The SHRP 2 Capacity Program

Background and Context for

Advances in Travel Demand Modeling

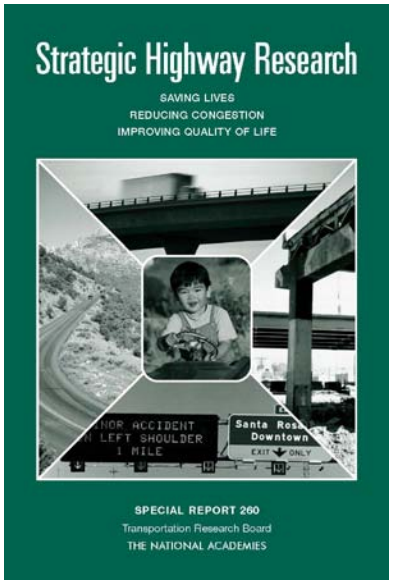
Steve Andrle, Transportation Research Board

SHRP 2 Focus Areas

- **Safety**: fielding the largest-ever naturalistic driving study to reduce crashes and save lives through understanding driver behavior
- **Renewal**: making rapid, innovative construction possible for "ordinary" projects
- **Reliability**: Providing management and technical tools to reduce congestion through operations
- **Capacity:** Systematizing collaborative decision making to achieve better, faster project decisions

Capacity Background

- Charge from Congress: "Develop approaches and tools for systematically integrating environmental, economic, and community requirements into the analysis, planning, and design of new highway capacity."
- Highway expansion projects were taking too long, were too often being delayed, or were not able to obtain the necessary approvals in the planning and environmental review process.



Research Approach

1. Compile lessons learned from case studies of successful delivery of 23 large and complex capacity expansion projects from across the United States
2. Develop methods to integrate transportation, environmental, community, and economic planning
3. Develop methods for addressing issues that were not being adequately addressed in the transportation planning and project development process

Issues with Travel Forecasting

- TRB Special Report 288 (2007) documented limitations of metropolitan travel demand forecasting models
- There was no feedback between the supply and demand side of forecasting models. What effect do network conditions have on route choice, time choice, mode choice, willingness to pay a toll, etc.
- It was difficult to deal with motorist reaction to pricing and congestion in planning models
- Activity-based models offered promise but were slow to be adopted. What are the real costs and hurdles to overcome?
- It was not clear to what extent activity-based model structures could be successfully borrowed
- There is no training guide for activity-based models
- A quick-response model for estimating the travel effects of smart growth strategies was not available

What SHRP 2 Did

- Modified existing travel demand and DTA models to operate in a feedback mode. The models were built and estimated for a 5-county region in the Jacksonville, Florida area and the SACOG area in Sacramento.
  - Daysim was linked to Transims in Jacksonville and a test network in Burlington VT.
  - Daysim was linked to DynusT in Sacramento and a transit simulation component was added (FastTrips)
  - Jacksonville demand model parameters were transferred to Tampa to test the feasibility of borrowing a model
- Estimated a series of equations from existing data sets for use in demand models (C04). The C04 results were used in the Jacksonville and Sacramento models

Continued

- Bullt SmartGap, a quick–response model based on prior work done by Oregon DOT, EPA, and FHWA. Estimates the travel demand effects of smart growth strategies
- SHRP 2 is in the process of building a primer on activity-based models that shows linkages to land use models and DTA's. The primer will become a part of TF (Travel Forecasting) Resources, a web-based resource being developed at TRB.

Status

- A “snapshot” of the Jacksonville and Burlington model sets is available. The report is in review and will be available shortly.
- The Sacramento work will be finished by the end of October 2013. The model sets will be available.
- SmartGap, a users guide, and *The Effect of Smart Growth Policies on Travel Demand* are available now on the SHRP 2 website
- *Improving our Understanding of How Congestion and Pricing Affect Travel Demand* (C04) is available on the SHRP 2 website
- The Primer is in progress and scheduled for completion in April 2014

Research Conducted on Other Issues

1. Collaborative Decision Making
2. Performance measurement
3. Analysis of economic benefits of projects
4. The relationship between operational improvements and the need for additional capacity
5. Joint transportation and environmental planning
6. Community visioning, smart growth, greenhouse gas emissions issues
7. Dealing with public-private partnership (P3) projects
8. Addressing freight issues
9. Means to the expedite planning and project delivery process

Direction of the Technical Coordinating Committee

- Document the decision points in a process that follows the steps used in successful capacity expansion projects
- Organize information on lessons learned from these successful projects around the decision points in the process and make all this information available via a web portal
- The web portal was named “Transportation for Communities - Advancing Projects through Partnerships,” and is referred to as “TCAPP.”

Conclusions of Research

1. Collaborative decision-making is a key to success, supported by an effective strategy for enhancing the environment, improving economic vitality, and achieving community goals
2. The transportation planning and project development process as practiced and as defined in federal statutes and regulations is an elaborate and complex process that involves a series of decision points
3. Improved forecasting tools can better represent the effects of operational improvements and aid decision making
4. Decisions need to be agreed to by key decision makers at each point in the process and not revisited
5. Many of the key decisions that enable a project to be approved should be made before the NEPA process begins

THE RIGHT SOLUTION DELIVERED ON TIME

To Here

Effective Collaborative Decision Making

Effective Strategies for Environmental, Economic, and Community Goals

From Here

SHRP2 Project C04: Improving Our Understanding of How Congestion & Pricing Affect Travel Demand

Advances in Travel Demand Forecasting

TRB Webinar October 1, 2013

Research Team

- Project Management
  - Robert Donnelly, Parsons Brinckerhoff
- Principal Investigators
  - Peter Vovsha, Parsons Brinckerhoff
  - Mark Bradley, MBRC
  - Hani Mahmassani, NU
- Others
  - Rosella Picado / Surabhi Gupta (Parsons Brinckerhoff)
  - Frank Koppelman
  - Ken Small / David Brownstone (UC-Irvine)
  - Kara Kockelman, UT-Austin
  - Tom Adler, John Bowman, RSG
  - Jean Wolf, GeoStats (Westat)

Primary Objectives and Focus

- Select and thoroughly analyze travel behavior data in order to formulate approaches to better model impacts of congestion and pricing on travelers and transportation systems … primarily within an Activity-Based Modeling (ABM) framework
- Focus on key challenging modeling issues:
  - Generalized cost formulation – assessment of delays /time in congestion
  - Variation in traveler preferences w/r to travel time, costs, VOT
  - (Un)Reliability of travel
- Site specific testing - estimation of new relationships with validation of findings and testing for cross sites / transferability
- Synthesis of findings and general recommendations for model developers, with an emphasis on model structure needed to accommodate the developed functions

C04 Data Sources

- Principal Sites: Integrated regional data and implementation testing:
  - Seattle (PSRC)
  - New York (NYMTC, MTA, NYCDOT, PANYNJ)
- Supporting Sites: Project site specific analysis / transferability testing:
  - San Francisco (SFCTA, MTC)
  - Minneapolis: I-394 MnPASS HOT (MnDOT)
  - Chicago (CMAP)
  - San Diego: I-15 ML (SANDAG)
  - Orange County: SR-91 (OCTA)
  - Baltimore Region: DYNASMART-P
  - NY BPM Region: Mode and Route choice demand model implementation with DYNASMART-P

Model Estimation Approach

- Progressive testing of increasingly more complicated model specifications
  1. Basic model – estimate parameters for time and cost only in linear function,
  2. Explore non-linear and distance effects
  3. Perception of travel time by congestion levels and facility type
  4. Impact of income
  5. Impact of car occupancy
  6. Impact of gender, age, and other person characteristics
  7. Incorporation of reliability measures
  8. Toll-averse bias
  9. Situational variability (unobserved heterogeneity) in traveler preferences

Specification of an Extended Auto Utility Function in Travel Choice Models

Basic Generalized Cost Function (Starting)

- ***U=b×Time+c×Cost***
  - ***b*** = travel time coefficient
  - ***c*** = travel cost coefficient
  - VOT = ***b/c*** (constant)
- Most of research and nearly all of models in practice use this simple function for auto utilities
- This function is simplistic and masks many important effects of congestion and pricing

Perceived Time by Congestion Levels

- $U = b \times Time + c \times Cost$
- $U = b_1 \times FFTime + b_2 \times Delay + c \times Cost$
- $b_2 / b_1 \approx 1.5\text{-}2.0$
- Every minute spend in congestion conditions is perceived as 1.5-2.0 min of free driving!
- May serve as a proxy for travel time unreliability:
  - Loses significance if reliability is incorporated directly
  - Useful for simple models that cannot incorporate reliability directly

Incorporation of Reliability

- $U = b \times Time + c \times Cost$
- $U_s = b \times Time + c \times Cost + d \times STD/Dist$
  - d = coefficient for reliability measure
  - VOR = $(d/c)/Dist$
  - VOR/VOT= $(d/b)/Dist$ (Reliability Ratio ≈ 0.5-1.5)
  - Typical VOR range:

Trip purpose	Distance	VOR
Work	5 miles	$54.9/hour
	10 miles	$27.5/hour
	20 miles	$13.8/hour
Non-work	5 miles	$40.8/hour
	10 miles	$20.4/hour
	20 miles	$10.2/hour

Toll-Averse Bias

- $U = b \times Time + c \times Cost$
- $U_t = a + b \times Time_t + c \times Cost_t$ (for toll routes)
- $U_{nt} = b \times Time_{nt} + c \times Cost_{nt}$ (for non-toll routes)
  - a = toll bias (toll-averse bias if negative)
- Toll bias represents psychological perception beyond time-cost tradeoffs:
  - Significant toll-averse bias equivalent of 15-20 min even in NY where tolling has long history

Impact of Car Occupancy

- $U = b \times Time + c \times Cost$
- $U = b \times Time + c \times (Cost / Occ^{f})$
  - $f \approx 0.6\text{-}0.8$
- VOT grows with occupancy but not linearly:
  - Less cost sharing for intra-household carpools
  - Almost proportional cost sharing for inter-household carpools
- Typical cost sharing:
  - SOV=1.00
  - HOV2=0.57
  - HOV3=0.41

Situational / Unobserved Heterogeneity

- $U = b \times Time + c \times Cost$
- $U = \int (b \times Time + c \times Cost) \times g(b)\,db$
  - b = randomly distributed with density $g(b)$
  - VOT= b/c (becomes randomly distributed)
- Unobserved heterogeneity is significant:
  - VOT is subject to many additional unknown parameters (for example, person taste and psychological type)
  - VOT is subject to situational variability for the same person and trip (trip to important meeting vs. routine trip to work)
  - VOR variance was difficult to explore; the result are inconclusive, better data on travel time variation is needed

Improved Final Generalized Cost Function

- $U = b \times Time + c \times Cost$
- Deterministic version:
  - $U_s = a_s + (b_{1s} + b_{2s} \times Dist + b_{3s} \times Dist^2) \times Time + c_s \times Cost / (Inc^{e_s} \times Occ^{f_s}) + d_s \times STD/Dist$
  - Applicable with any model that generates STD reliability measure
  - If STD reliability measure cannot be produced perceived highway time can be used as a proxy
- Probabilistic version:
  - $U_s = \int [a_s + (b_{1s} + b_{2s} \times Dist + b_{3s} \times Dist^2) \times Time + c_s \times Cost / (Inc^{e_s} \times Occ^{f_s}) + d_s \times STD/Dist] \times g(b_{1s}) db_{1s}$
  - Applicable only with advanced microsimulation model

Where,

VARIABLES

- TIME = average travel time
- DIST = travel distance
- STD = day-to-day standard deviation of the travel time
- COST = monetary cost including tolls, parking, and fuel
- INC = (household) income of the traveler
- OCC = vehicle occupancy

PARAMETERS

- a_{1s} = alternative-specific “bias” constant for tolled facilities
- b_{1s} = basic travel time coefficient, ideally estimated as a random coefficient to capture unobserved user heterogeneity
- $b_{2s}, b_{3s}, \ldots$ = coefficients reflecting the impact of travel distance on the perception of travel time
- c_s = auto cost coefficient
- e, f = coefficients reflecting the impact of income and occupancy on the perception of cost
- d_s = coefficients reflecting the impact of travel time (un)reliability

SHRP2 C04 – Incorporation of Issues and Findings in C10 and in emerging modeling Practice

SHRP 2 C04 Issues and Findings in C10A

- Route Choice:
  Toll versus Free
- Traveler-specific coefficients applied in calculation of route utilities

- Incorporated a binary path type Toll / Non-Toll choice model in DaySim+CUBE
- Continuous Income function
- Vertical integration with mode & destination choice models
- Functional form and magnitude for:
  - Toll bias
  - Income and Occupancy effect on cost coefficient
  - Travel time coefficient – drawn from log-normal distribution (mean 1.0; Std 0.8 work, 1.0 non-work)
  - Scale parameter for higher level choices (inverse of path type choice logsums)

SHRP 2 C04 Issues and Findings in C10B

- Variable VOT specifications in Mode Choice
  - Segmentation of by income group
  - SACOG RP survey data did not yield usable locally estimated models of segmented VOT
  - Adopted VOT distributions by from recent SFCTA SP analysis analyzed in C04
  - VOT=Applied to InVehicleTime (IVT)
- Incorporated travel time (Un)reliabilty
  - Applied with DynusT simulation
  - Concept of "extra impedance"
    - TTI = FF / actual speed
    - TTE = Mean Time + **a** * (80th TT – 50th TT, where
    - **a** = value of unreliability relative to mean travel time (a value of 0.8 proposed)

SHRP 2 C04 Issues and Findings in MPO Activity-Based Model Developments

Finding	Applied
Impact of commuting distance on VOT	CMAP ABM
Impact of income on VOT	CMAP ABM, MAG ABM, JTMT ABM, MORPC ABM, NOACA ABM, OKI ABM, Ottawa Trans Tour-Based model, SACOG, PRSC, Tampa, Jacksonville
Impact of car occupancy on VOT	CMAP ABM, MAG ABM, JTMT ABM, MORPC ABM, NOACA ABM, OKI ABM, SACOG, PRSC, Tampa, Jacksonville
Incorporation of travel time reliability in mode and route choice	Ottawa Trans Tour-Based model, SHRP 2 L04
Randomized VOT	CMAP ABM, MAG ABM, JTMT ABM, SACOG, PRSC, Tampa, Jacksonville
New methods of ABM-DTA integration	SHRP 2 L04, CMAP ABM-DTA integration

Highlighting
a Few Statistically-Based Findings
and their Policy Implications

Behavioral Insights for Policy

1. ***VOT and Willingness to Pay*** have a wide range from $5/hour through $50/hour across income groups and major travel purposes. There is a significant situational variation (unobserved heterogeneity) on the top of it with the “tail” of the distribution going beyond $100/hour.

