On-Call Simulation Modeling Training

Scoping a Simulation Project

presented to

Caltrans

presented by

Cambridge Systematics, Inc.

June 7, 2018

Webinar Overview

- Background and objectives
- Simulation overview
- Scoping a simulation project
  - Interactive exercise
- Selecting the appropriate analysis tool
  - Interactive exercise
- Data needs for model development and calibration
  - Types of data required
  - System performance profiles
  - Diagnostics
  - Data preparation and challenges
  - Operational conditions

Project Background and Objectives

- Senate Bill (SB) 375 (Sustainable Community), SB 743 (CEQA Reform), and SB 391 (California Transportation Plan) require a more robust quantitative and analytic evaluation to describe the relative performance of transportation policies, strategies, and programs.

- SB 1, now in force, created the Solutions for Congested Corridors Program. Caltrans will be collaborating with regional partners to identify and develop fixes for these corridors, which cannot be analyzed using static methods alone.

- On-call traffic simulation training will enable Caltrans to meet the mandate of these bills by educating Caltrans staff about how to perform complex analyses of our facilities for critical planning, operations, and capital improvement projects using the latest generation of traffic analysis tools.

Webinar Four-part Series

- Webinar 1 - Transportation Analysis and Simulation Overview – Delivered in January 2018

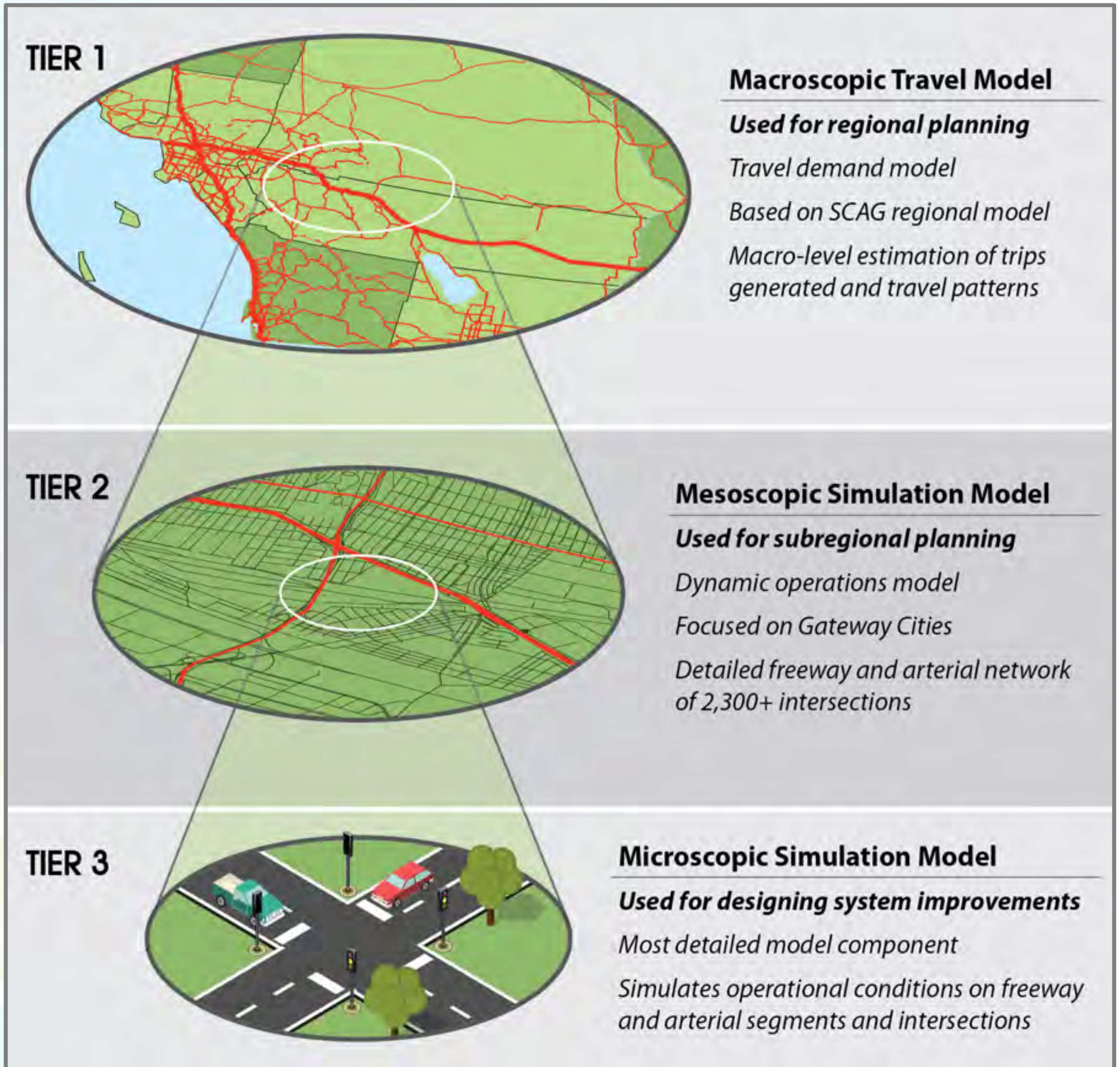
- **Webinar 2 – Today**

- Webinar 3 - How to Develop, Calibrate & Review Models – How to develop a simulation model including network and trip table development, what inputs and data are required, how to conduct the required data collection, model calibration and model calibration parameters, how to conduct reviews of simulation models

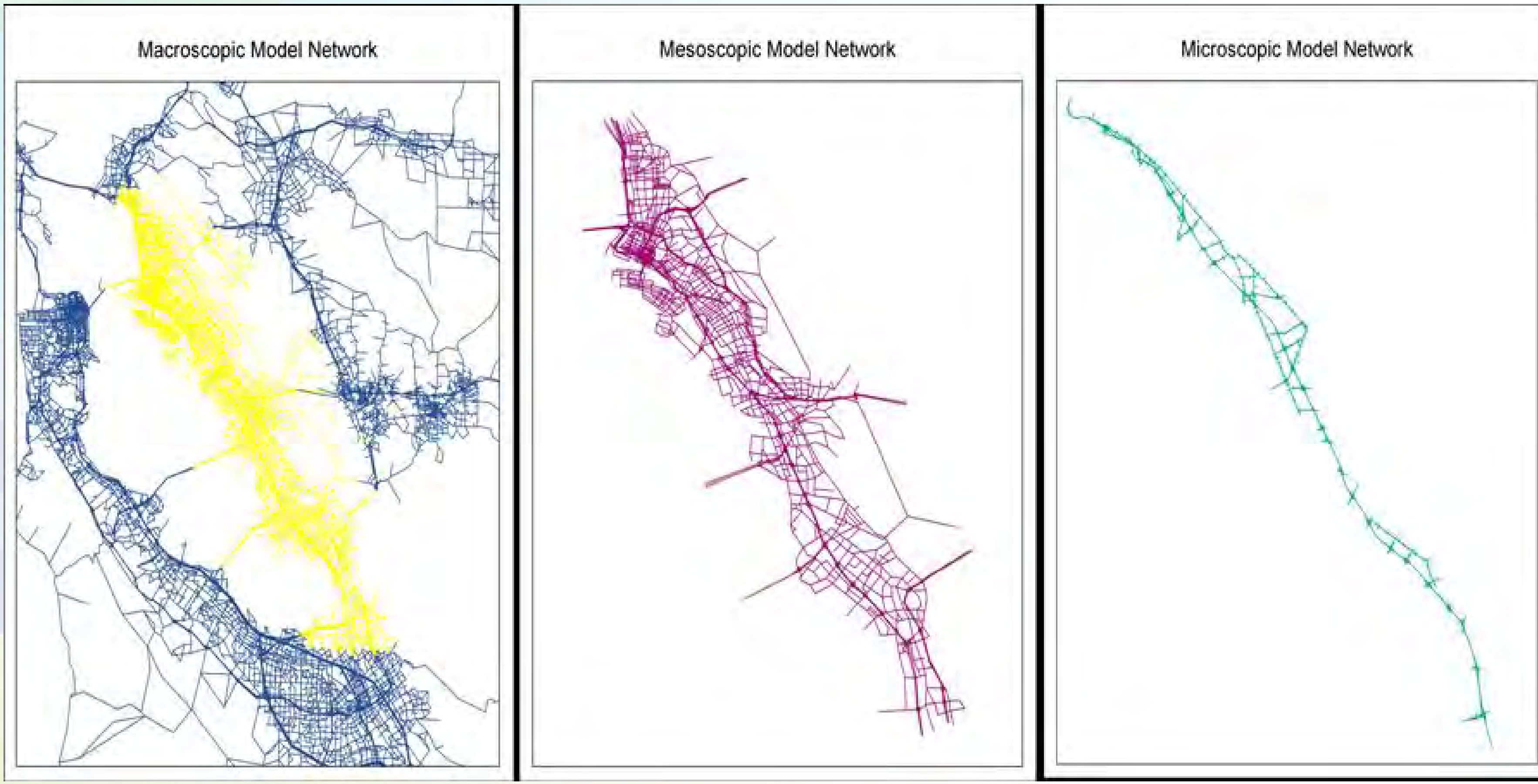
- Webinar 4 - How to Interpret and Communicate Model Results and How to Produce Output for Environmental Studies from Simulation Models – Documentation of calibration assumptions and results; documentation of overall analysis results; with and without project; tables, charts, graphics and maps summaries of performance measures. Key output from simulation models, key needs for environmental studies (volumes, delays, speeds, queueing, travel time, VMT, etc.), how to use and interpret simulation model output for environmental studies

Macro, Meso and Micro Modeling

- ***Macro*** - Long range traffic forecasts, regional patterns and mode shift
- ***Meso*** - Traveler information, HOT lanes, congestion pricing, regional diversion
- ***Micro*** - Detailed analysis of physical improvements and traffic control strategies, congested conditions



Analysis Resolutions



Simulation is Preferred for the Analysis of Congestion

- **Conditions suited for Microsimulation Modeling:**
  - Significant congestion with low speeds
  - Longer periods of congestion than one hour
  - Queues spillback from one freeway segment to another
  - Queues spillback from one intersection to another
  - Queues overflow turn pockets
  - Queues from city streets back up onto freeway
  - Queues from freeway ramps back up onto streets

Typical Microsimulation Applications

- Corridor Improvement Projects
- HOT/Express Lanes
- Active Traffic Management
- Real-time Simulation for Integrated Corridor Management and Connected Corridors
- Connected and Autonomous Vehicles
- Multi-modal Applications

SB-1 Implications - 1

- Additional Funds for Highway Projects
  - $26 B for State Highway System / $26 B for cities and counties
  - $1.5 B annually for State Highway System
  - $300 M annually for Trade Corridor Enhancements
  - $250 M annually for Congested Corridors
  - $200 M annually matching for local agencies
- ***Some of these could result in specific projects that require detailed microsimulation analysis***

SB-1 Implications - 2

- **Trade Corridor Enhancement Program (examples):**
  - High-priority grade separation projects statewide that improve safety where vehicles and trains intersect
  - Construction of a 7th border crossing at the Mexico/ California border — Otay Mesa East
  - I-710 improvements from the Southern California Ports
  - Highway 99 improvements in the Central Valley
  - Phase 2 of the 680/80/12 intersection in the Bay Area
- ***Many of these would likely benefit from simulation analysis***

