –

> (1) provide funding for completion of core development of the advanced transportation model;
> (2) develop user-friendly advanced transportation modeling computer software and graphics packages;
> (3) provide training and technical assistance with respect to the implementation and application of the advanced transportation model to States, local governments, and metropolitan planning organizations with responsibility for travel modeling; and
> (4) allocate funds to not more than 12 entities described in paragraph (3), representing a diversity of populations and geographic regions, for a pilot program to enable transportation management areas designated under section 134(i) of title 23, United States Code, to convert from the use of travel forecasting procedures in use by the areas as of the date of enactment of this Act to the use of the advanced transportation model.

(c) Funding –

> (1) In general. – There are authorized to be appropriated from the Highway Trust Fund (other than the Mass Transit Account) to carry out this section $4,000,000 for fiscal year 1998, $3,000,000 for fiscal year 1999, $5,600,000 for fiscal year 2000, $5,000,000 for fiscal year 2001, $4,000,000 for fiscal year 2002, and $2,5000,000 for fiscal year 2003.

APPENDIX A - FULL TEXT LEGISLATION, (CONTINUED)

(2) Allocation of funds –

    (A) Fiscal years 1998 and 1999 – For each of fiscal years 1998 and 1999, 100 percent of the funds made available under paragraph (1) shall be allocated to activities as described in paragraphs (1), (2), and (3) of subsection (b).

    (B) Fiscal years 2000 through 2003 – For each of fiscal years 2000 through 2003, not more than 50 percent of the funds made available under paragraph (1) may be allocated to activities described in subsection (b)(4).

(3) Contract authority. – Funds authorized under this subsection shall be available for obligation in the same manner as if the funds were apportioned under chapter 1 of title 23, United States Code, except that the Federal share of the cost of –

    (A) any activity described in paragraph (1), (2), or (3) of subsection (b) shall not exceed 100 percent; and

    (B) any activity described in subsection (b)(4) shall not exceed 80 percent.

APPENDIX B - TRANSPORTATION ANALYSIS AND SIMULATION SYSTEM (TRANSIMS) PUBLICATIONS

These documents can be ordered through the TMIP web page.

TRANSIMS Travelogues, (May 1996, June 1995, January 1995, November 1995, May 1996, November 1996)

Fast Low Fidelity Microsimulation of Vehicle Traffic on Supercomputers, January 1994

Traffic at the Edge of Chaos, July 1994

TRANSIMS Project Description Travel Model Improvements Program, August 1994

TRANSIMS: TRansportation ANalysis and SIMulation System - Module Description, May 1995

An Operational Description of TRANSIMS, June 1995

TRANSIMS Model Design Criteria as Derived From Federal Legislation, June 1995

Creating Synthetic Baseline Populations, 1995

Issues in the Representation of Traffic Using Multi-Resolution Cellular Automata, 1995

Network Traffic as a Self-Organized Critical Phenomena, September 1995

Traffic Jam Dynamics in Stochastic Cellular Automata, September 1995

Physical Modeling of Traffic with Stochastic Cellular Automata, September 1995

Self-Organized Criticality and 1/f Noise in Traffic, October 1995

Emergent Local Control Properties in Particle Hopping Traffic Simulations, October 1995

Particle Hopping Models, Traffic Flow Theory, and Traffic Jam Dynamics, November 1995

Particle Hopping vs. Fluid-Dynamical for Traffic Flow, November 1995

Two-Lane Traffic Simulations Using Cellular Automata, December 1995

Parallel Traffic Miro-Simulation by Cellular Automata and Application for Large Scale Transportation Modeling, January 1996

Development of the TRANSIMS Environmental Module, June 1997

Particle Hopping Models and Traffic Flow Theory, August 1995