***Policy Implications*:**

Prices have to be at significant levels to influence congestion. Variability by time of day, vehicle occupancy, and frequency of travel allows prices to have more effect.

Behavioral Insights for Policy

2. In parallel with relatively high VOT (Willingness to Pay for Travel Time Savings) there is a ***significant negative toll bias*** ("threshold" effect equivalent to 15-20 min). This is generally found in both Revealed Preference and Stated Preference data, and supported by research in behavioral economics.

Policy Implications:

Pricing makes sense if it is associated with significant travel time savings and reliability improvements to overcome a psychological bias against any tolls.

Behavioral Insights for Policy

3. Traveler's ***responses to congestion and pricing*** are dependent on the range of available options. They generally follow the sequence:
   - Primary: route/lane type change, small shifts in departure time (up to ±60 min),
   - Secondary: switch to transit (in transit-rich areas), carpooling
   - Tertiary: principal rescheduling of trips & activities by time-of-day periods
   - Longer term changes in home, work, other locations.

***Policy Implications*:**

Impact of peak period pricing on congestion level may be minor if the peak period is already spread over 2-3 hours and transit service is limited.

Behavioral Insights for Policy

4. Improvements in ***travel time reliability*** are as important as improvements in average travel time. Reliability Ratio (cost of 1 minute of standard deviation versus cost of 1 minute of average time) is in the range of 0.5-1.5

***Policy Implications*:**

Dynamic pricing, traffic accident management and other strategies that specifically guarantee stable travel times (and avoid non-recurrent congestion) are highly valued by travelers.

Behavioral Insights for Policy

5. ***Income*** has a strong although not linear effect on VOT and Willingness to Pay. To account for income effect Cost/Toll variables in travel models should be scaled by Income powered by 0.6-0.8.

Policy Implications:

Pricing studies need to explicitly consider income distributions and future income growth in each region, corridor, and area. In the absence of locally calibrated models, model parameters from he other region have to be scaled by income differences.

Principal Conclusions

- Policy implications may be quite significant for:
  - More accurate forecast of response and performance levels
  - Capture of additional benefits associated with tolled roads and managed lanes, particularly with guaranteed reliability
- Universal fully transferable model:
  - Impossible, due to regional specifics, data / model limitations
  - Seed conceptual structures are becoming clear
- Complete operational models incorporating extended behavioral sensitivities
  - Definitely yes!
  - Reliability is extremely important and statistically significant
  - Mostly requires ABM platform
  - Integrated ABM+DTA framework is the best

SHRP 2 C05

UNDERSTANDING THE CONTRIBUTION OF OPERATIONS, TECHNOLOGY, AND DESIGN TO MEETING HIGHWAY CAPACITY NEEDS

Presented by:
Brandon Nevers, PE
Kittelson & Associates, Inc.

Project Team

- **Kittelson & Associates, Inc.**
  - Wayne Kittelson, PE and Brandon Nevers, PE
- **Institute of Transportation Research and Education**
  - Nagui Rouphail, PhD
- **University of Utah**
  - Xuesong Zhou, PdD (now with Arizona State University)
- **Ruhr University**
  - Werner Brilon, PhD

Project Scope and Objectives

- **Objectives:**
  - Quantify capacity benefits of improvements at the network level
  - Provide information and tools to analyze operational improvements as an alternative to traditional construction
  - Develop guidelines for "sustainable service rates" to be used in planning networks
- **Limits of project scope:**
  - Automobile mode focus, not transit or non-motorized travel
  - Capacity focus, not demand management

Categories of Potential Strategies

- Operations-based, such as
  - Signal coordination
  - Ramp metering
- Design-based, such as
  - Narrow lanes
  - Alternative left turn treatments
- Technology-based (ATIS, Advanced Traveler Information System), such as
  - Pre-trip information
  - In-vehicle information
- Strategies to improve freeway performance, arterial performance, or both

25 Non-Lane Widening Strategies to Improve Capacity Selected for Evaluation

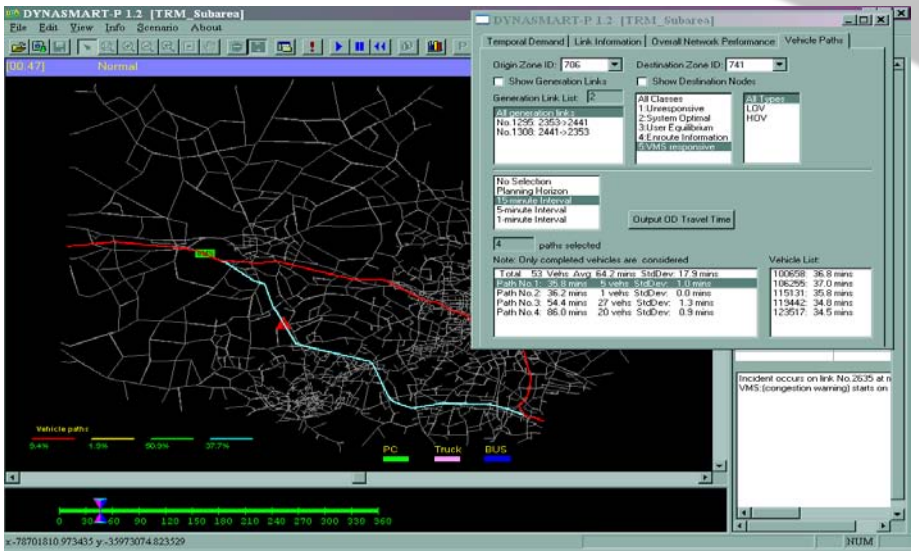
Freeway	Arterial	Both
HOV Lanes	Signal Retiming	Narrow Lanes
Ramp Metering	Signal Coordination	Reversible Lanes
Ramp Closures	Adaptive Signals	Variable Lanes
Congestion Pricing	Queue Management	Truck Only Lanes
Pricing by Distance	Raised Medians	Truck Restrictions
HOT Lanes	Access Points	Pre-Trip Information
Weaving Section	Right/Left Turn Channelization	In-Vehicle Info
Frontage Road	Alt LT/RT Treatments	VMS/DMS
Interchange Modifications		

Insights on Strategy Effectiveness

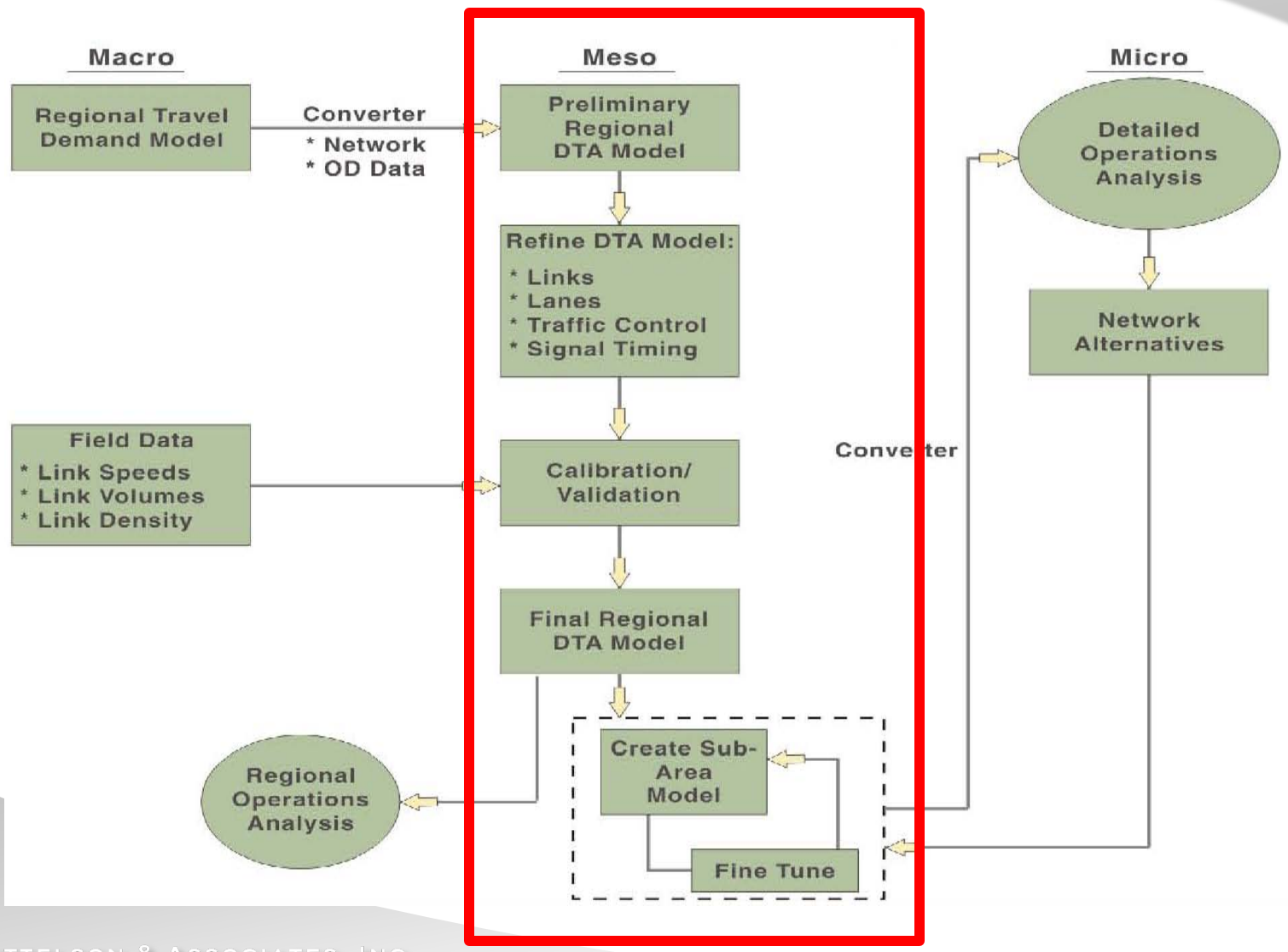
- **Effectiveness needs to be tested in network context**
  - Requires the use of a travel demand/dynamic traffic assignment (DTA) model
  - Cannot be done with static look-up tables or simple spreadsheets
- **Impacts most pronounced at the link and corridor levels, and often difficult to see at the network level**
  - Demand-side issues are best viewed from an O-D perspective
  - Supply-side issues are best viewed at the link and corridor level
- **Pre-trip information can reduce buffer time and improve reliability**
- **En-route information may create instabilities**

Dynamic Traffic Assignment (DTA) Modeling

- Estimate travel patterns and driver behavior (route choice) in "real time" across a network
- Serves as a "bridge" between high-level travel forecasting models and detailed microsimulation models



Multi-Resolution Modeling



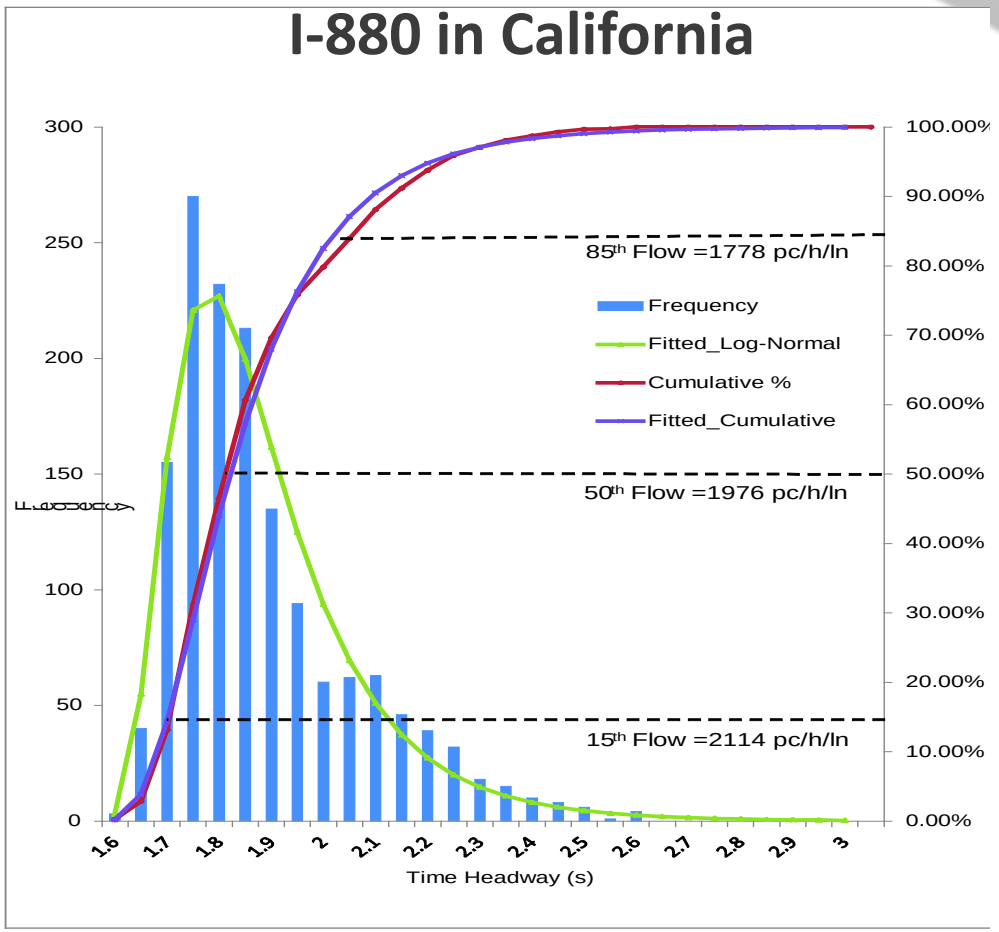
Modeling Enhancements Made in C05

1. Stochastic capacity
2. Driver learning
3. Short lane effects on arterials
4. Performance measurement

1. Stochastic Capacity

Resulting Pre-Breakdown Headway Distribution

- Shows that single headway value not appropriate for defining breakdown conditions
- Probability of breakdown increases with increasing flow rate
- Stochastic capacity for arterials also developed