SB-1 Implications - 3

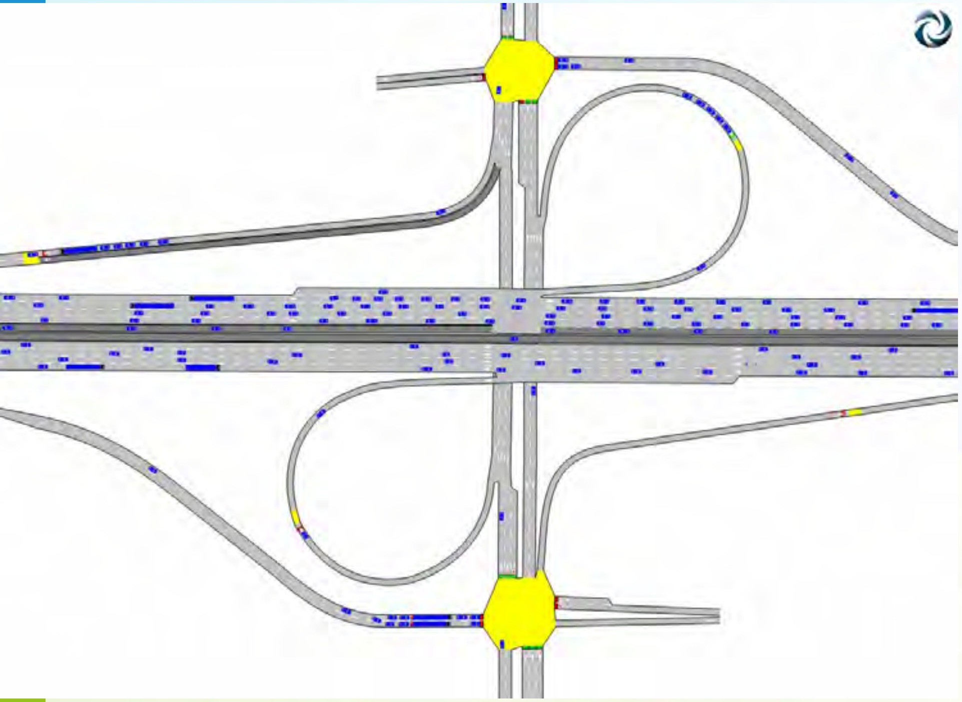
- **Congested Corridors Program** - projects from regional agencies and the state that will improve traffic flow and mobility along the state's most congested routes while also seeking to improve air quality and health.
  - Improve traffic flow while improving air quality and taking on environmental/health challenges
  - Caltrans and local or regional partners working together to find wide-reaching solutions
  - Funding: Nominations by local agencies and the State
- ***Microsimulation is well suited for Congested Corridors***

SAMPLE MICROSIMULATION APPLICATION SR-91 WESTBOUND (DISTRICT 7)

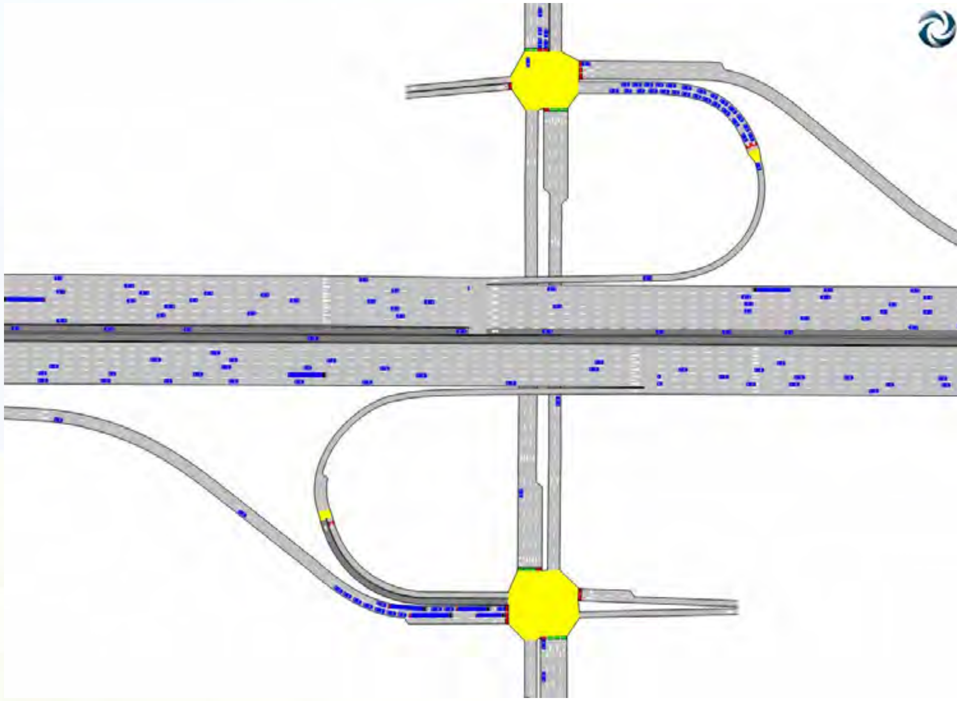
Microsimulation Example: Simulation of Ramp Modification

SR-91 & Pioneer

Base Year Model



2035 'Build' Scenario



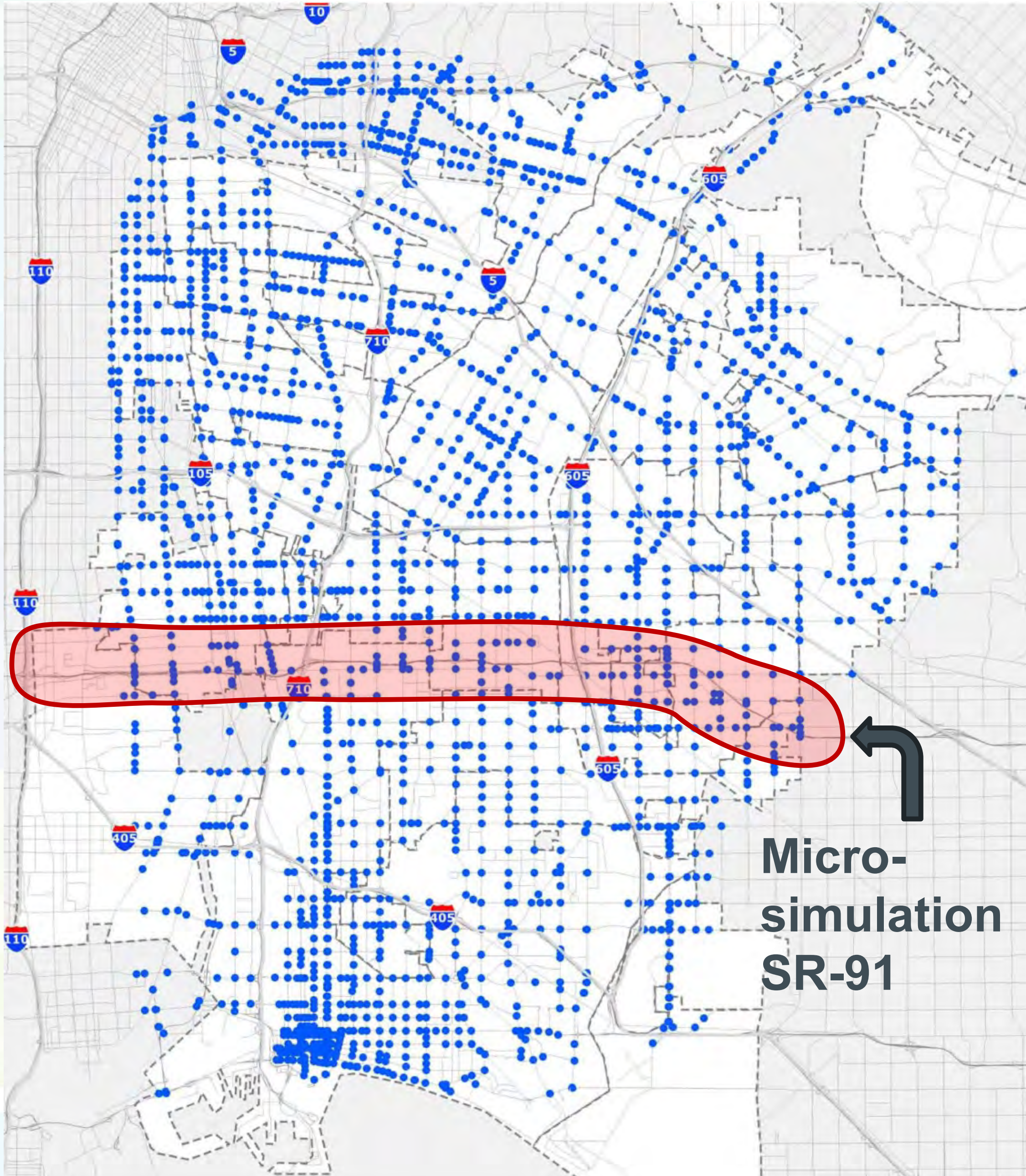
EXAMPLE SIMULATION APPLICATION IN DISTRICT 7

Subregional Example – Gateway Cities

- **LA Metro** – Historically no county level highway plan with prioritization
- Gateway Cities subarea did their own highway planning using Measure R funds
  - Early high-level corridor needs analysis
  - More detailed "Congestion Hot Spot Analysis" to identify freeway "Hot Spots" – (travel forecasting only)
  - Detailed Strategic Transportation Plan – STP (Mesoscopic and Microscopic simulation completed)
  - Resulted in prioritized highway corridor plan
  - Simulation was conducted at corridor level

Mesoscopic Model:

- 27 city area
- 2 million population
- All arterial highways
- All freeways (5, 91, 405, 605, 710)
- All ramps and ramp meters
- Over 2,300 signals

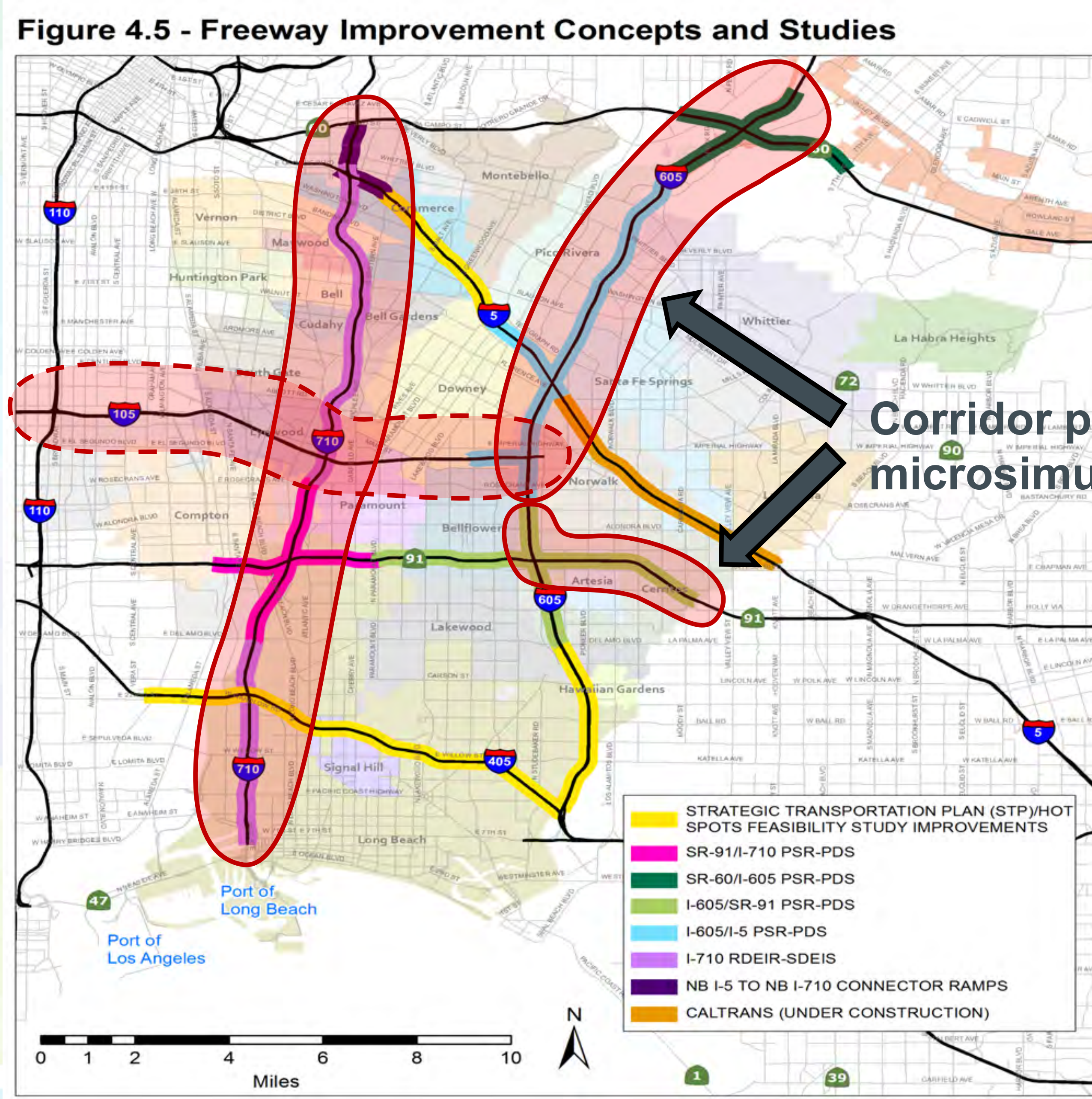


Micro-simulation SR-91

Gateway Cites Simulation Program

- Mesoscopic model completed and used to test 16 scenarios
- Corridor level simulation then conducted:
  - I-710 Major Corridor Project – VISSIM model for EIR
  - SR-91 Westbound from Artesia to I-605 – Aimsun model for PA&ED
  - I-605 Corridor Improvement Program – 2 VISSIM models in progress
    - From I-105 to north of I-10
    - Includes HOV direct connectors
    - Includes Express Lanes simulation
  - I-105 – Simulation modeling to study Express Lanes (early 2018)

Subregional Freeway Improvement Program



ATM, ICM and HOT Lanes Simulation Examples

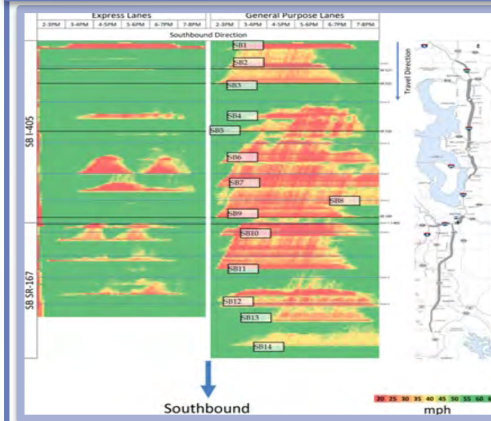
Caltrans District 7 Active Traffic Management Study

Simulation analysis of active traffic management strategies on a 17-mile freeway corridor in Los Angeles that included dynamic speed limits, dynamic shoulder use, adaptive ramp metering, signal coordination, and other relevant strategies.

Caltrans I-15 ICM Analysis, Modeling, and Simulation

Analysis, modeling, and simulation of the ICM Pioneer Sites on I-15 and U.S. 75, including development of suitable methods and tools, in-depth research regarding modeling of ICM operations, and overall evaluation of these sites postdeployment.

Washington State DOT I-405 Traffic and Revenue Review



Operational simulation-based dynamic toll revenue estimation of proposed HOT lanes. Probabilistic revenue estimates were based on combinations of potential pricing policies, growth scenarios forecasts, pricing sensitivities of the public, and traveler's value of time.

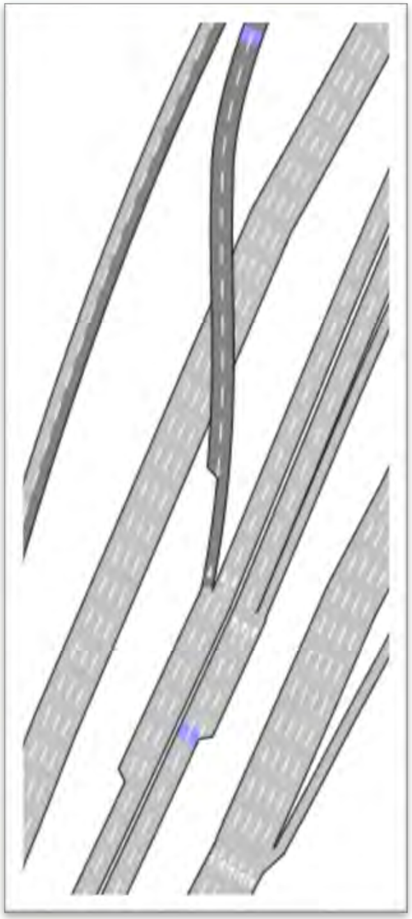
San Diego I-15 ICM – Real-Time Multimodal Decision Support System

Predict
- Next 60 minutes
- Every 5 minutes

Decide
- Capacity
- Availability
- Posture

Evaluate
- Response Strategies
- 15 min. interval

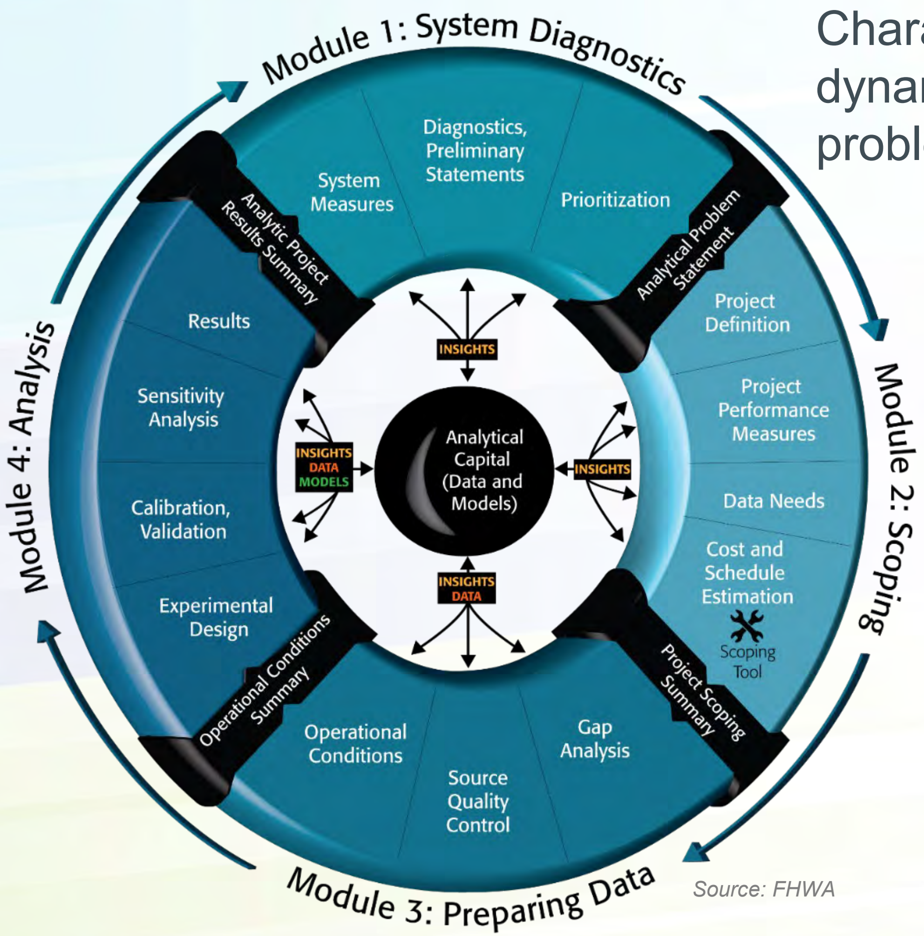
Control
- Send to the field
- Monitor



Source: Cambridge Systematics and San Diego Association of Governments.

Analysis Scoping

The 21st Century Analytical Project Scoping Process



Source: FHWA

Characterize system dynamics and diagnose problems.

Perform data-driven transportation analysis project scoping.

Collect and organize the data needed to conduct a transportation analysis.

Conduct and document transportation analyses.

Components of a Scoping Plan

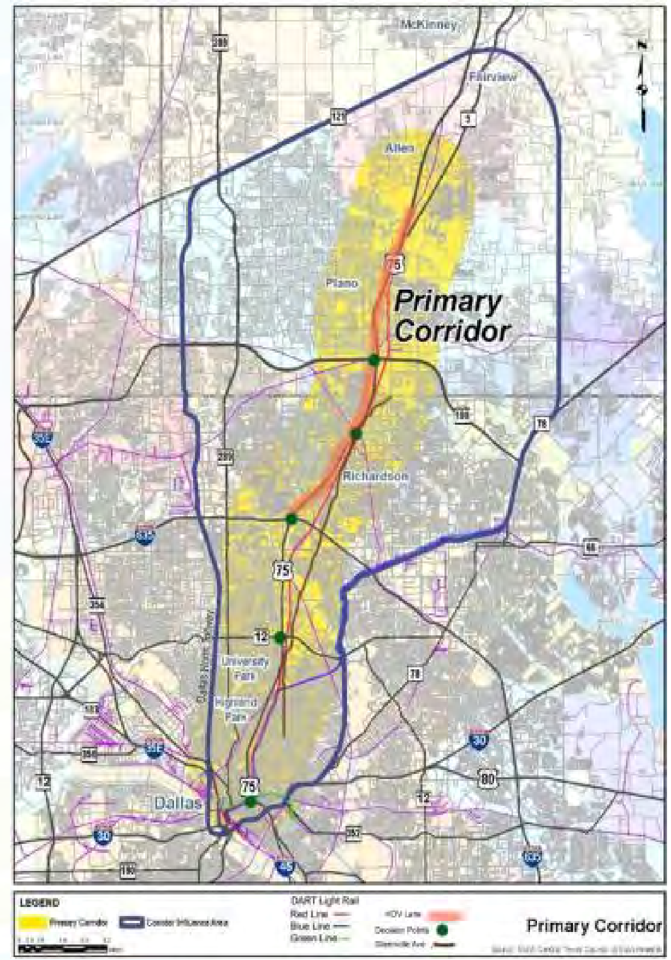
- Project definition
- Affected Stakeholders
- Selection of the appropriate analysis tool type
- Performance measures to be used in the analysis
- Analysis data requirements
- Preliminary list of alternatives to be studied, including analysis scenarios and transportation mitigation strategies
- Expected cost, schedule, and responsibilities for the analysis

Project Definition

- Describe the purpose of the project.
- Provide the project background.
- Document existing operational conditions.
- Identify underlying causes.
- Present the problems and issues that the analysis is intended to address.
- The objectives should be “SMART”.
  - **S**pecific, **M**easurable, **A**ctionable, **R**ealistic, and **T**ime-bound.

Geographic Scope
US 75 Corridor Networks

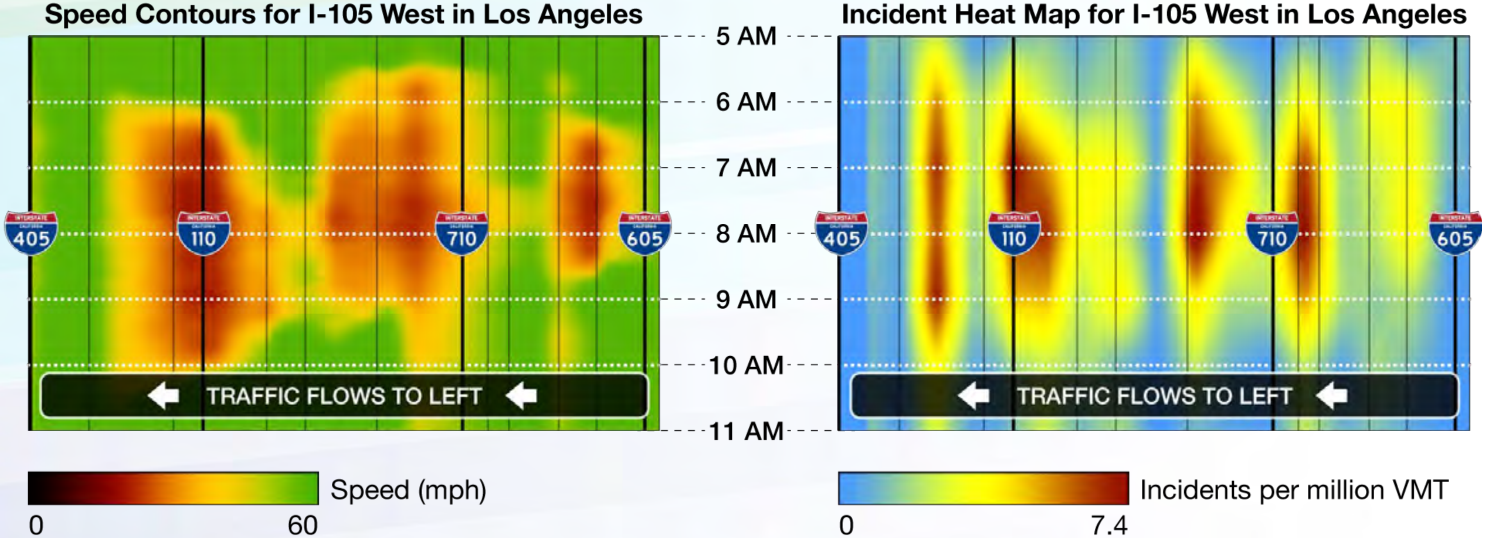
- Freeway with continuous Frontage Roads
- Managed HOV lanes
- Dallas North Tollway
- 167 Miles of Arterials
- DART Bus Network
- DART Light Rail
- 900 Signals
- Multiple TMCs
- Regional ATIS



Document Existing Operational Conditions

- Average daily and peak traffic levels
- Directionality of traffic flow
- Variability of traffic flow
- Status of construction activities
- Known bottlenecks
- Queuing conditions
- Free flow and average peak speeds
- Summary incident and accident statistics for the study area

LA I-105 Active Traffic Management



Affected Stakeholders

- Identify a complete set of stakeholders and partners who ***fully*** represent the agencies and organizations affected by the project.
  - e.g., highway or roadway agencies, transit agencies, program managers and stakeholders, freight industry groups, bike/pedestrian groups, emergency responders, toll authorities, media representatives.
- To minimize the risk of having to redo parts of the analysis late in the process, agencies with reviewing and/or approving authority over the analysis ***should be at the table from the start of the project***.