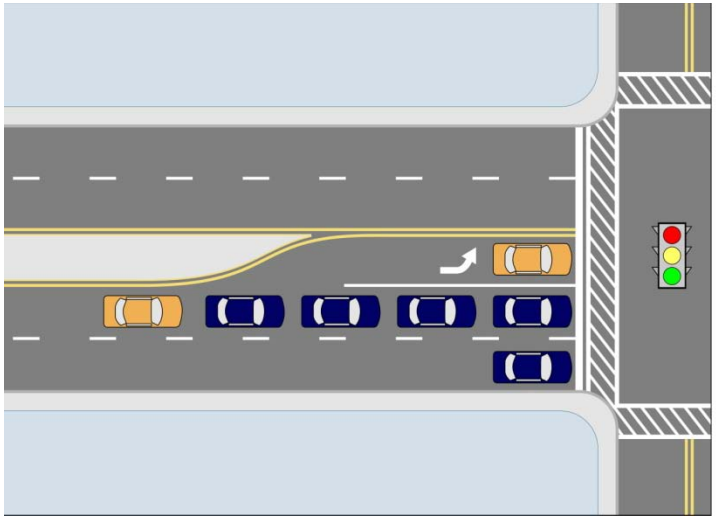


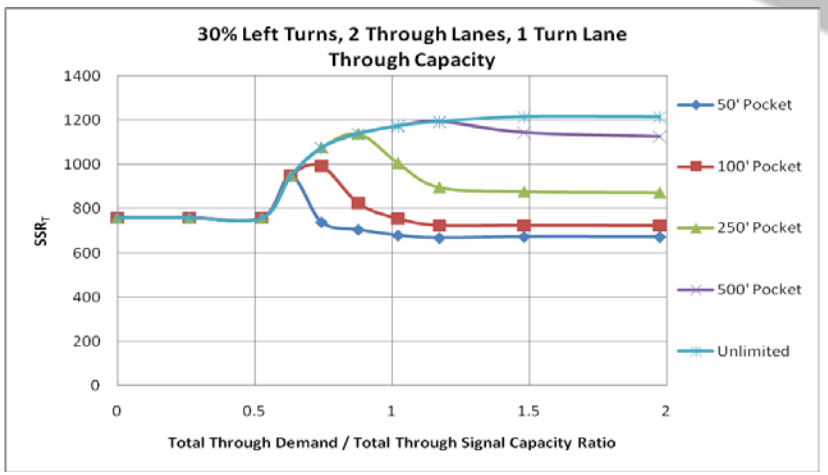
2. Day-to-Day Driver Learning

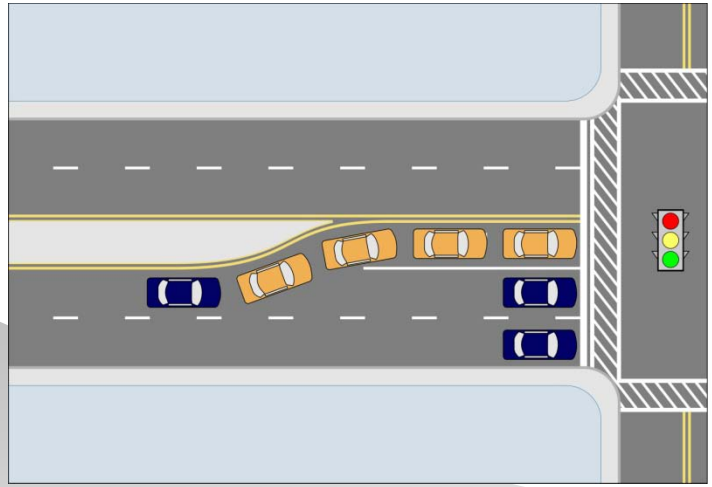
- Traveler's route choice is based on experiences remembered from the past two weeks
- Limits applied to number of travelers who will adjust their trip each day
- Important in the evaluation of non-recurring congestion

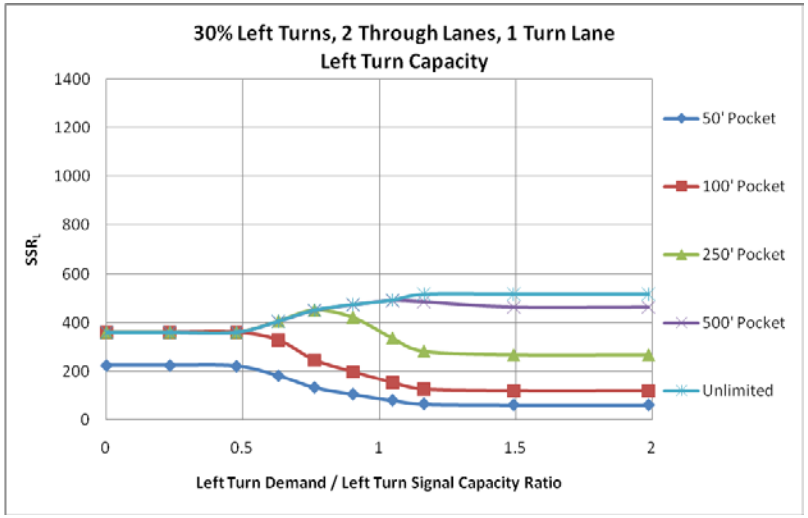
3. Method for Estimating Lane Blockage Effects

SSR = Sustainable Service Rate









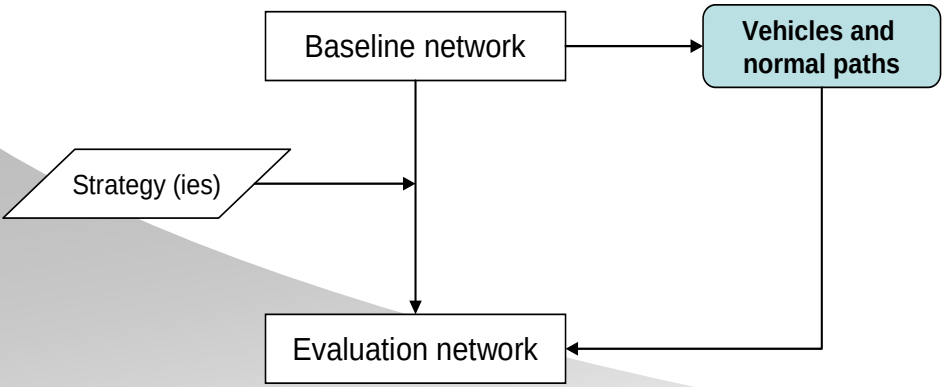
4. Performance Measurement

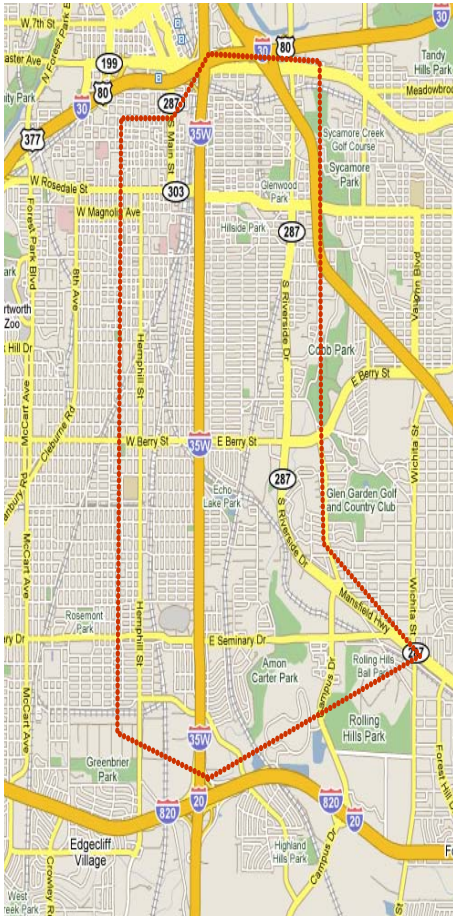
- **Performance Measures**
  - Volume, capacity, delay, **density, travel time, queue, breakdown count**
- **Spatial Level**
  - Node, **Link, corridor, O-D pair, subarea, and whole network**
- **Temporal Level**
  - 15-min, 1 hour, **multiple hours, whole day, time periods across multiple days (reliability)**

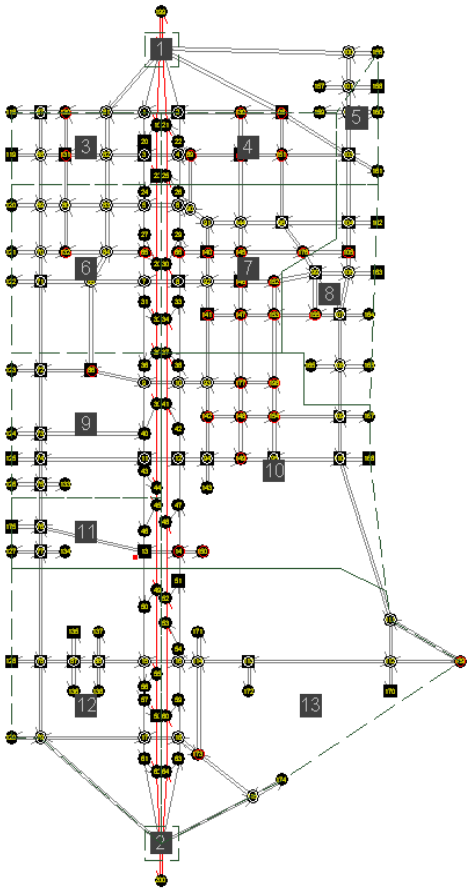
Green = enhancements to conventional practice

Overview of Strategy Testing Plan

- **Two networks tested:**
  - Freeway corridor with parallel arterials (Dallas-Fort Worth, Texas)
  - More complex and realistic subarea network (Portland, Oregon)

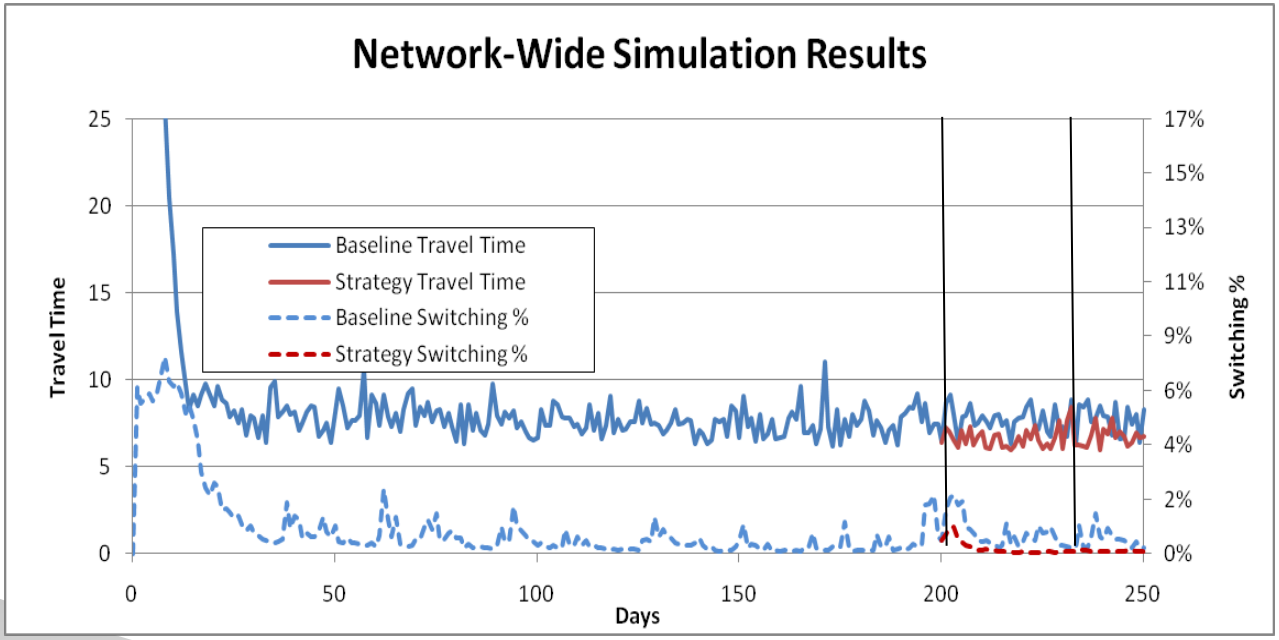




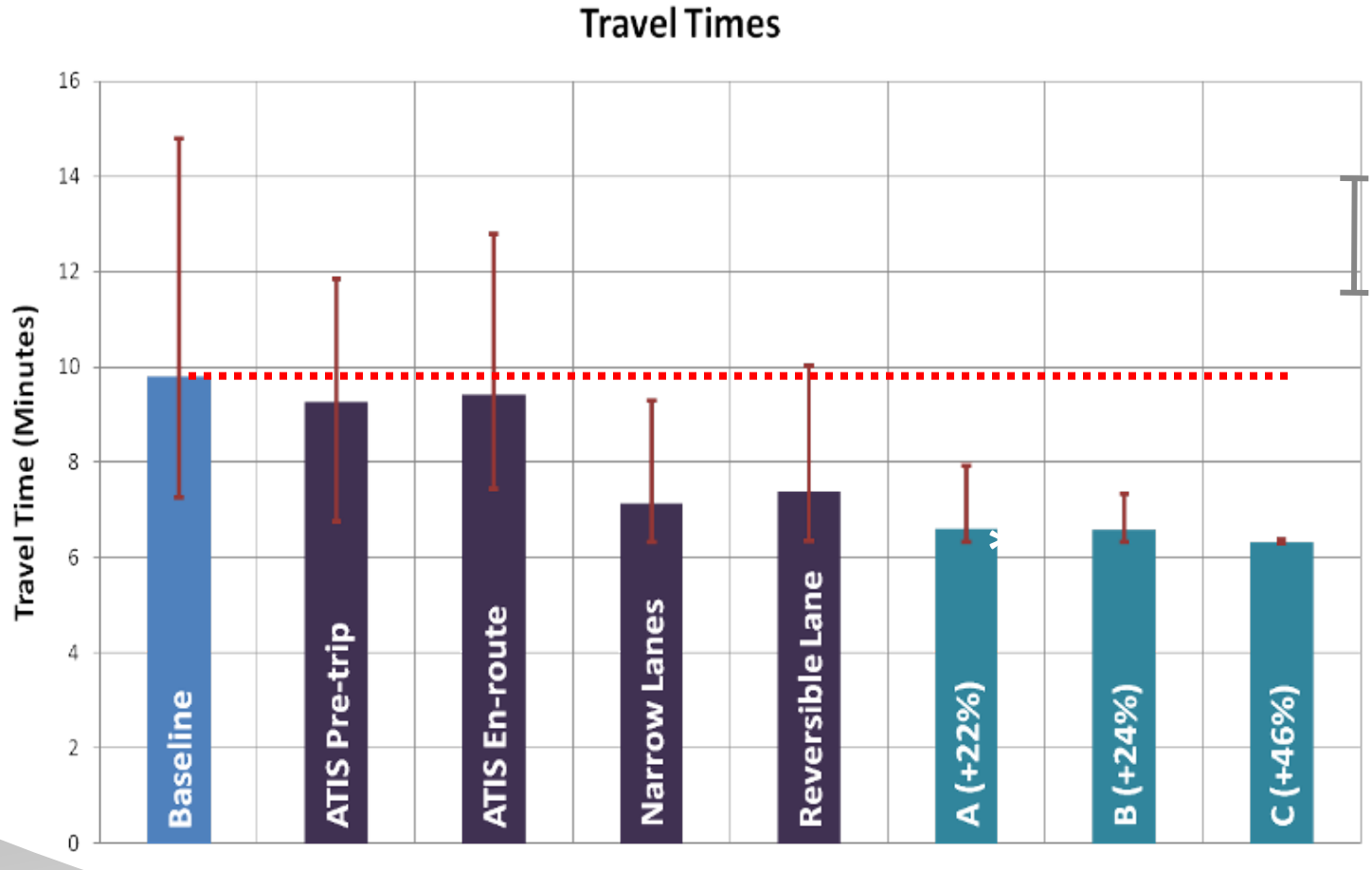


Overview of Strategy Testing Plan (cont.)