Performance Measures for the Analysis

Mobility	*(travel time, delay, throughput)*
Reliability	*(changes in the Planning Index, changes in the standard deviation of travel time)*
Emissions and Fuel Consumption	*(monetized using costs per ton of pollutants released and the purchase price of fuel)*
Benefits and Cost Comparison	*(capital costs, operations and maintenance costs, annualized costs)*
Safety	Accidents or crashes in the study area (fatalities, injuries, property-damage-only accidents). *This is an area deserving of new research.* *Limited data on the direct impact of mitigation strategies on safety*

Analysis Details

Study Area, Facility Types, and Affected Modes	• Study area must cover beyond the end of the of the full spatial extent of queues/congestion in the baseline and future years of analysis. • May be necessary to include all modes in the study area for mode shift.
Analysis Time Period	• Time period defined (AM/PM/Midday peak hour and/or peak period, off-peak period, etc.) must cover the beginning and end of full temporal extent of queues and congestion in the baseline and future years of analysis.
Alternatives Definition	• Scenarios should include geometric and operational alternatives to be analyzed and compared to the baselines.
Analysis Time Horizon	• A future baseline model (or future no-build alternative) is the basis for comparison between alternatives in a future time horizon.

Project Scoping Summary Elements - 1

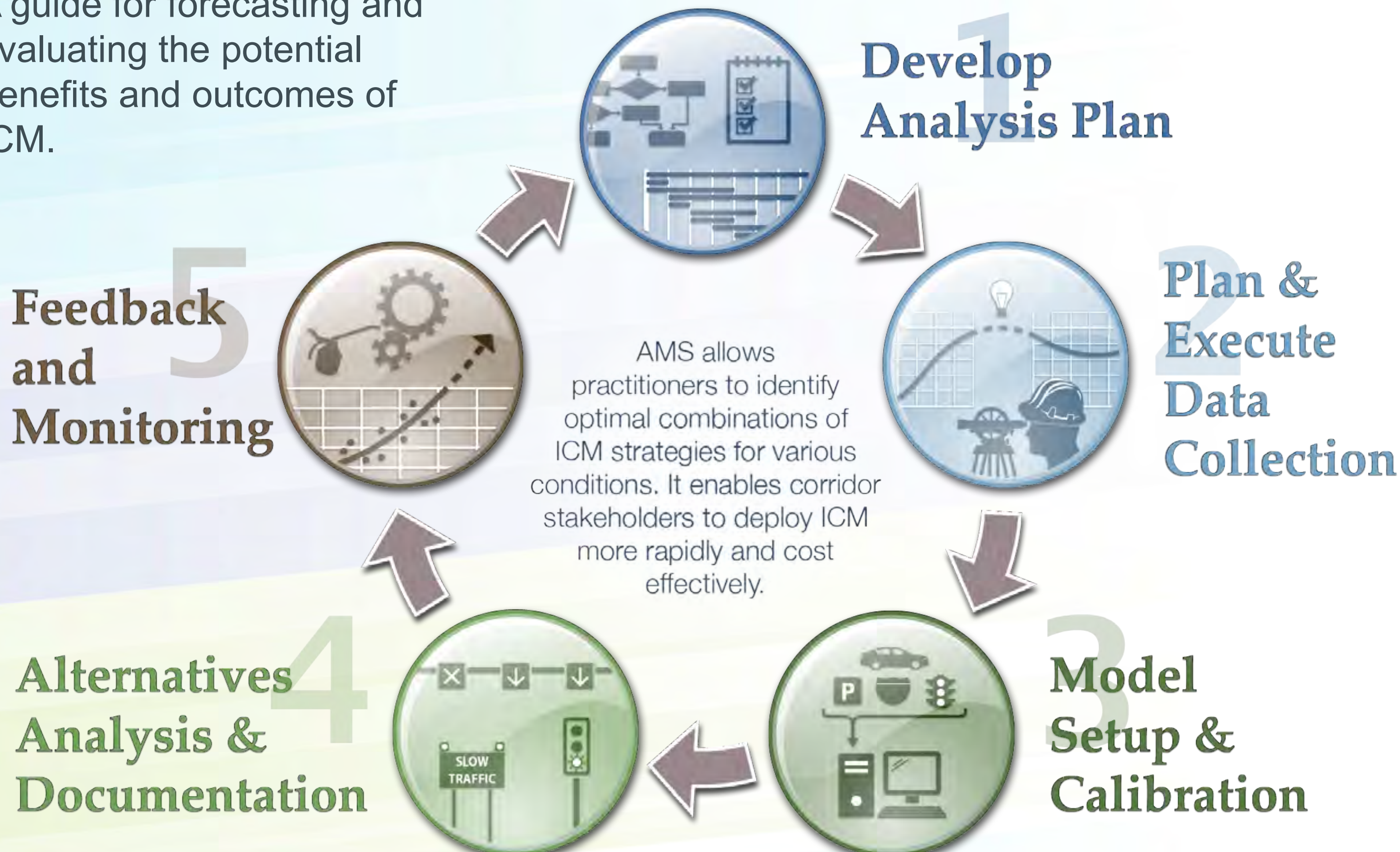
Project Definition	A concise statement of the overall system problem includes cross-validation and other insights from stakeholders on the nature of the issue and potential solutions.
Geographic Scope	The geographic area to be covered by the analytical project includes a statement of the required detail of representation within this geographical area.
Temporal Scope	The times of day, days of week, seasonality, and years of operation are assessed in the analytical effort. This includes an assessment of the simulation horizon.
Candidate Hypothesis	The candidate hypothesis represents the leading underlying cause of the system performance issue.
Analytical Approach	This element describes of the proposed method for evaluating the effectiveness of the mitigating strategies in resolving the system performance issue.
Selected Tool Type(s)	The one or more tool types will be used in the analytical approach. This section should identify if existing models are to be employed, or if new models must be developed.
Data Requirements	A summary of data will be used to characterize operational conditions, represent alternatives, and model the geographic and temporal aspects of the system.

Project Scoping Summary Elements - 2

Preliminary List of Alternatives	High-level description of the alternative solutions and/or operational practices will be assessed within the analytical project.
Key Operational Conditions	The set of travel demand, incident, and weather conditions under which a meaningful examination of alternative impacts must be conducted.
Selected Performance Measures	The measures of system performance selected for the effort. These measures should be most suited to differentiate alternatives, be meaningful to stakeholders, and can be well-represented/estimated within the proposed analytical approach.
Expected Costs	The projected cost of the analytical project, including data collection.
Expected Schedule	The projected time to conduct the analysis, including data collection.
Expected Assignment of Responsibilities	An assessment of responsibilities related to the project and how those responsibilities are allocated among departments, contractors, and other organizations engaged in the effort.
Risks	A summary of risks comprising risks in data collection, technical risks, and non-technical risks.

ICM Analysis, Modeling, and Simulation (AMS) Framework

A guide for forecasting and evaluating the potential benefits and outcomes of ICM.



Example High-Level Allocation of Analysis Responsibilities

Work Step	Analysis Project Manager	Operations Manager	Planning Manager	Modeler s	Systems Manager	Stakeholde rs
Develop Analysis Plan	X	O	O	O	O	O
Develop Data Collection Plan and Collect Data	X	O	O	O	O	O
Model Setup and Calibration	X	O	–	X	–	–
Alternatives Analysis and Documentation	X	O	O	X	O	–

*Note: “**X**” represents primary responsibility, “O” repre*
responsibility, “–” represents not relevant.

Estimated Level of Effort

- **Develop Analysis Plan**
  - 15-25%
- **Develop Data Collection Plan and Collect Data**
  - 15-25%
- **Set up and Calibrate Model**
  - 25-35%
- **Analyze and Document Alternatives**
  - 25-35%

These Level of Effort ranges are dependent on a number
such as:
a) the Analysis Team's and the stakeholders' experience
transportation analysis; b) the quantity and
the number of scoping changes, additions of new alternatives

Cost Implications

Seemingly similar projects may require different levels of effort for a number of reasons:

- Experience of project manager, analysis team, and reviewers.
- The project purpose, objectives, and scope.
- The availability of good data for model calibration.
- Temporal and spatial resolution requirements for the analysis.
- The number and complexity of the alternatives being analyzed.
- Performance measures used.
- Software used.
- The amount of documentation, meetings, and presentations required.
- Number and effectiveness of project reviews conducted.

Interactive Exercise Using the Scoping Tool

Analysis Scoping Tool

Summary of Example User Inputs

Transportation Analysis Project Costing Tool

Developed for the USDOT by: CAMBRIDGE SYSTEMATICS

Press This Button to Start

Summary of User Inputs:

Name of Study Area:	Standard TIS
Number of Intersections:	8
Number of Freeway Ramps:	2
Base Model Availability:	Yes
Is the Base Model Calibrated:	No
Number of Analysis Horizons:	3
Number of Alternatives:	3
Number of Representative Days:	2
Number of Peak Periods	2
Data Collection Requirements:	Medium
Complexity of Analysis Scenarios:	Simple
Complexity of Methodology:	Stochastic/Dynamic
Complexity of Outputs:	Simple
Analyst Experience:	Some

Note: This Transportation Analysis Costing Tool is provided "as is" without warranty of any kind, and without any documentation, user's guide, or maintenance agreement

Analysis Scoping Tool
Example Output

Transportation Analysis Project Costing Tool

OUTPUT REPORT
Estimate of Labor Hours Required to Complete the Analysis of:
Standard TIS

	Project Task	Manager Hours	Engineer/ Planner Hours	Technician Hours	Total Hours	Lower Bound	Upper Bound
1	Develop workplan, analysis plan, and project management	30	30	10	**70**	**60**	**80**
2	Select analysis tool	10	10	-	**20**	**20**	**20**
3	Develop data plan and process data	-	-	40	**40**	**40**	**40**
4	Define clusters and representative days	30	50	-	**80**	**70**	**90**
5	Develop and calibrate baseline model(s)	20	40	70	**130**	**120**	**170**
6	Develop future baseline model(s)	30	30	30	**90**	**80**	**100**
7	Analyze alternatives	90	180	90	**360**	**320**	**400**
8	Reports and presentations	30	30	10	**70**	**60**	**80**
	Total Labor Hours	**240**	**370**	**250**	**860**	**770**	**980**

Analysis Tool Selection

Analysis Context: Planning, Design, or Operations/Construction

1 Geographic Scope

What is your study area?

- Isolated Location
- Segment
- Corridor/ small network
- Region

2 Facility Type

Which facility types do you want to include?

- Isolated intersection
- Roundabout
- Arterial
- Highway
- Freeway
- HOV lane
- HOV bypass lane
- Ramp
- Auxiliary lane
- Reversible lane
- Truck lane
- Bus lane
- Toll plaza
- Light rail

3 Travel Mode

Which travel modes do you want to include?

- SOV
- HOV (2, 3, 3+)
- Bus
- Rail
- Truck
- Motorcycle
- Bicycle
- Pedestrian

4 Management Strategy

Which mgmt strategies should be analyzed?

- Freeway mgmt
- Arterial intersections
- Arterial mgmt
- Incident mgmt
- Emergency mgmt
- Work zone
- Special event
- APTS
- ATIS
- Electronic payment
- RRX
- CVO
- AVCSS
- Weather mgmt
- TDM

5 Traveler Response

Which traveler responses should be analyzed?

- Route diversion (pre-trip and en-route)
- Mode shift
- Departure time choice
- Destination change
- Included/ foregone demand

6 Performance Measures

What performance measures are needed?