- **Test Protocol**
  - I: Baseline stabilization
  - II: Strategy stabilization
  - III: 20-day results comparison period



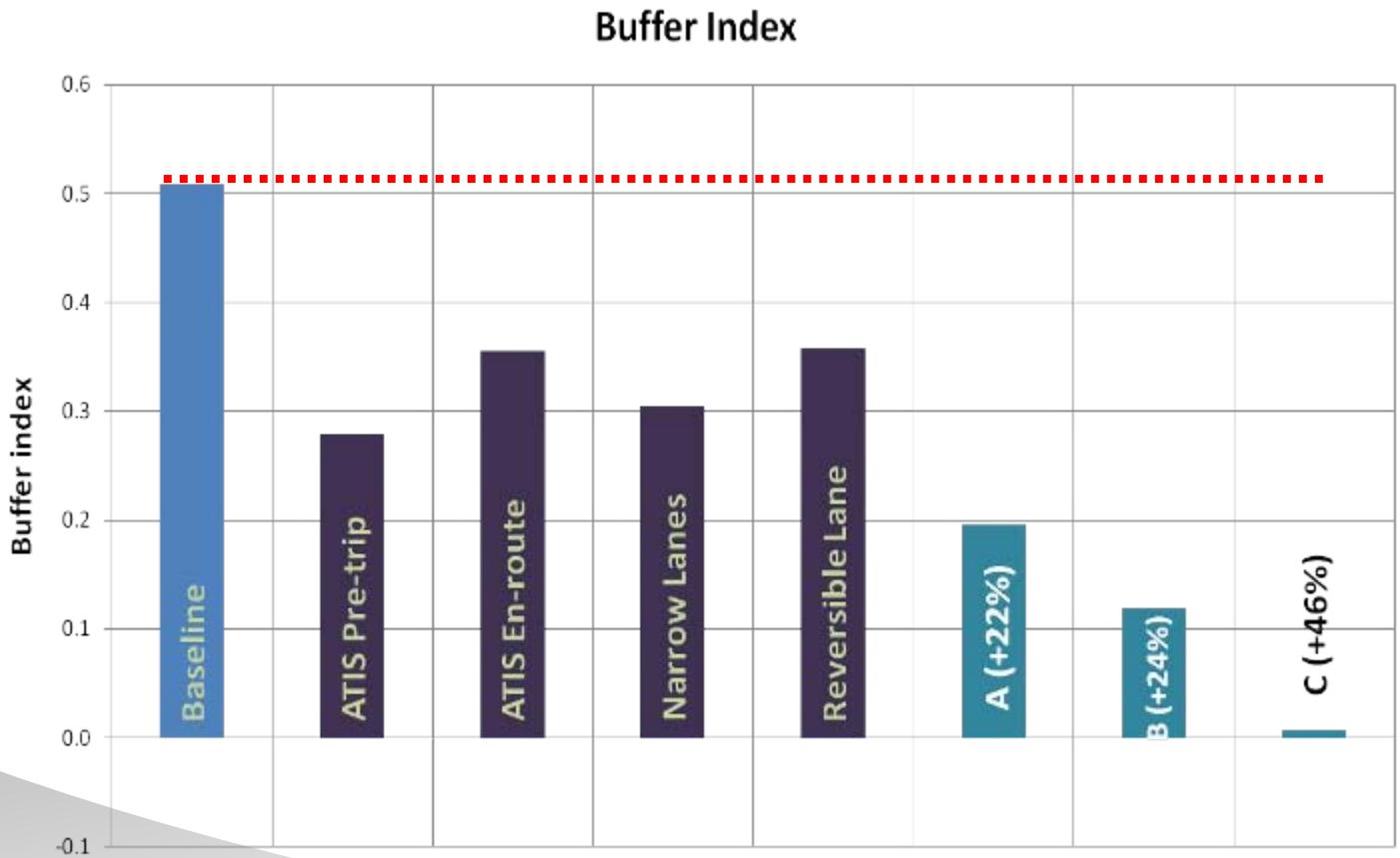
20-Day Average Results for the Primary SB O-D Ft. Worth, TX Subarea



* Effects in peak direction with lane addition for one hour

20-Day Average Results (cont.)

- Buffer Index = (95th %ile TT – Mean TT)/Mean TT

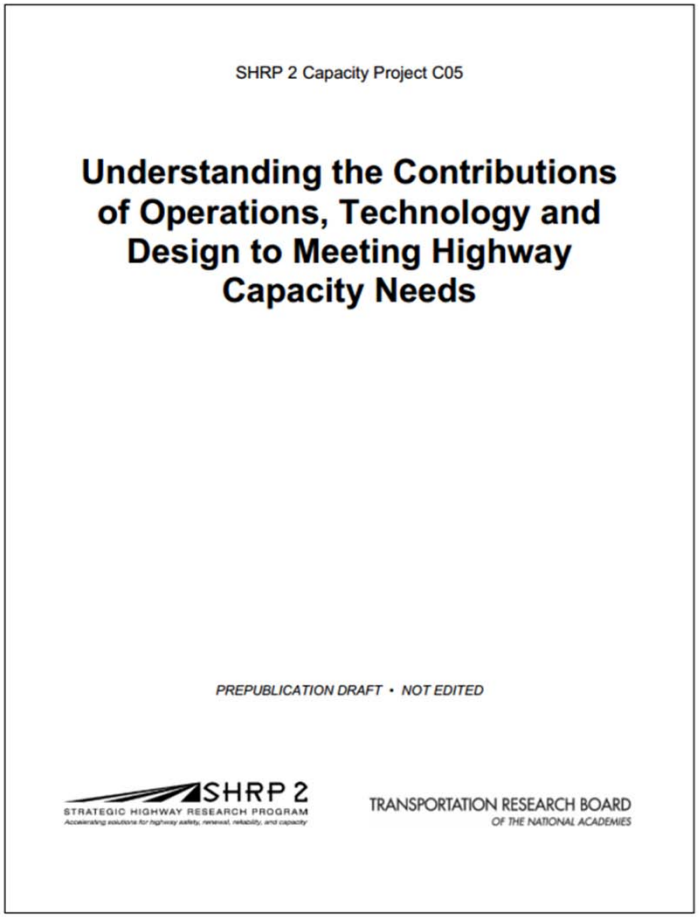


Conclusions

- Dynamic Traffic Assignment (DTA) models can be effective in assessing lower-cost strategies
- New modeling capabilities are available that can be extended to a variety of DTA models
- Capacity and reliability can be tied together with travel time reliability
- Further enhancements to include non-recurring congestion will create additional value for practitioners and decision makers

Key Products

- Traffic Model Enhancements
- Diagnostic Tools
  - Visualization Capabilities (DTALite)
  - Spreadsheet-Based Models
- Strategy Evaluation Approach
- Final Report
- Guidebook


SHRP 2 Capacity Project C05

Understanding the Contributions of Operations, Technology and Design to Meeting Highway Capacity Needs

PREPUBLICATION DRAFT • NOT EDITED

SHRP 2
STRATEGIC HIGHWAY RESEARCH PROGRAM
Accelerating solutions for highway safety, renewal, reliability, and capacity

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

Advances in Travel Demand Forecasting

Considerations for Implementing New Technologies and Methods

(SHRP2 Capacity C10)

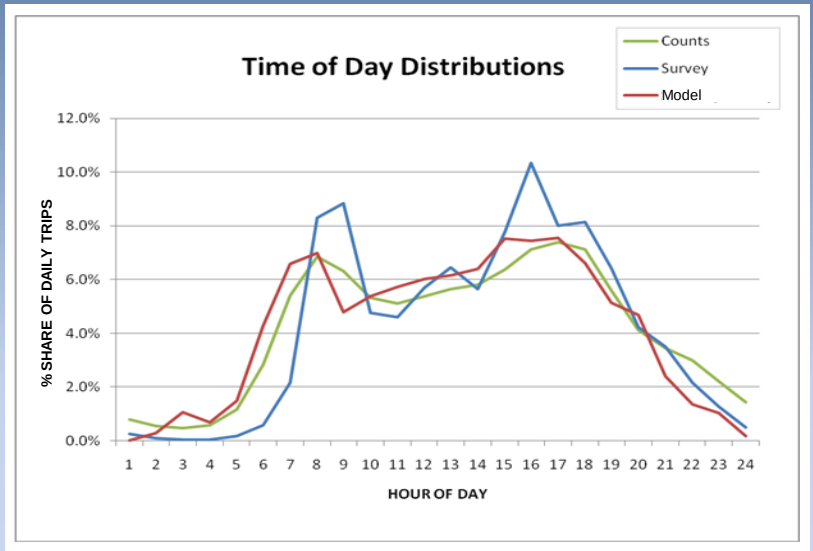
Brian Gardner, FHWA
Matt Hardy, AASHTO

Planning, Programming, Project Development

- Continuing emphasis on management and operations
- Strategic reconfiguration scenarios
- Congestion, tolling, and pricing
- Support other, higher fidelity analyses

Need better representation of dynamic systems in planning models

Current Technologies



FHWA 2013

- Activity-Based Demand Models
  - Time-space constraints
  - Scheduling
- Dynamic Network Models
  - Times and costs change over time

Implementation

- Activity-Based Models
  - Increasing number of regional planning agency deployments
- Dynamic Network Models
  - Subarea, project, and corridor level deployments
- Joint Interaction & Application

Translating SHRP2 Methods & Lessons into Practice

- Data
  - Users, Networks, Controls, Validation
- Methods & Software
  - Interaction, Interpretation
- People
  - Public Agencies, Consultants, Developers

Implementation

- In 2012, the AASHTO Board of Directors approved funding the implementation of SHRP2 products
  - Funding came from State Planning and Research money
  - AASHTO is committed to the successful implementation of SHRP2
- The AASHTO Standing Committee on Planning (SCOP) and FHWA are developing a SHRP2 Capacity Strategic Implementation Plan
  - Five “bundles” of projects:
    - Freight Modeling
    - Analytical Tools
    - Economic Analysis Tools
    - Process
    - TCAPP
  - All of the products discussed here are part of the Analytical Tools bundle

What's Next

- Implementation Planning Workshop in CY 2014 Q1
- Implementation Assistance Program
- For more information:

  www.fhwa.dot.gov/goshrp2/

  www.fhwa.dot.gov/planning/tmip/

  http://shrp2.transportation.org/Pages/default.aspx

SHRP 2 C10A

Partnership to Develop and Integrated Advanced Travel Demand Model with a Fine-Grained, Sensitive Network Model

SHRP 2 C46

Activity-Based Model Primer
& Integrated Model Considerations

Joe Castiglione, RSG

C10A Project Team

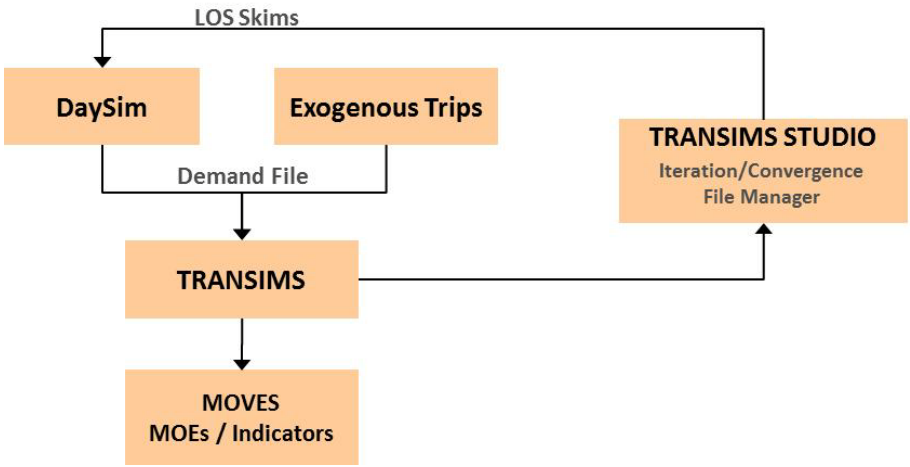
- RSG
- AECOM
- Dr. John Bowman
- Dr. Travis Waller, UNSW
- Dr. Mohammed Hadi, FIU
- Dr. Ram Pendyala, ASU
- Dr. Chandra Bhat, UT Austin
- NFTPO

C10A Objectives

- Develop an operational “integrated” model
  - Advanced demand model
  - Time-dependent network supply model
- Demonstrate value of model
  - Validation / calibration
  - Sensitivity tests
- Implement in a framework that is easily transferable to the local jurisdictions for policy analysis
- Incorporate findings from other SHRP 2 efforts

What is an integrated model?

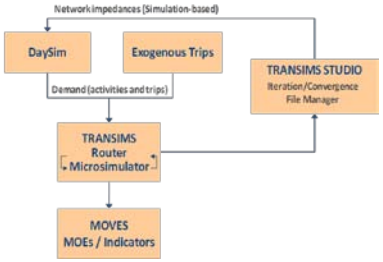
- A model system in which different models exchange information in a systematic and mutually dependent manner
  - AB info to DTA
  - DTA network impedances to ABM
- C10A model components
  - Daysim “activity-based” model
  - TRANSIMS network simulation model
  - MOVES
- C10A integrated model system implemented in both Jacksonville, FL and Burlington, VT



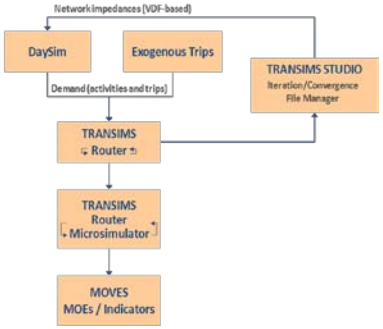
Why develop an integrated model?