- LOS
- Speed
- Travel time
- Volume
- Travel distance
- Ridership
- AVO
- v/c ratio
- Density
- VMT/PMT
- VJJT/PHT
- Delay
- Queue length
- # stops
- Crashes/duration
- TT reliability
- Emissions/fuel
- Noise
- Mode shift
- Benefit/cost

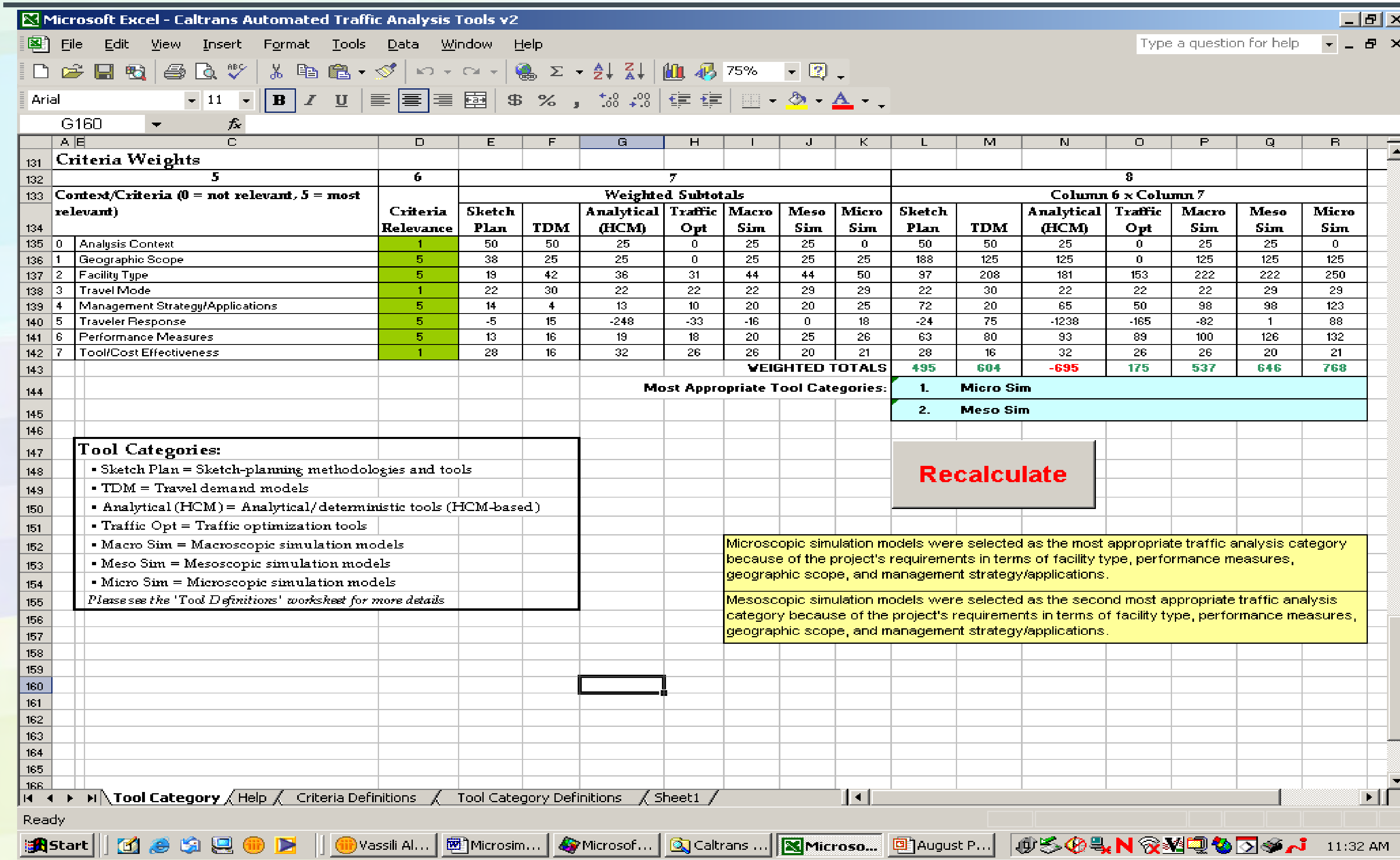
7 Tool Attributes

What operational characteristics are important?

- Tool capital cost
- Effort (cost/training)
- Ease of use
- Popular/well-trusted
- Hardware requirements
- Data requirements
- Run time
- Post-processing
- Documentation
- User support
- Key parameters user definable
- Default values
- Integration
- Animation

Interactive Exercise Using the Analysis Tool Selection Methodology

Which Analysis Tool Type to Use



Microsoft Excel - Caltrans Automated Traffic Analysis Tools v2

Criteria Weights

5	6	7							8						
Context/Criteria (0 = not relevant, 5 = most relevant)	Criteria Relevance	Weighted Subtotals							Column 6 x Column 7						
		Sketch Plan	TDM	Analytical (HCM)	Traffic Opt	Macro Sim	Meso Sim	Micro Sim	Sketch Plan	TDM	Analytical (HCM)	Traffic Opt	Macro Sim	Meso Sim	Micro Sim
0 Analysis Context	1	50	50	25	0	25	25	0	50	50	25	0	25	25	0
1 Geographic Scope	5	38	25	25	0	25	25	25	188	125	125	0	125	125	125
2 Facility Type	5	19	42	36	31	44	44	50	97	208	181	153	222	222	250
3 Travel Mode	1	22	30	22	22	22	29	29	22	30	22	22	22	29	29
4 Management Strategy/Applications	5	14	4	13	10	20	20	25	72	20	65	50	98	98	123
5 Traveler Response	5	-5	15	-248	-33	-16	0	18	-24	75	-1238	-165	-82	1	88
6 Performance Measures	5	13	16	19	18	20	25	26	63	80	93	89	100	126	132
7 Tool/Cost Effectiveness	1	28	16	32	26	26	20	21	28	16	32	26	26	20	21
								WEIGHTED TOTALS	495	604	-695	175	537	646	768

Most Appropriate Tool Categories:
1. Micro Sim
2. Meso Sim

Tool Categories:
- Sketch Plan = Sketch-planning methodologies and tools
- TDM = Travel demand models
- Analytical (HCM) = Analytical/deterministic tools (HCM-based)
- Traffic Opt = Traffic optimization tools
- Macro Sim = Macroscopic simulation models
- Meso Sim = Mesoscopic simulation models
- Micro Sim = Microscopic simulation models

Please see the 'Tool Definitions' worksheet for more details

Recalculate

Microscopic simulation models were selected as the most appropriate traffic analysis category because of the project's requirements in terms of facility type, performance measures, geographic scope, and management strategy/applications.

Mesoscopic simulation models were selected as the second most appropriate traffic analysis category because of the project's requirements in terms of facility type, performance measures, geographic scope, and management strategy/applications.

Tool Category / Help / Criteria Definitions / Tool Category Definitions / Sheet1

Data and Resources


CAMBRIDGE SYSTEMATICS

Microsimulation Scoping Template

technical report

prepared for

California Department of Transportation

prepared by

Cambridge Systematics, Inc.


CAMBRIDGE SYSTEMATICS

Microsimulation Solicitation Template

technical report

prepared for

California Department of Transportation

prepared by

Cambridge Systematics, Inc.

Computational Platforms

- Computational power of analytical platforms double every two years (Moore's Law).
- Desktop or cloud-based computational tools at an analysts' disposal are more powerful and more ubiquitous.
- Improvement in power will be largely realized in data storage and visualization.

Analytics/Visualization Tools

Pros

- Increasingly complex tools will be increasingly capable
- Potential to provide greater insight into transportation system

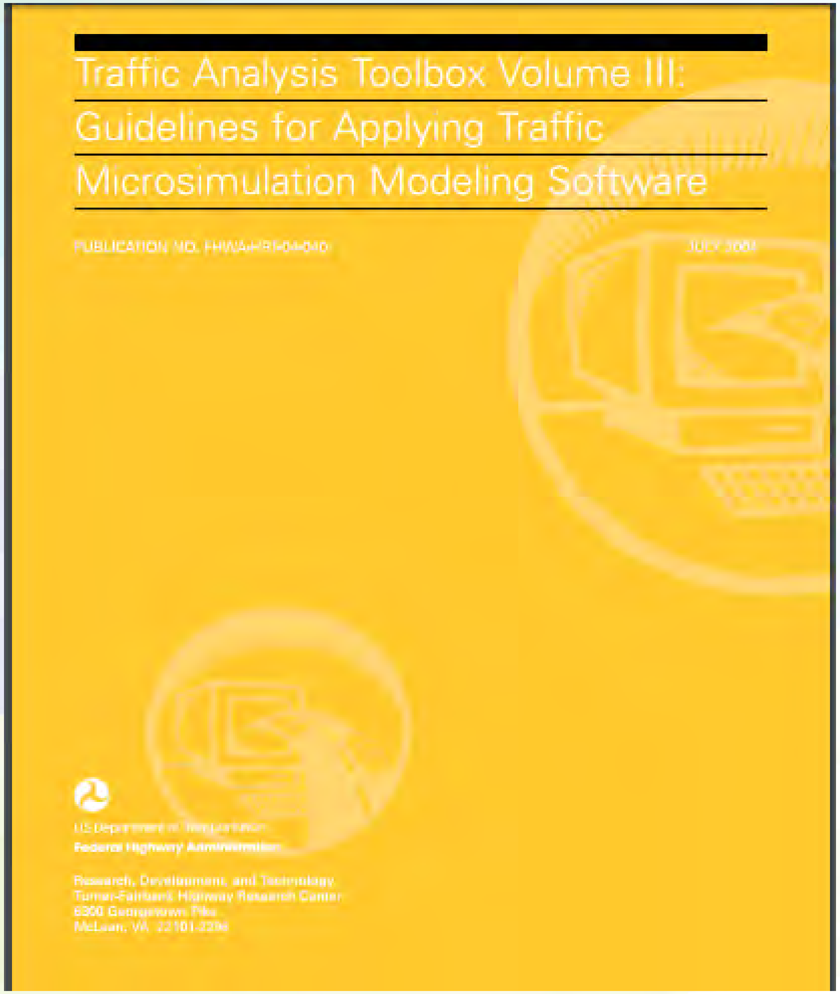
Cons

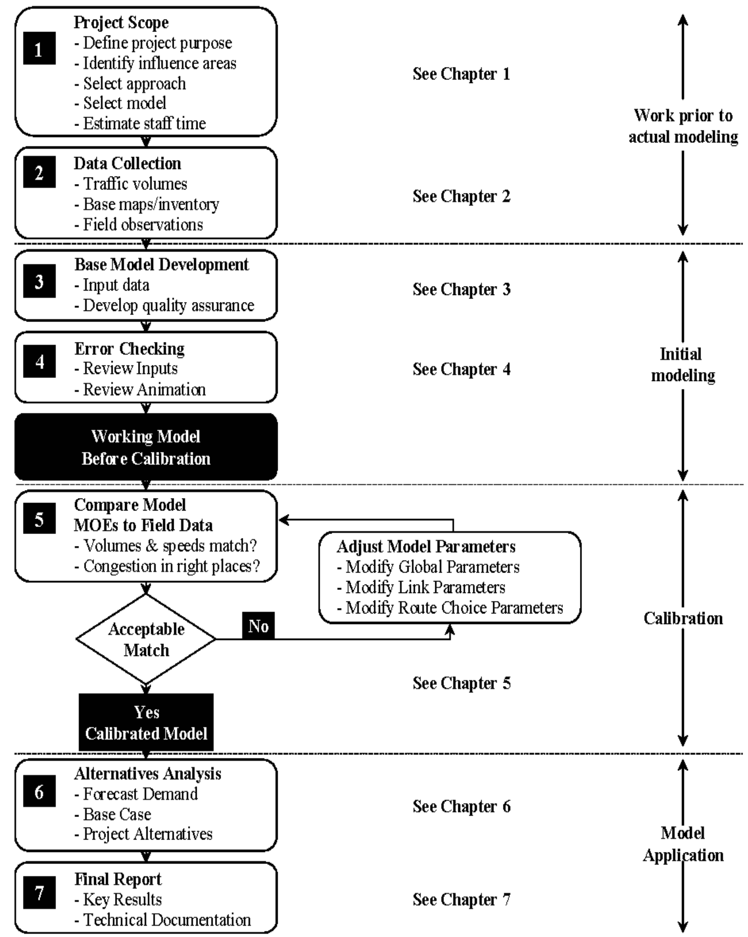
- Learning curve increases
- Harder to manage and estimate all required parameters

Pick the right sized tool for the

Data Needs for Model Development and Calibration

Model Calibration Requirements - FHWA Microsimulation Guidance





Developed by the FHWA Traffic Analysis Tools Team and later adapted from *Advanced Corsim Training Manual*, Short, Elliott, Hendrickson, Inc., Minnesota Department of Transportation, September 2003.

Analysis Model Input Types

- Network geometry
- Traffic control data (signal timings, signs, …)
- Travel demand (O-D), traffic volumes, and intersection turning movements
- Performance data, such as queue locations, queue lengths, travel times, and speeds
- Data on vehicle characteristics, such as vehicle classifications or vehicle mix

Types of Data

Travel Demand

- Traffic counts
- Vehicle classification counts
- Speeds
- Travel times
- Congestion
- Queuing observations

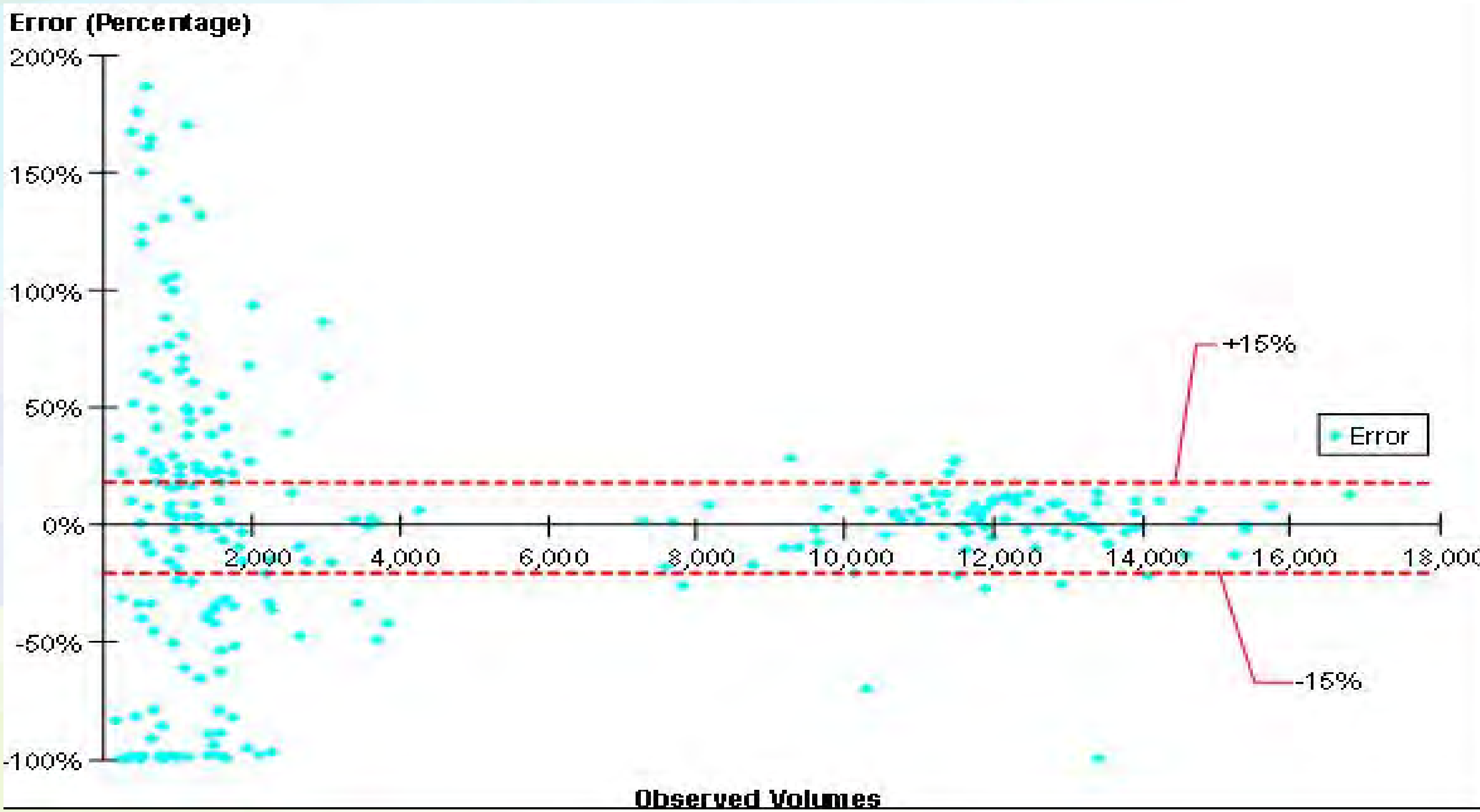
Traffic Control

- Signs
- Signal control
- Timing plans

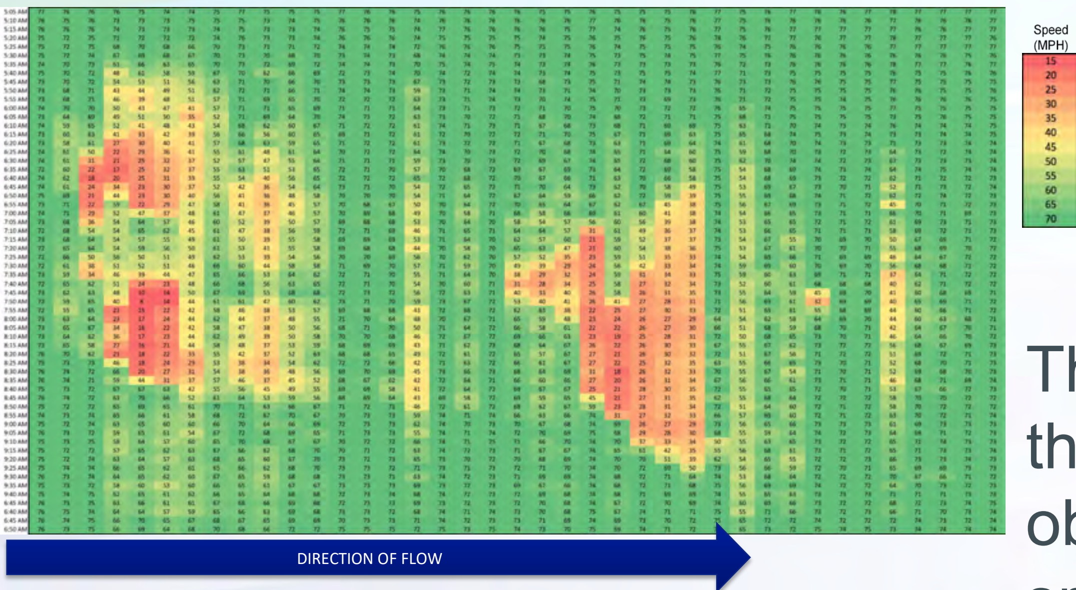
Physical Geometry

- Rectified aerial photography
- Base mapping files

Example Observed vs Modeled Volumes



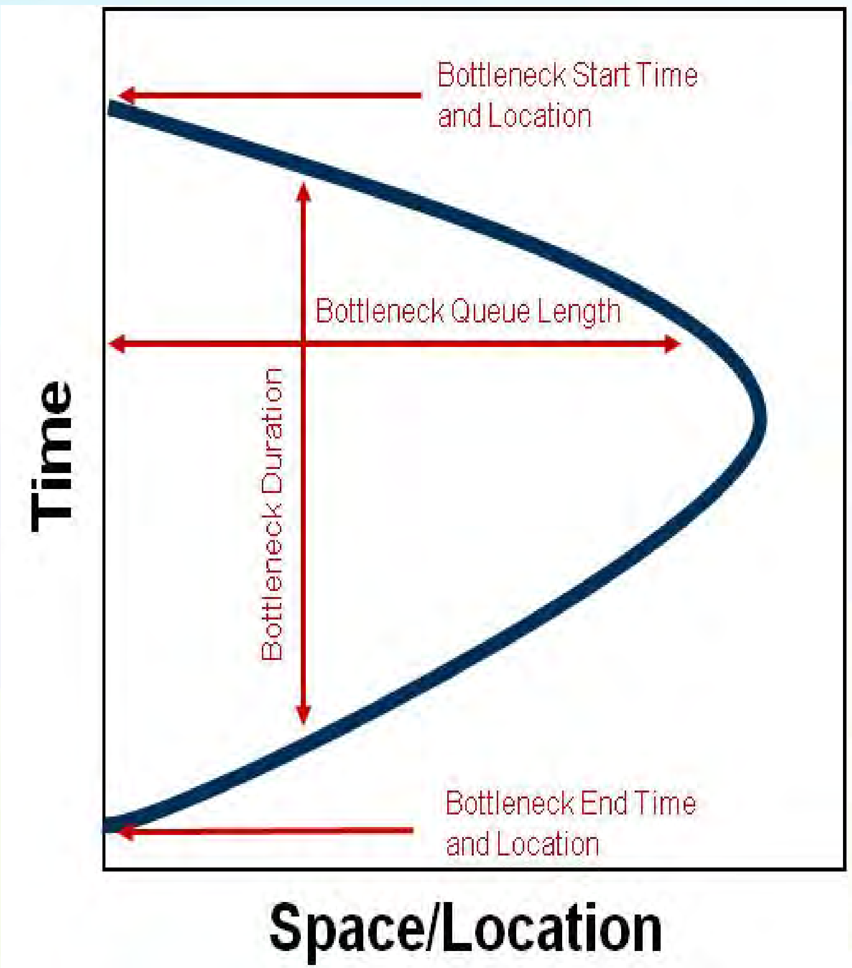
Speed Diagram for an Analysis Scenario

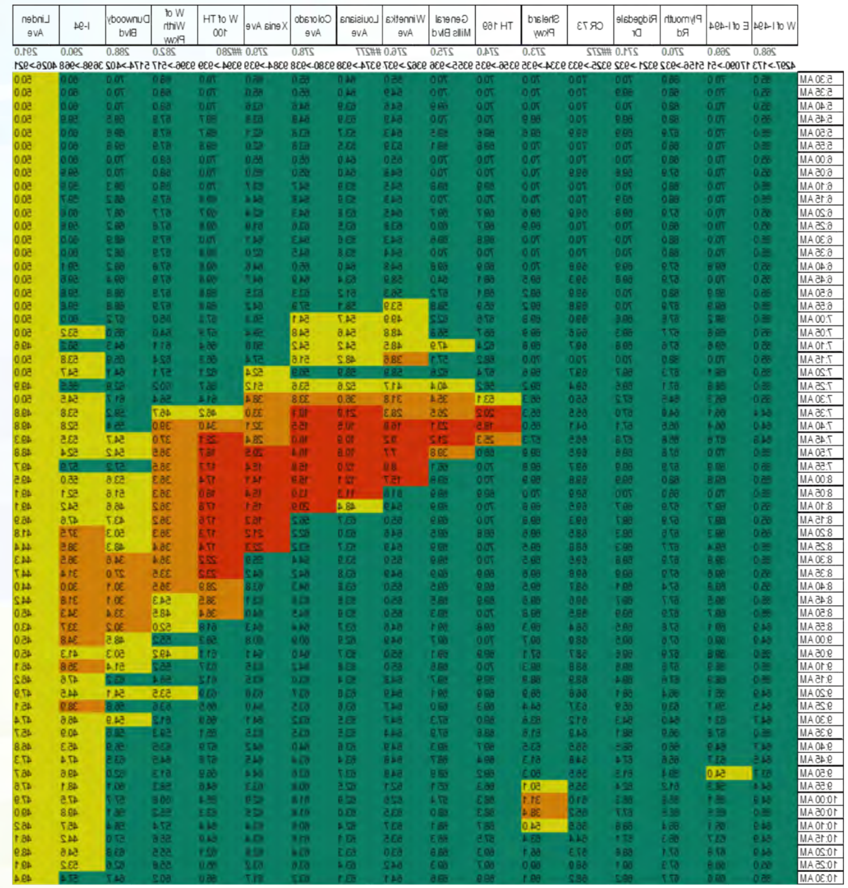


(Source: Federal Highway Administration.)

This type of diagram helps the analyst compare observed and modeled speeds in space and in time, so an assessment can be made about whether the model can adequately replicate existing conditions.