- Current models are limited
  - Not sufficiently sensitive to travel behavior and network conditions
  - Unable to represent the effects of policies such as variable road pricing and TDM
- Integrated model systems represent demand changes and network performance better
  - Peak spreading, mode choices, destination choices
  - Capacity and operational improvements such as signal coordination, freeway management and variable tolls

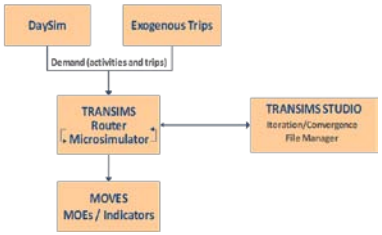
Planning & Operations



Planning

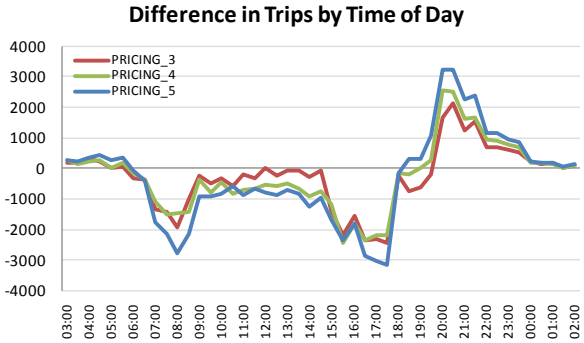


Operations



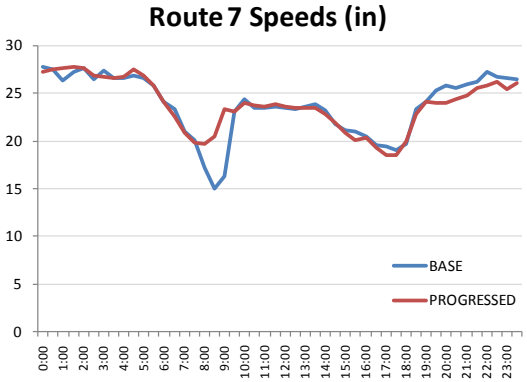
How can an integrated model be used?

- Freeway Tolling
  - Vary tolls by detailed time of day and facility
  - Demonstrate shifts by time of day and purpose
- Travel Demand Management
  - “Flexible Schedule” scenario
  - Demonstrate that fewer work activities results in more non-work activities
- Operations
  - Corridor signal progression
  - Challenging to code and interpret results



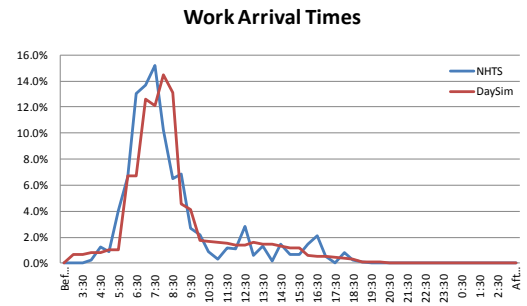
Tours by Purpose (Fulltime Workers)

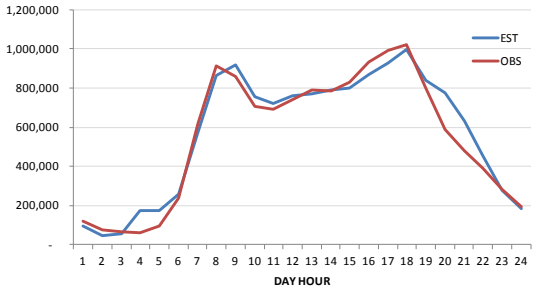
	Original	Adjusted	Adj/Orig
Work	94,408	78,472	0.83
School	115	140	1.22
Escort	8,070	9,023	1.12
Pers Bus	13,519	16,848	1.25
Shop	10,531	12,938	1.23
Meal	3,817	3,842	1.01
Soc/Rec	13,076	14,360	1.10
Workbased	27,949	23,211	0.83
Total	171,485	158,834	0.93

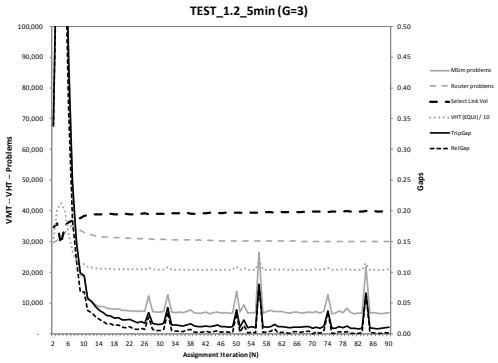


C10 Lessons Learned

- Data development
  - Simulation network sensitivity
  - Detailed alternative scenario assumptions
- Transferability
- Calibration / Validation
- Configuration
  - Convergence
  - Consistency
- Application







C10A Conclusions

- Integrated model system
  - is more sensitive to a wider range of policies
  - produces a wider range of statistics of interest to decision-makers
- Level of effort required to effectively test different types of improvements varied widely
- Debugging the model system, and individual scenarios was the greatest challenge
- Must have willingness to investigate and experiment

C46 Objectives

- Develop Primer on activity-based (AB) travel demand models
  - Practical, how-to guide for practitioners and managers
  - Explain concepts and implementation
  - Consider linkages between AB models and dynamic network models and land use models
- Develop Implementation Considerations Report

Primer on Activity-Based Models

- Three primary sections
  - Moving to AB Models
    - For agency managers
    - Capabilities, sensitivities
  - Technical roadmap
    - For modeling managers
    - Component selection, linkages, data and resource requirements
  - AB concepts and algorithms
    - For practitioners
    - Design, components, development tasks

Implementation Considerations Report

- Examine benefits, barriers, practical issues agencies face in migrating from “traditional” to “advanced” approaches using SHRP2 products
- Identify challenges and strategies for overcoming
- Inform implementation

SHRP C10B

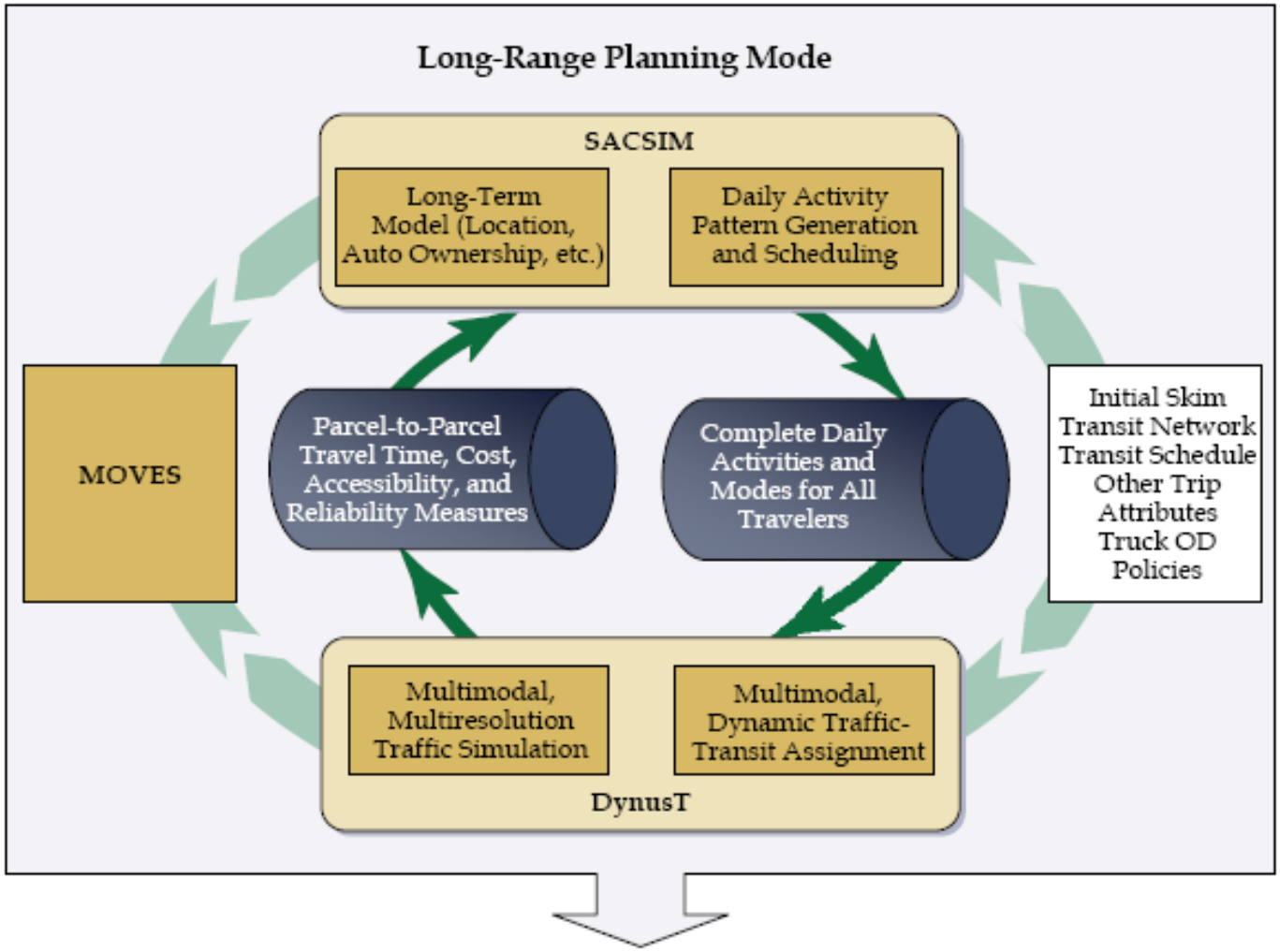
Partnership to Develop an Integrated Advanced Travel Demand Model with Fine-Grained, Time-Sensitive Networks

Thomas Rossi, Cambridge Systematics, Inc.

SHRP C10B Team

- Cambridge Systematics, Inc.
- Sacramento Area Council of Governments
- University of Arizona
- University of Illinois, Chicago
- Sonoma Technology, Inc.
- Fehr and Peers

Integrated Modeling Approach



SHRP C10B

- Integration of SACSIM with DynusT
- Implemented in Sacramento, California
- Uses original DaySim model estimated in Sacramento
- Incorporates new transit simulation process (FAST-TrIPS)
- Integration with MOVES
- Testing using policy alternatives in Sacramento

Model Features

- Integrated model components
  - DaySim (tours/trips) → DynusT/FAST-TrIPS (auto/transit simulation)
  - Exogenous trips → DynusT (auto simulation)
  - DynusT → MOVES
- User interface
  - Enables users to create, run, manage scenarios
- Run times for Sacramento regional model – about one day per feedback loop
  - 10 iterations of DynusT assignment per loop

MOVES Integration

Main components

1. DynusT processing to prepare network and activity data for MOVES
2. MOVES input files set-up using other data sources
3. MOVES CO_2 emissions modeling
   - Running exhaust (related to roadway links)
   - Start exhaust (related to traffic analysis zones)

Other Model Features

- DaySim revised to incorporate variable value of time (for road pricing analysis)
- Travel time reliability incorporated into DynusT
- Feedback process for using travel times from DynusT as inputs to SACSIM
- Conversion of shared ride person tours to vehicle tours

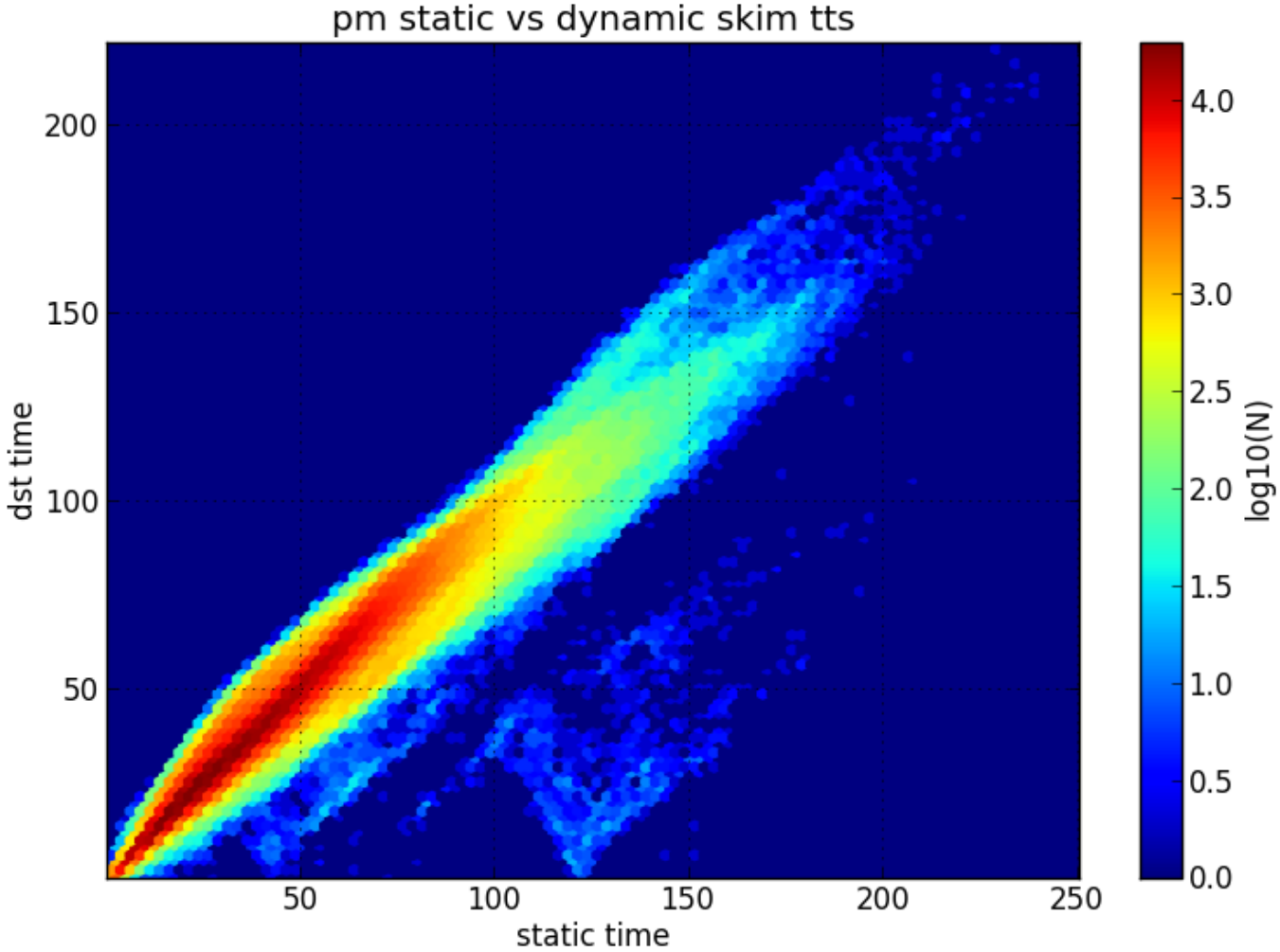
Policies/Projects Tested

- Scenarios compared between the original SACSIM model and the new C10B integrated model
  - Operations-Oriented Interchange Project
  - New Transit Line
  - Freeway Bottleneck Analysis
- Scenarios tested using only the new C10B integrated model
  - ITS/Arterial Signal Coordination
  - Transit Schedule Coverage Change
  - HOT Lane project

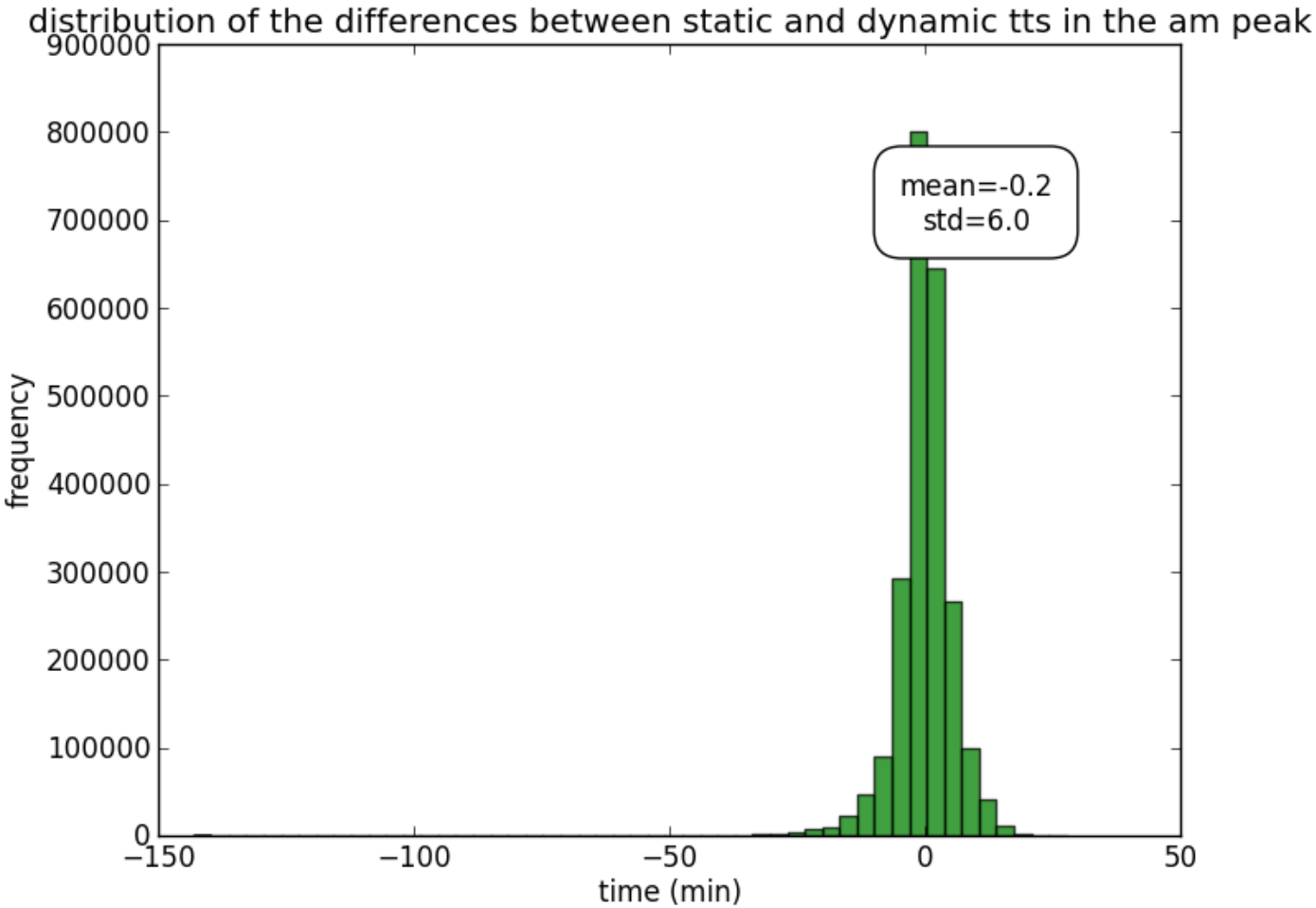
Some Interesting Results…

- Removal of freeway bottleneck (still analyzing)
  - Logical changes in vicinity
  - Some changes away from project
  - Due to simulation noise?
- Doubling frequency on transit route
  - Static model shows large ridership increase, reductions on nearby routes
  - C10 model shows almost no change in ridership
  - May be due to bus bunching resulting in unchanged wait times

Comparison of Static And Dynamic Skim Times



Comparison of Static and Dynamic Skim Times



Project Status – Final Tasks

- Documentation of policy/project testing
- Final project documentation
- Finalization of integrated model and software

For Further Information…

- Thomas Rossi, Cambridge Systematics
  - trossi@camsys.com
- **http://www.shrp2c10.org/SHRPC10Portal/Home.aspx**
- **www.dynust.net**

The Strategic Highway Research Program 2 Capacity Program

Smart Growth Area Planning Tool (SmartGAP)

The Effect of Smart Growth Policies on Travel Demand

Maren Outwater
RSG

October 1, 2013

Overview

Purpose

- Provide tools, methods, and resources to evaluate smart growth policies on travel demand

Objectives

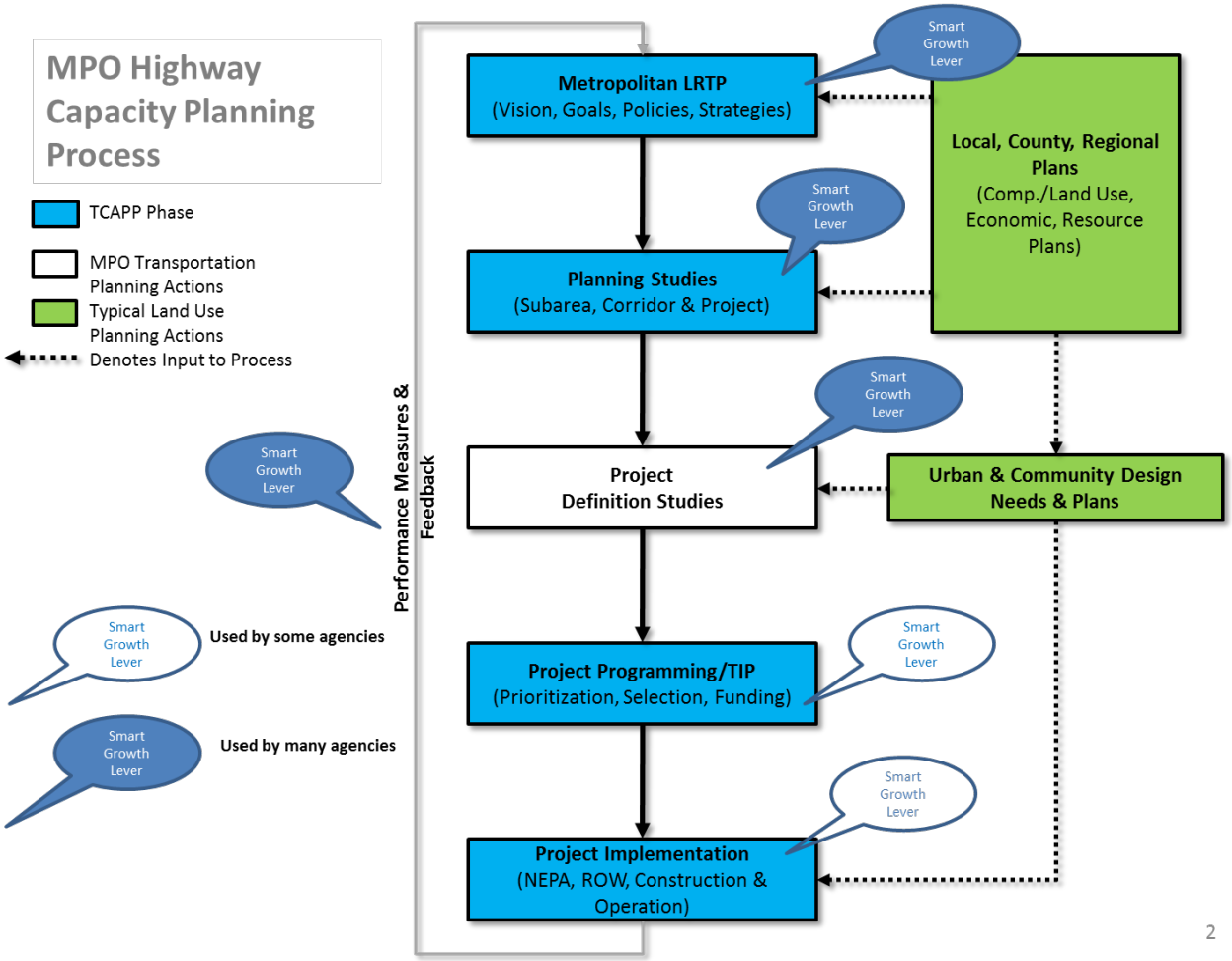
- Understand critical decision points in the transportation planning process and how smart growth approaches affect demand for capacity
- Research the dynamics and inter-relationships of smart growth strategies with the performance of a transportation investment
- Identify range of features and capabilities that new tools need to represent
- Facilitate improved communication, interaction and partnerships between decision-makers and planners in transportation and land use arenas

Decision Points for Smart Growth in the Planning Process

Process maps for State DOTs and MPOs

Areas where smart growth levers can be used

- Policy Studies
- Planning studies
- Programming
- Implementation



2

Key Practitioner Information Needs

Based on interviews with planning officials

Most agencies are interested in scenario planning as a strategy for evaluating smart growth

- Develop a regional scenario planning tool

Many agencies need coordination, cooperation, and communication with local governments on land use policy, since land use regulations are governed by local governments

- Develop a tool that can be used by land use and transportation planners to provide opportunities for interaction on common goals

Agencies also want to understand

- Induced demand, TDM and urban form
- Congestion reduction
- Outcomes and performance

Background Research

Topic	Well-established Relationships	Gaps in Research
Built environment impact on peak auto demand	Impact on daily travel	Impact by time of day
Mobility by mode and purpose	Impact on daily travel	Impact by trip purpose
Induced traffic and induced growth	Capacity expansion on an expanded facility	Route shifts, time of day shifts, mode shifts, induced trips, new destinations, growth shifts on the network; effects of operational improvements, land use plans
Relationship between smart growth and congestion	Localized effects	Macro-level or regional effects
Smart growth and freight	Freight is necessary for population centers	Impacts of loading docks, truck routing, full-cost pricing, freight facilities and crossings, inter-firm cooperation, stakeholder communication

Smart Growth Area Planning Tool (SmartGAP)