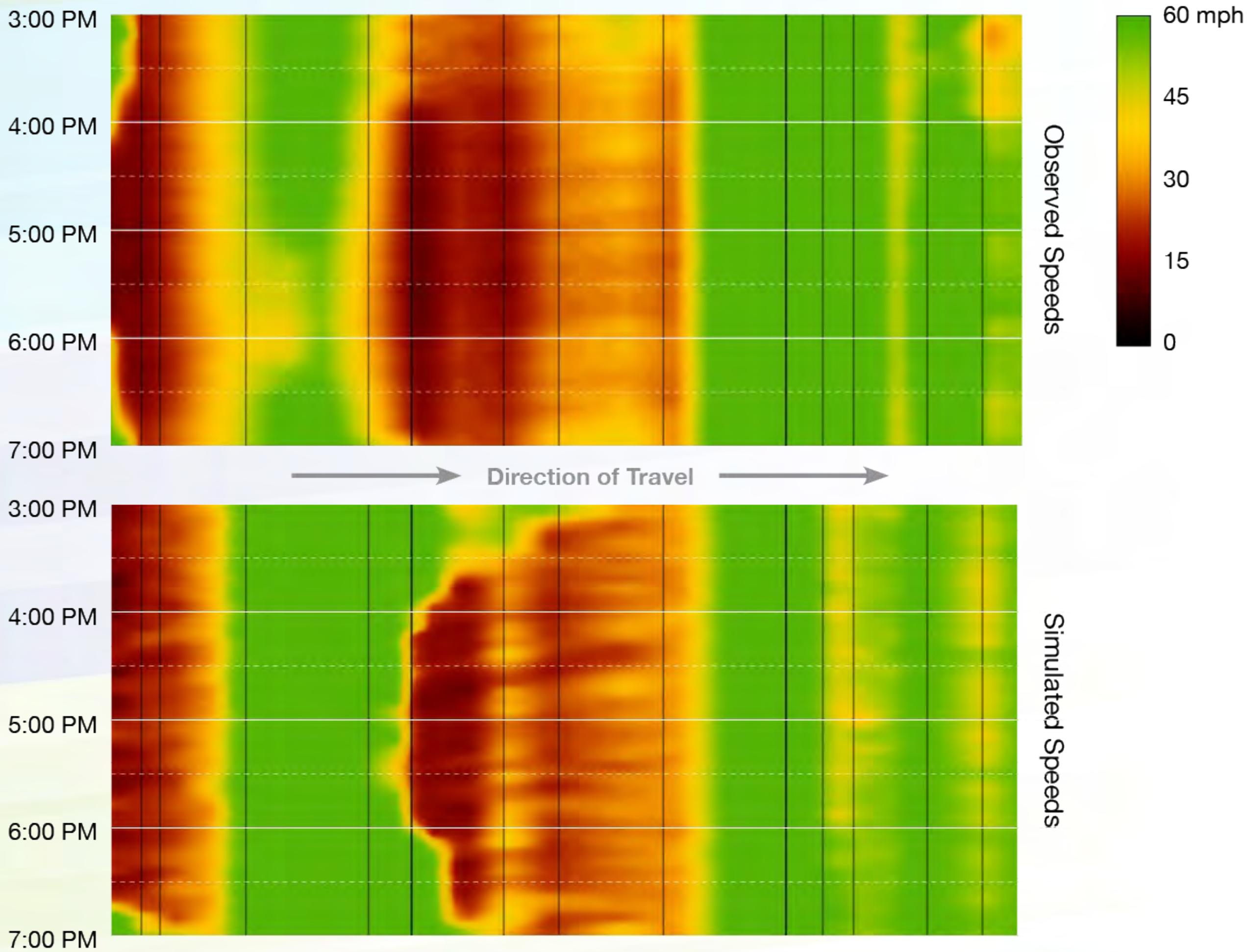
Substep 3.4: Example Speed Contour Diagram





Example Bottleneck Model Calibration

PM Eastbound



Comparison of Change in Delays

(Source: Federal Highway Administration.)

Such comparisons help stakeholders visually assess expected improvements and reductions in service in different parts of the network.

Available Databases

Transportation Databases - Federal

Database	Description	Extents
FHWA Highway Performance Monitoring System (HPMS)	Data on the extent, condition, performance, use and operating characteristics of the nation's highways. Also captures characteristics of some arterial and collector functional systems.	Nationwide
FHWA National Bridge Inventory (NBI)	Condition data on more than 600,000 bridges located on Interstate Highways, U.S. highways, State and county roads, and publicly-accessible bridges on Federal lands.	Nationwide
FHWA National Household Travel Survey (NHTS) Add-On	Supplementary survey data purchased by State DOTs, MPOs, and COGs for their local areas.	Survey Partners (also known as Add-Ons) exist nationwide

Transportation Databases – State and Regional

Database	Description	Extents
Caltrans Performance Measurement System (PeMS)	Real-time and historical traffic data collected from nearly 40,000 individual freeway detectors.	All major metropolitan areas in California
Location-Based Services Data	Set of mobile phone location based services data used to glean insights into linked trips and tours, robust demographics, and travel purpose.	Southern California
Arterial Performance Measurement Tool (APMT)	Establishes baseline performance conditions for selected subregional arterial corridors, such as travel demand, productivity, mobility and reliability.	Specific to Los Angeles County
Caltrans Automated Pavement Condition Survey	Condition data collected at highway speeds using specialized vehicles with inertial profilers, transverse laser system, and high resolution cameras for all lanes	Within the State of California

Transportation Databases – State and Regional

Database	Description	Extents
Statewide Integrated Traffic Records System (SWITRS)	Data gathered from collision scenes by California Highway Patrol staff and members of its Allied Agencies.	Within the State of California
California Vehicle Inventory and Use Survey (CA-VIUS)	State-level vehicle inventory survey that has collected information about commercial vehicle operations from establishments that operate trucks on California's roadways.	Mostly geared towards trucks that operate in California
Caltrans Traffic Counts	Individual Caltrans Districts have calculated the volumes hourly, daily, and monthly to derive an annual average daily traffic count.	Within the State of California
Truck Activity Monitoring System	Uses inductive loop signature technology to obtain high resolution truck data at	Various locations

Transportation Databases – Private Sector

Database	Description	Extents
INRIX	Real-time, historical and predictive traffic information using anonymous, real-time aggregated GPS probe data from a wide array of commercial vehicle fleets, connected cars and mobile apps.	Nationwide and in 45 countries
Streetlight Data	Collection of anonymized location records created by mobile phones, GPS devices, connected cars, commercial trucks, fitness trackers, etc.	Nationwide
Airsage	Collection of real-time mobile signals, GPS and other location data to produce and process billions of anonymous data points every day.	Nationwide

Transportation Databases – Other

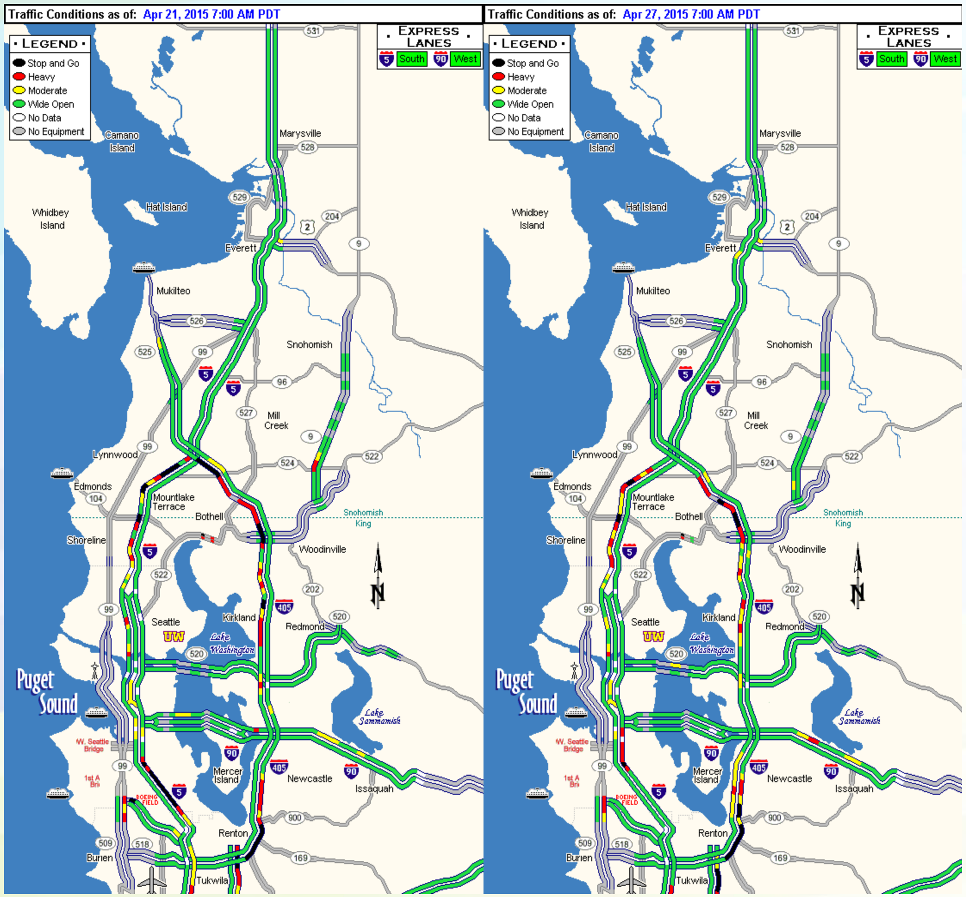
Database	Description	Extents
American Transportation Research Institute (ATRI)	Real-time anonymized freight truck GPS data (e.g., periodic time, location, speed) sourced through unique industry partnerships.	Nationwide

System Performance Profiles

System Profiles

- Characterize system performance
  - Is the system is getting better or worse?
- Identify anything missing in the profile so the profile can be improved over the long term.
- Profile examples:
  - Congestion Profiles
  - Reliability Profiles
  - Safety Profiles

Congestion Profiles

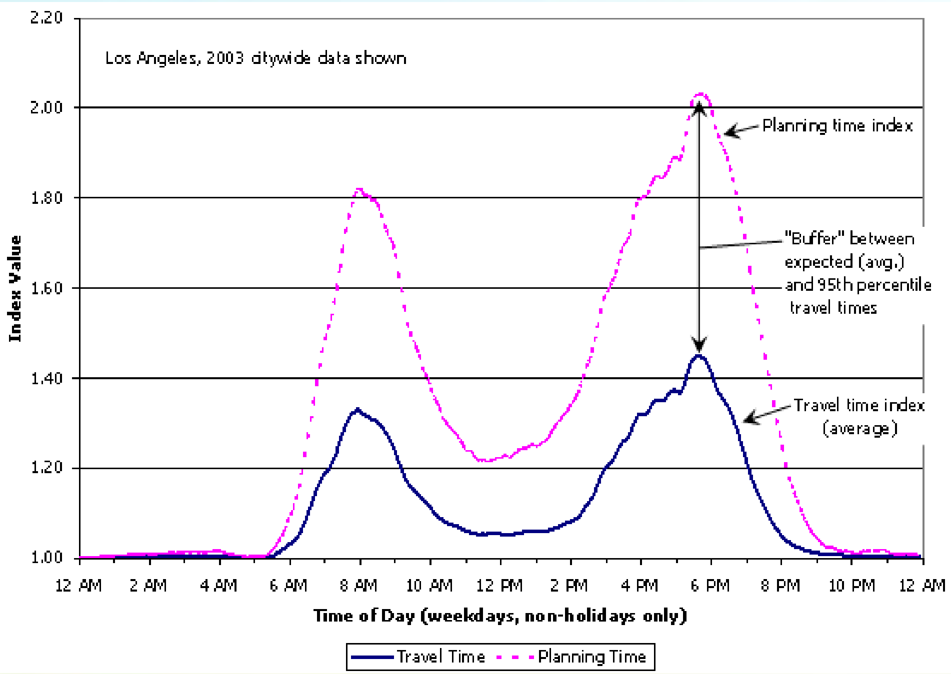


Source: Washington State Department of Transportation

Time-variant congestion measures:

- Travel time
- Vehicle speeds
- Vehicle delay
- Bottleneck throughput
- Queue length
- Vehicle stops