Developed for regional decision-makers of transportation and land use policies

Evaluates regional scenarios

- Built environment
- Travel demand
- Transportation supply
- Policies

Considers households and firms individually

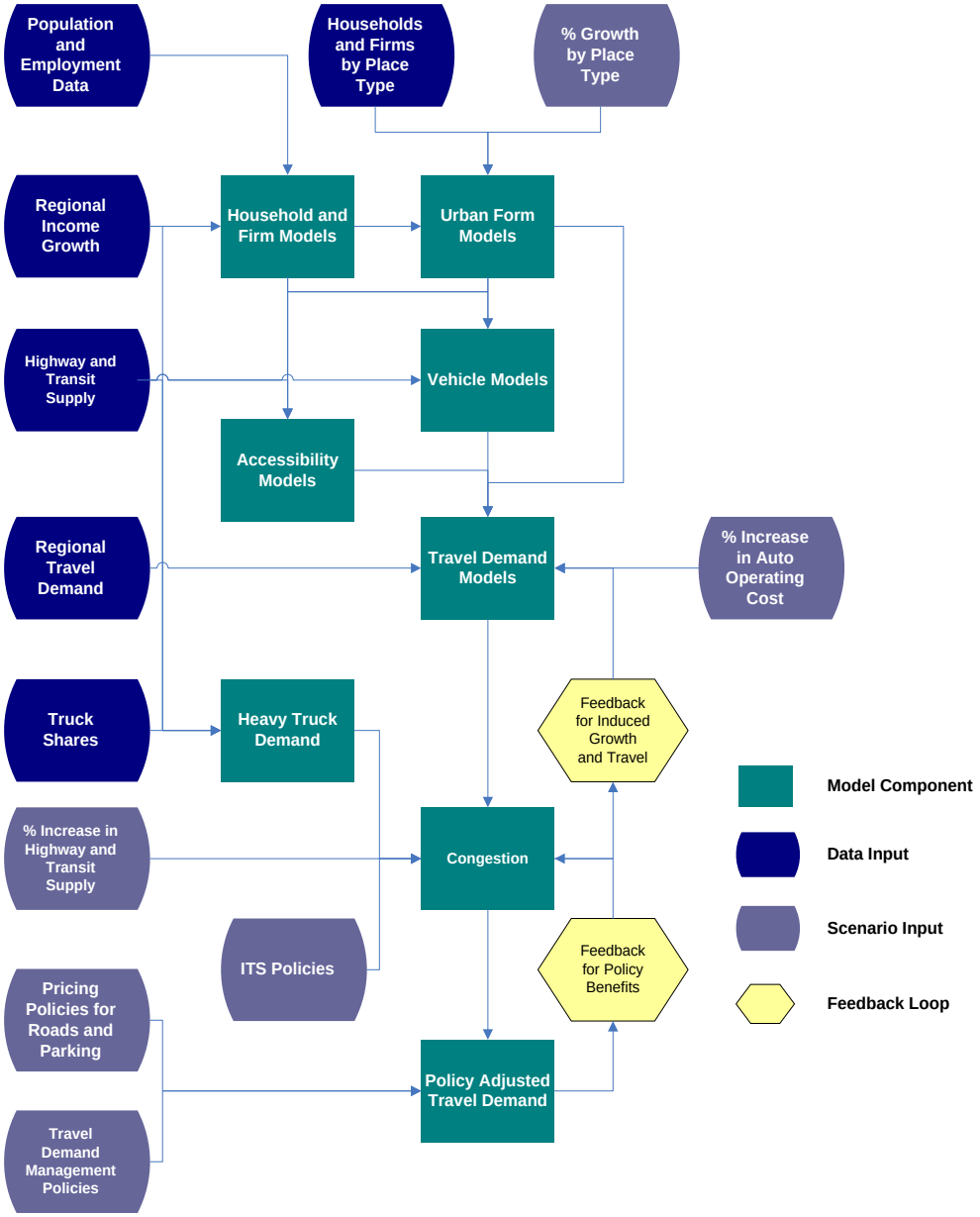
Easy to use and freely distributed

PLACE TYPES

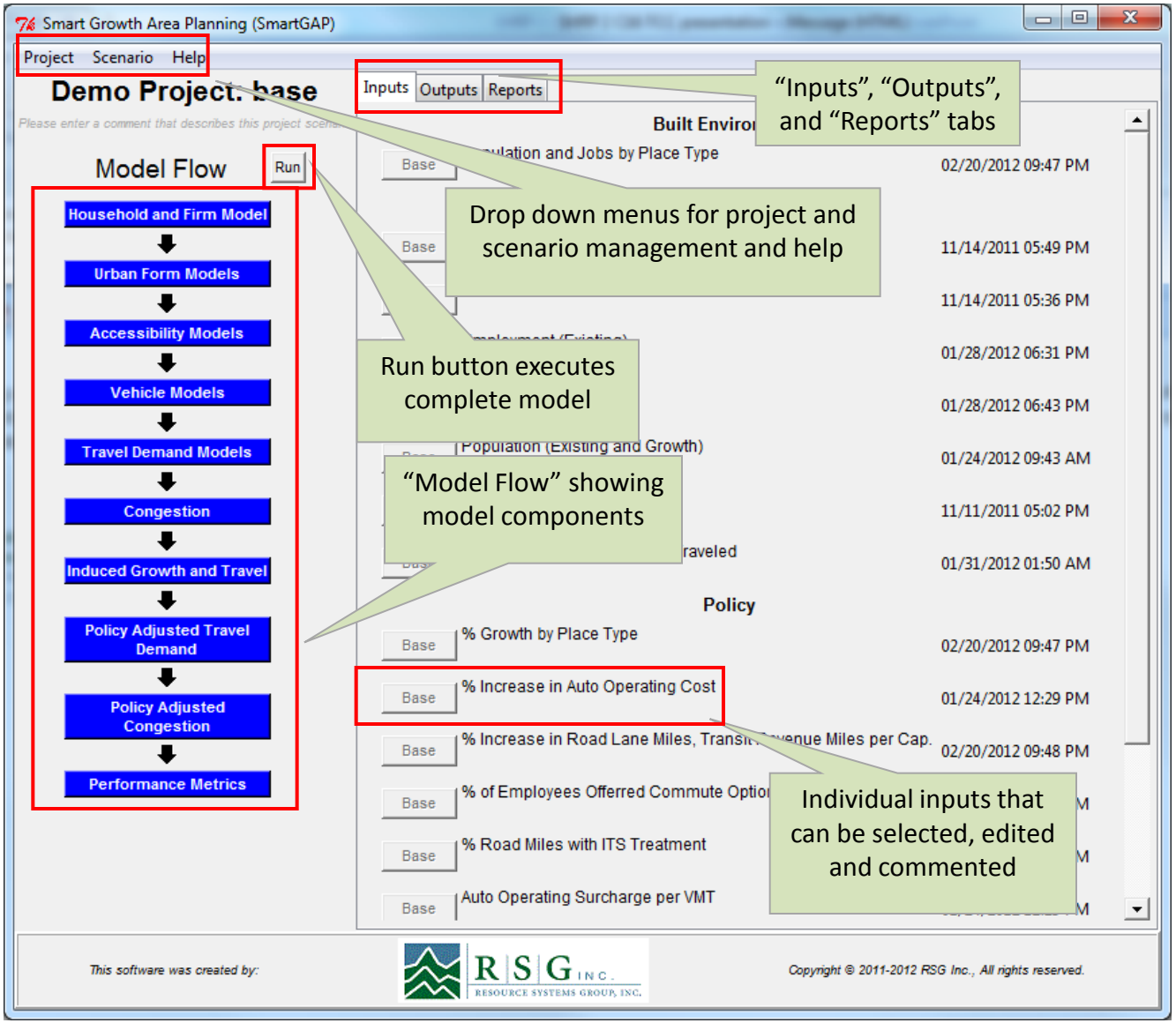
	Area Type			
Development Type	Urban Core	Close in Community	Suburban	Rural
Residential	✓	✓	✓	
Employment	✓	✓	✓	
Mixed-Use	✓	✓	✓	
Transit Oriented Development	✓	✓	✓	
Rural/ Greenfield				✓

SmartGAP Process

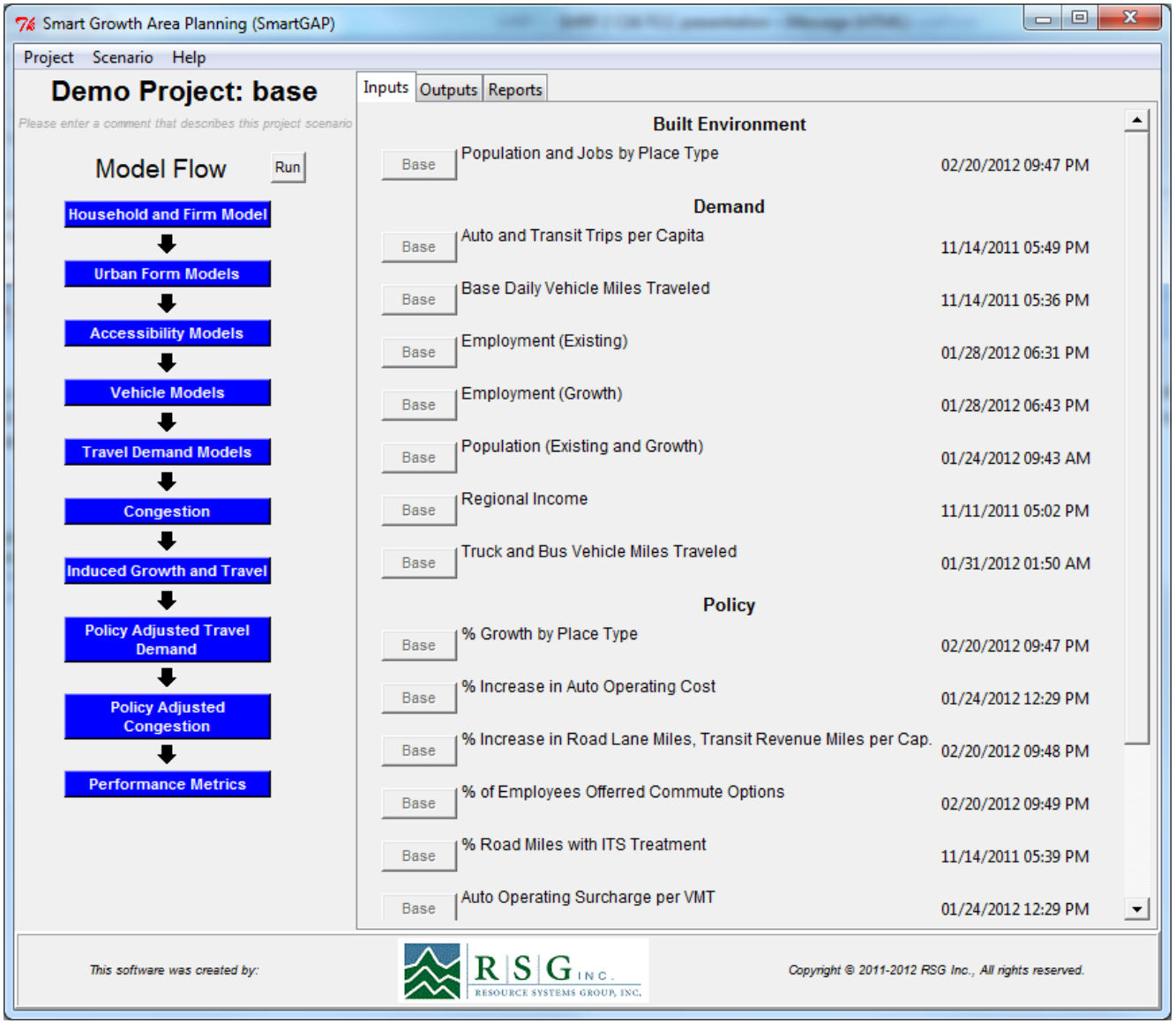
Evaluates transportation impacts of smart growth strategies



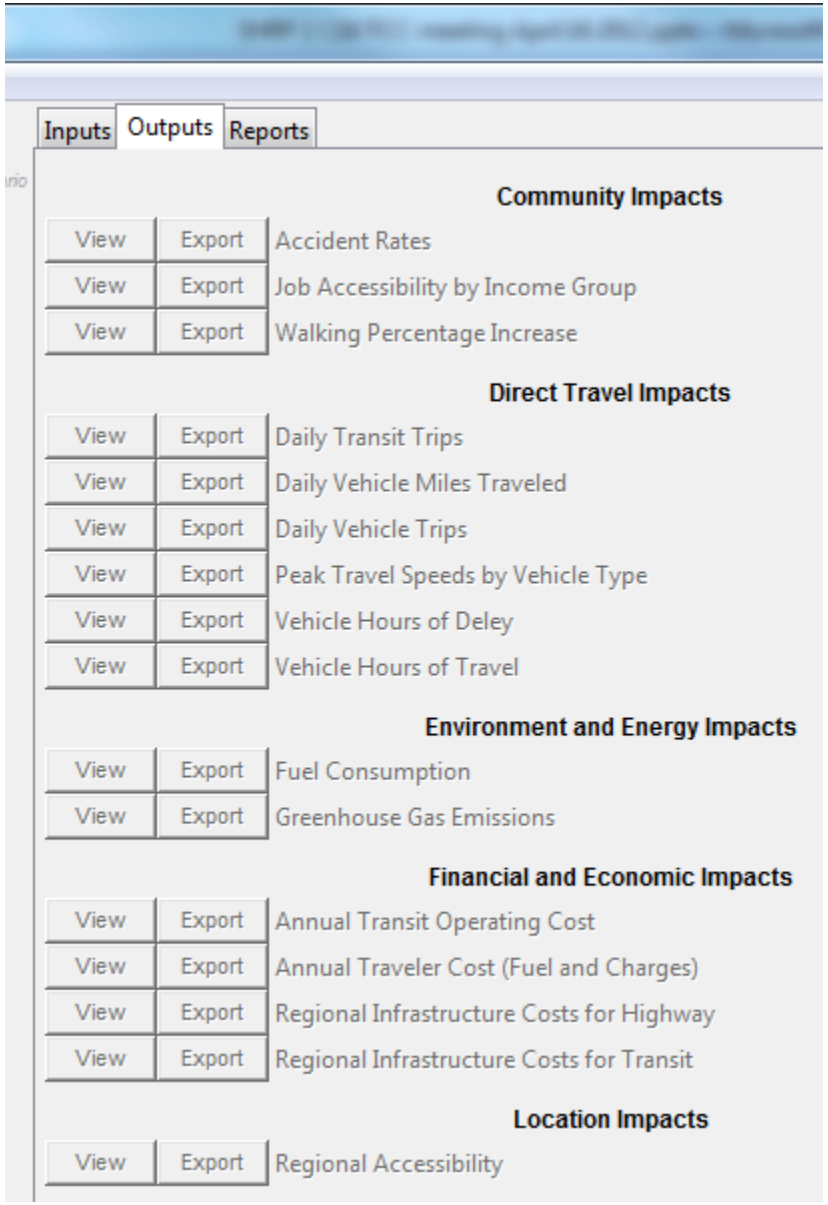
Graphical User Interface



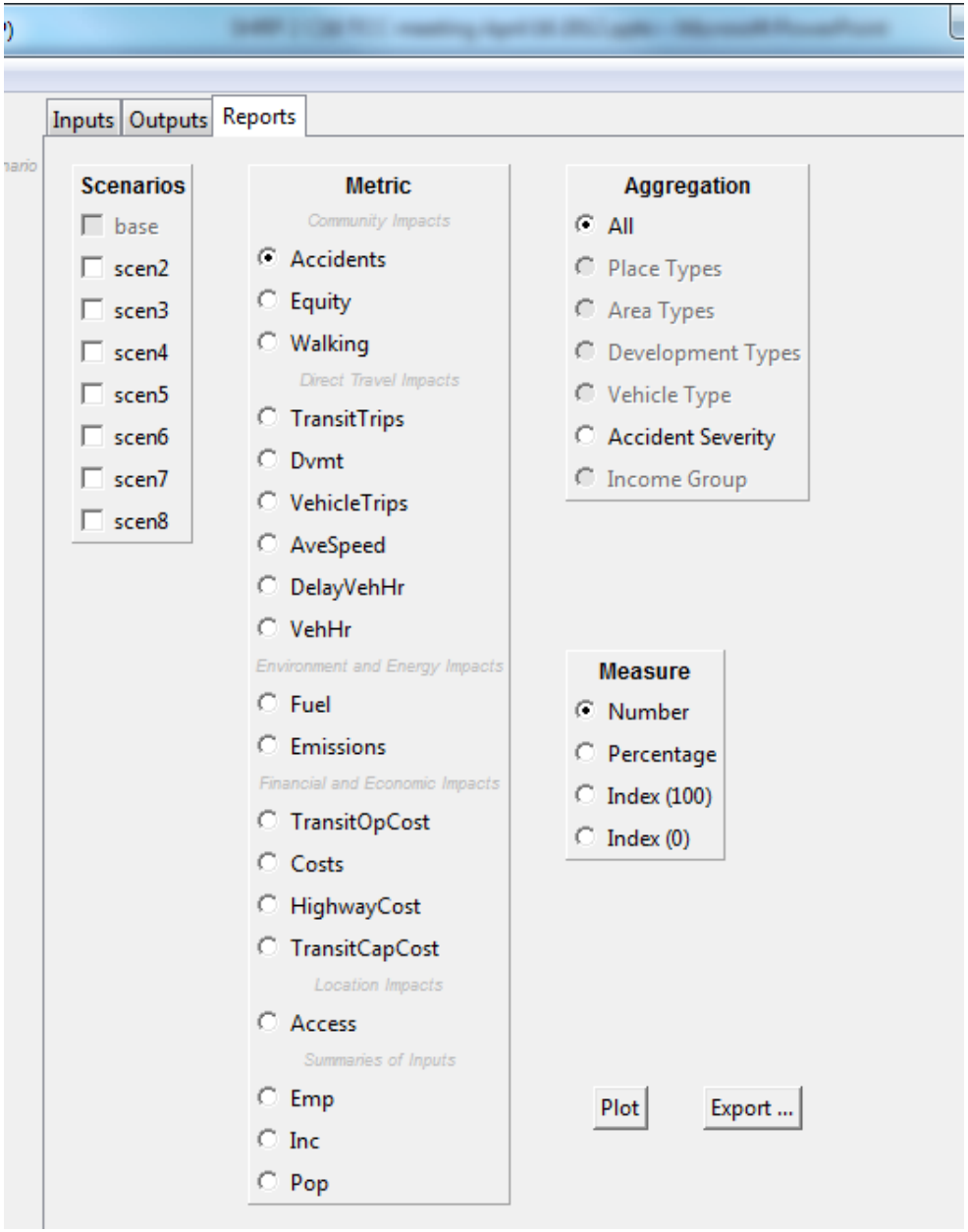
Input Data


Smart Growth Area Planning (SmartGAP)
Project
Scenario
Help
Demo Project: base
Please enter a comment that describes this project scenario
Model Flow
Run
Household and Firm Model
Urban Form Models
Accessibility Models
Vehicle Models
Travel Demand Models
Congestion
Induced Growth and Travel
Policy Adjusted Travel Demand
Policy Adjusted Congestion
Performance Metrics
Inputs
Outputs
Reports
Built Environment
Base
Population and Jobs by Place Type
02/20/2012 09:47 PM
Demand
Base
Auto and Transit Trips per Capita
11/14/2011 05:49 PM
Base
Base Daily Vehicle Miles Traveled
11/14/2011 05:36 PM
Base
Employment (Existing)
01/28/2012 06:31 PM
Base
Employment (Growth)
01/28/2012 06:43 PM
Base
Population (Existing and Growth)
01/24/2012 09:43 AM
Base
Regional Income
11/11/2011 05:02 PM
Base
Truck and Bus Vehicle Miles Traveled
01/31/2012 01:50 AM
Policy
Base
% Growth by Place Type
02/20/2012 09:47 PM
Base
% Increase in Auto Operating Cost
01/24/2012 12:29 PM
Base
% Increase in Road Lane Miles, Transit Revenue Miles per Cap.
02/20/2012 09:48 PM
Base
% of Employees Offerred Commute Options
02/20/2012 09:49 PM
Base
% Road Miles with ITS Treatment
11/14/2011 05:39 PM
Base
Auto Operating Surcharge per VMT
01/24/2012 12:29 PM
This software was created by:
RSG INC.
RESOURCE SYSTEMS GROUP, INC.
Copyright © 2011-2012 RSG Inc., All rights reserved.

Performance Metrics



Model Reports



Distribution and Use of SmartGAP

Available on SHRP 2 Web Site

- Final Report, Software and User's Guide
  http://www.trb.org/main/blurbs/168761.aspx

SmartGAP Installation

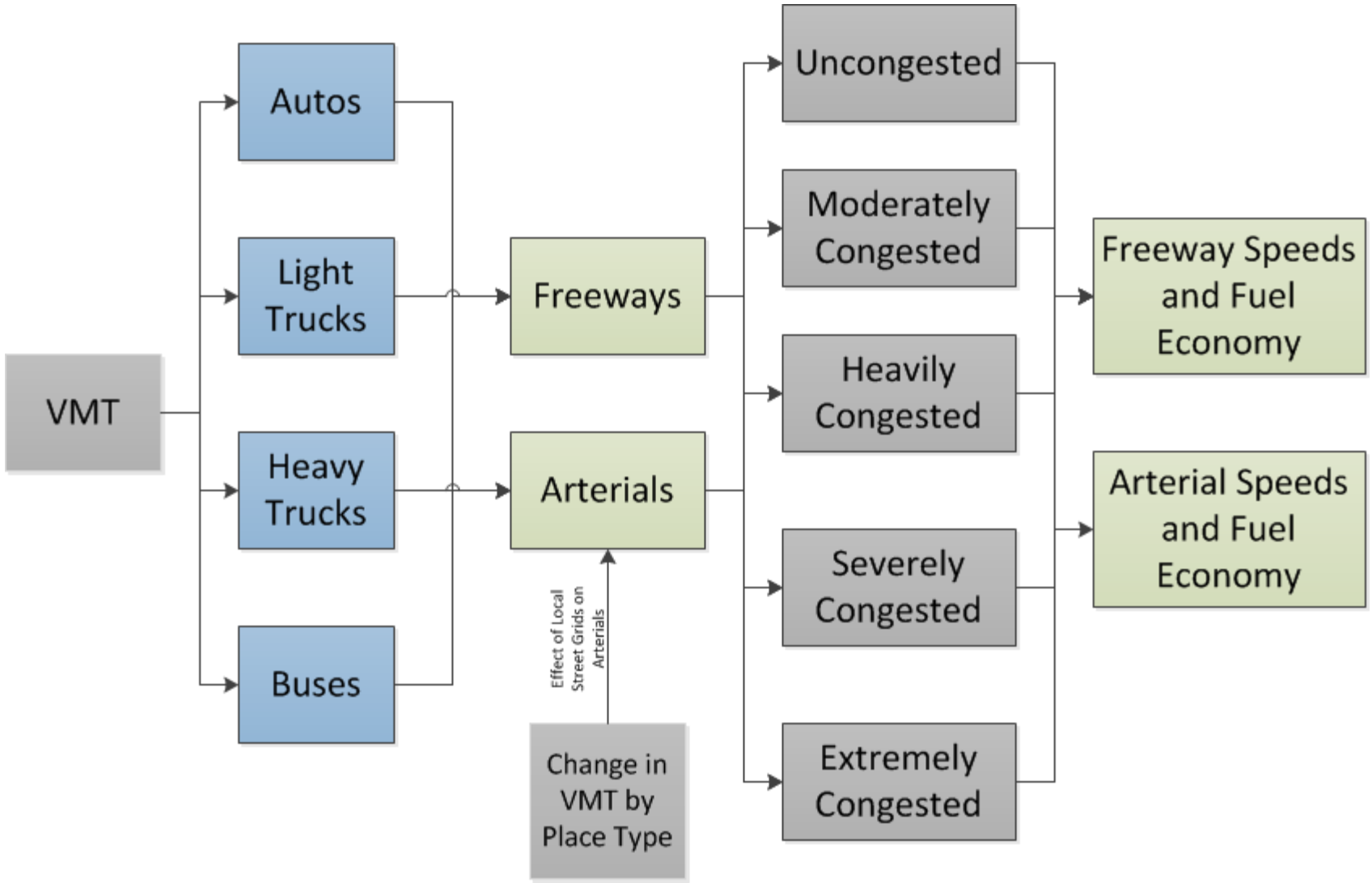
- Install by simple unzipping to a location on your computer's hard drive, e.g. c:\SmartGAP
- Consists of text file scripts, csv file input files, and .Rdata binary files holding containing models

R is an open source statistical software platform

- SmartGAP runs in R so R must be installed on the computer
- SmartGAP uses several add in packages to R which it will download automatically the first time it is run
- R is available at: http://cran.r-project.org/

Congestion Impacts

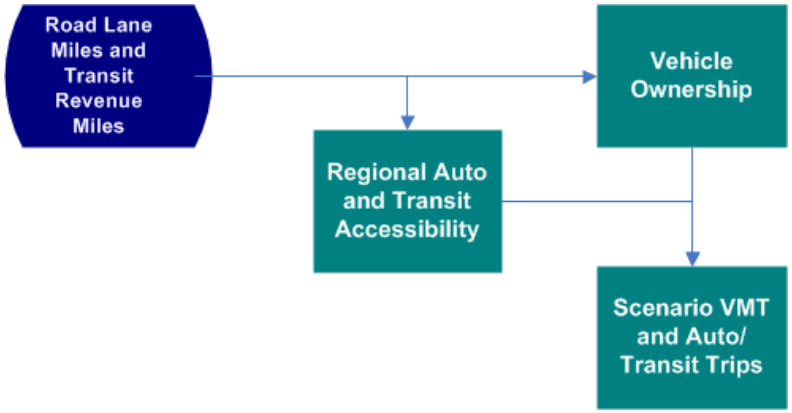
Accounts for recurring and nonrecurring congestion on local streets, arterials and freeways



Induced Demand and Urban Form Effects on Travel

Predicts the change in VMT for each household due to changes in urban form and the short and long term induced demand effects of increases in transportation supply.

Category	Urban Form Description	Elasticity for Change in VMT
Density	Household/Population Density	-0.04
Diversity	Land Use Mix (entropy)	-0.09
Design	Intersection/Street Density	-0.12
Distance to Transit	Distance to Nearest Transit Stop	-0.05



Transportation Policies

Predicts the Change in VMT for each Household due to Transportation Policies

Pricing Policies

- VMT charges
- Parking pricing

ITS strategies

- Freeways
- Arterials

Travel Demand Management Strategies

- Ridesharing
- Transit Passes
- Telecommuting
- Vanpool Programs

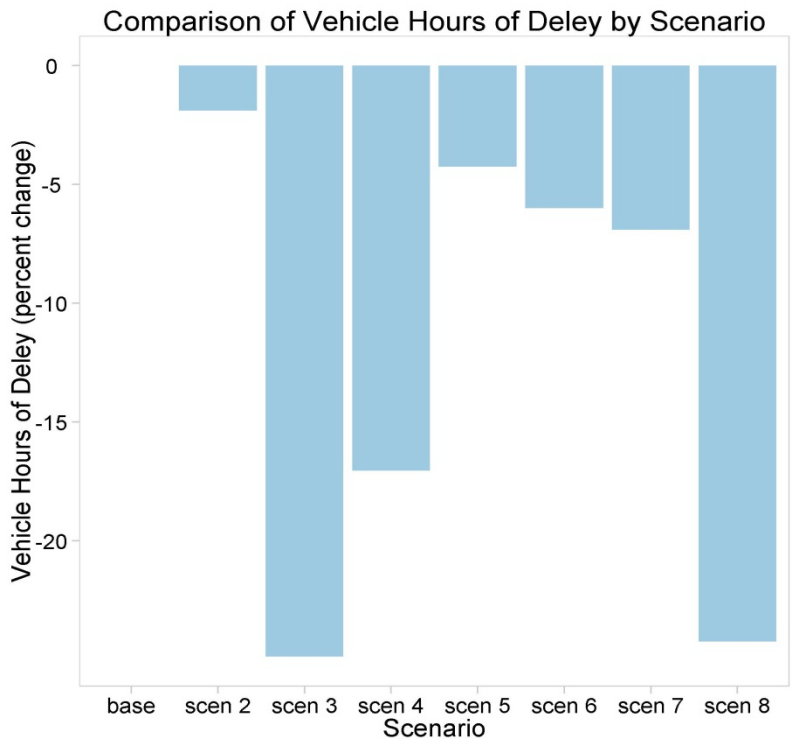
Pilot Tests: Objectives for each Region

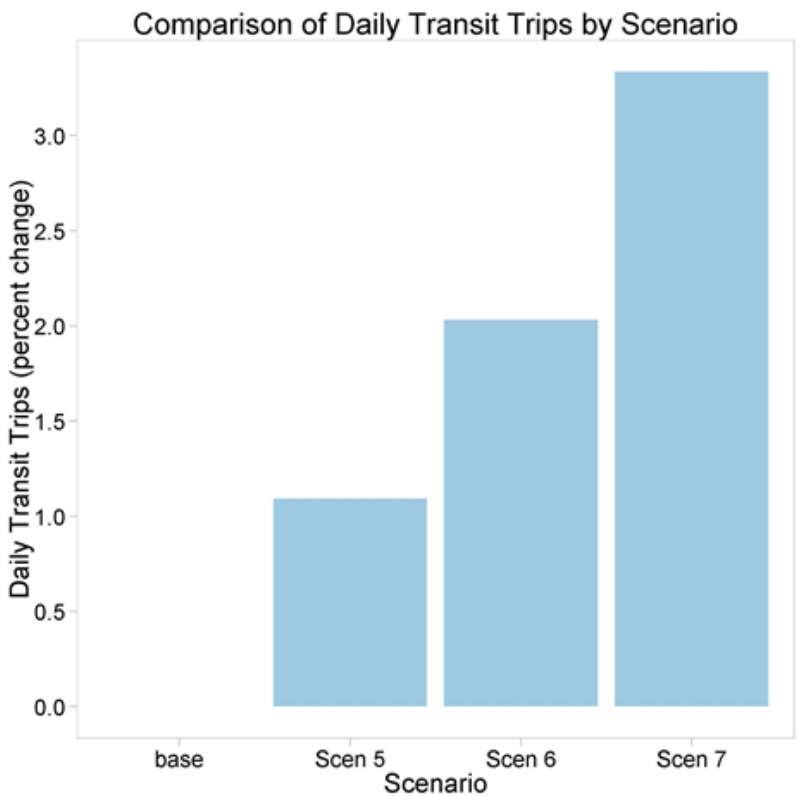
- **Atlanta Regional Commission (ARC)**
  - Large MPO setting
  - Test success of scaling to large area (e.g. run time issues)
  - Plan to compare with detailed land use scenario test results (INDEX)
- **Thurston Regional Planning Commission (TRPC)**
  - Smaller/medium MPO setting
  - Test network installation for multi-user access
- **Maryland DOT (MDOT)**
  - DOT setting
  - Test larger urban/suburban county and smaller rural county
  - Plan to compare with regional travel demand model results
- **RSG Test Bed for Portland Metro Region**
  - Used for debugging purposes and reasonableness testing of the model components and the performance metrics
  - Results generated for the 8 standard scenarios, plus pricing scenarios

Test Scenarios

Scenario	Land Use	Transportation	Policy
#1	Baseline	Baseline	Baseline
#2	Baseline	+ 20% in Transit Supply	Baseline
#3	Baseline	+ 20% in Roadway Supply	Baseline
#4	Baseline	Baseline	+20% in Lane Miles with ITS
#5	Shift 10% of Population and Employment to Close in Community and 10% to Urban Core. Proportional reduction from Suburban Area	Baseline	Baseline
#6	Shift 20% of Population and Employment to Close in Community and 20% to Urban Core. Proportional reduction from Suburban Area	Baseline	Baseline
#7	Shift 30% of Population and Employment to Close in Community and 30% to Urban Core. Proportional reduction from Suburban Area	Baseline	Baseline
#8	Shift 30% of Population and Employment to Close in Community and 30% to Urban Core. Proportional reduction from Suburban Area	+20% in Transit Supply	+20% in Lane Miles with ITS

Example Performance Metrics from the Pilot Tests





Changes in Vehicle Hours of Delay in Atlanta
Delay decreases most with additional lane miles and ITS to reduce congestion.

Transit Trips in Olympia
The transit trip metric is based on land use effects only

Pilot Test Summary

- **Performance metrics were consistent with expectations**
- **Installation and input file preparation were easy**
- **Regional policy scenario testing is useful for**
  - Smaller MPOs, local jurisdictions without advanced travel demand models
  - Bigger MPOs, state agencies to pre-screen policy scenarios before undertaking extensive travel demand modeling exercises that are resource intensive
- **Run times are reasonable**

SmartGAP Summary

Use

- SmartGAP can evaluate smart growth policies on travel demand

Features

- Represents critical decision points in the transportation planning process and how smart growth approaches affect demand for capacity
- Includes the dynamics and inter-relationships of smart growth strategies with the performance of a transportation investment
- Facilitates improved communication, interaction and partnerships between decision-makers and planners in transportation and land use arenas

Contact

Maren Outwater
Resource Systems Group, Inc
maren.outwater@rsginc.com
414-446-5402
www.rsginc.com