Reliability Profiles

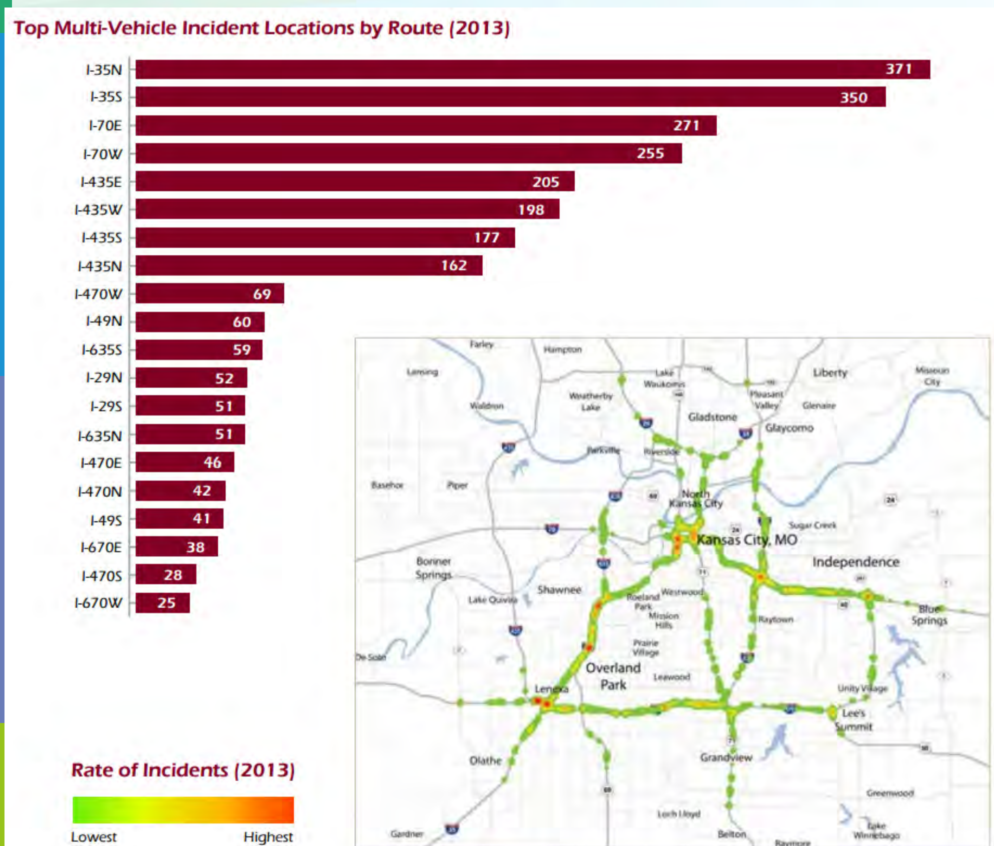


Source: Mobility Monitoring Program, http://mobility.tamu.edu/

Travel time reliability measures:

- 90^{th} or 95^{th} percentile travel time
- Buffer index
- Planning time index
- Frequency that congestion exceeds a certain expected threshold

Safety Profiles

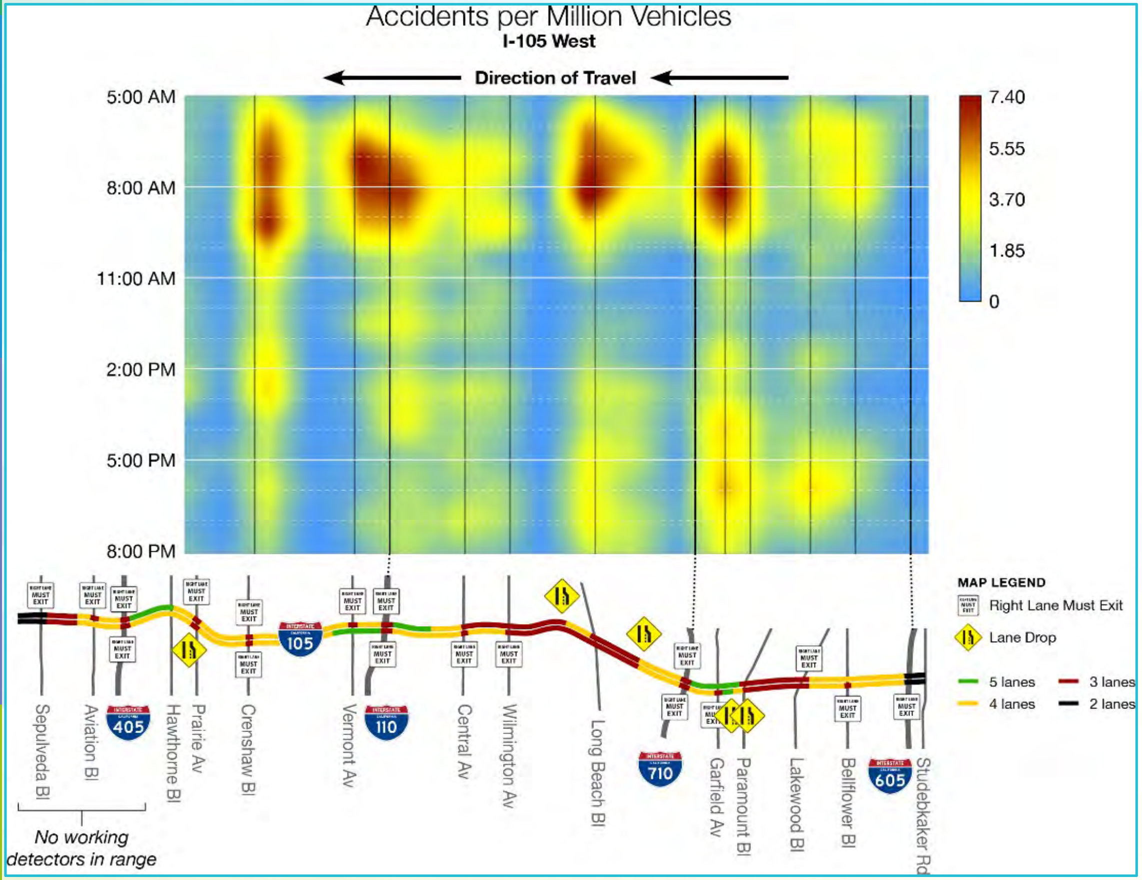


Source: Kansas City Scout

Safety measures:

- Crash rates
- Number of fatalities, injuries, property damage-only crashes

Accident Rates in Space and in Time



(Source: Federal Highway Administration.)

This figure shows how existing accident rates can be presented in space and in time and how this depiction can help analysts determine problematic locations and time spans when accident rates are greater than average.

Special Considerations for System Profiles

- Inconsistent data
  - May not be comprehensive or collected consistently over time.
- Outlier events
  - Can cause bias if not separated from regular traffic conditions.
  - Operational conditions can be identified using cross reference approaches (data mining) or statistical approaches (cluster analysis).
- Seasonality and cyclical trends
  - Time series data that repeats every year.
  - Trends can be obtained by examining weekly, monthly, or seasonal averages of demand, congestion, and safety

Diagnostics

Diagnostics

- The process of considering historical system performance profiles to identify problematic elements of current system performance.
  - Direct diagnostics allows the analyst to develop new insights derived solely from the ***data***.
  - Indirect diagnostics can reveal important insights regarding potential issues in the system from stakeholders with different experiences in the system, and therefore different viewpoints that are ***not data-driven***.

Leveraging Data and Stakeholder Insight

Cross-validating direct (data-driven) and indirect (non-data) observations to create a candidate hypothesis.

DATA-DRIVEN OBSERVATION

"Northbound afternoon travel time reliability has really suffered in the last three months – and peak delay seems to be occurring 45 minutes earlier"

+

NON-DATA OBSERVATION

"I've noticed that after this winter there are some sections where pavement conditions are really playing havoc with northbound traffic"

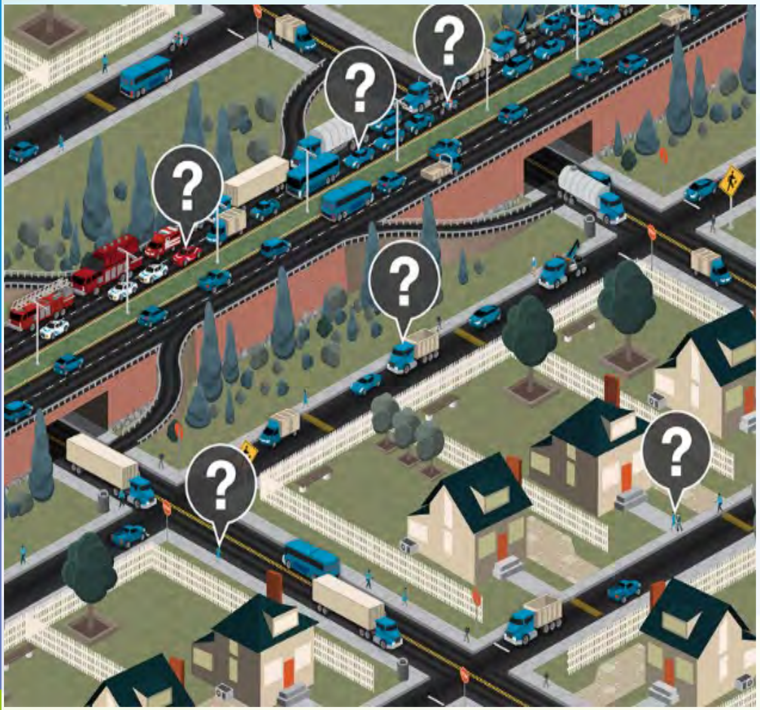
=

CANDIDATE HYPOTHESIS

"Poor pavement conditions are causing reliability and delay issues in the northbound direction of our corridor"

Reconciling Perception and Observation

The "Underutilized" Arterial Example

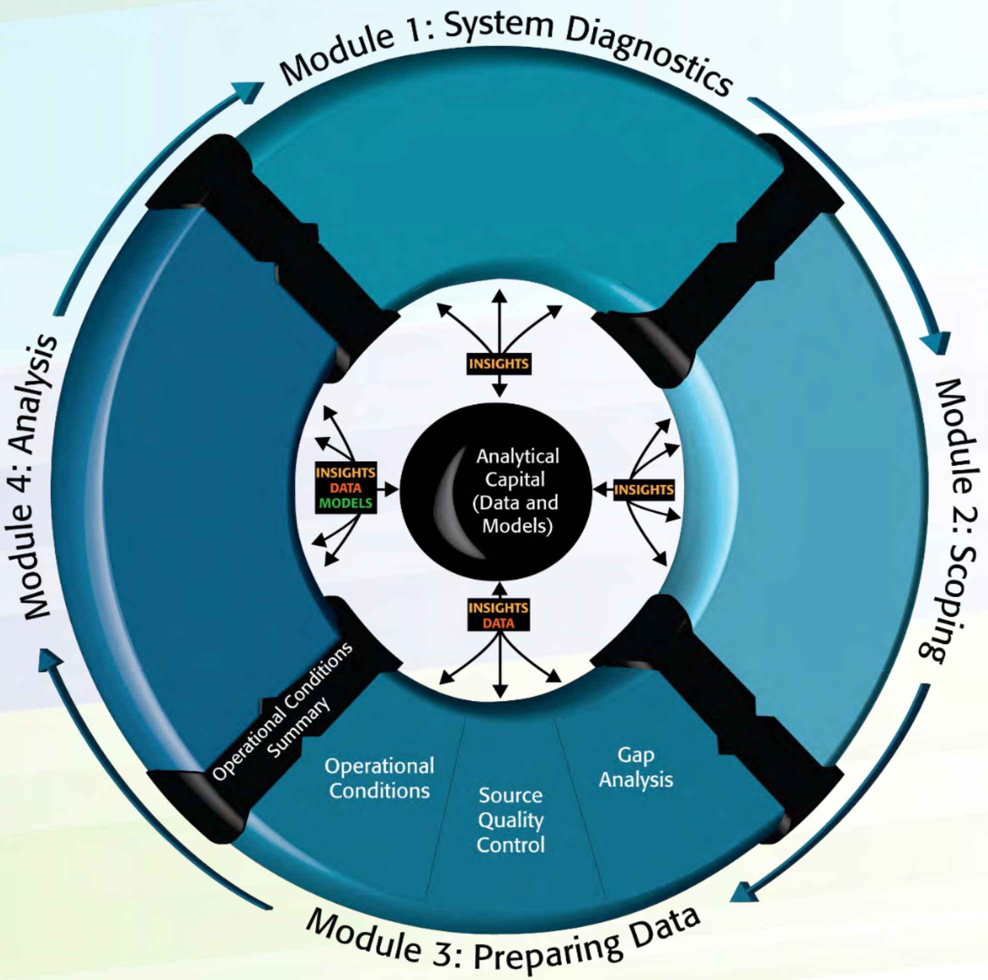


Source: U.S. Department of Transportation

- **Observation:** Daily buildup and dissipation of congestion at a major on-ramp next to a arterial network.
- **Perception:** Rerouting these travelers onto the arterials would decrease their travel time.
- **Analysis Results:** Travel times on the freeway were comparable to travel times on the arterial system during morning peak periods.

Data Preparation

Preparing Data for the Analysis



1. **Gap Analysis.** If targeted primary data collection is required, a data collection plan is developed and existing data are assessed and integrated.

2. **Quality Control.** An analyst verifies the consistency and the quality of the data available.

3. **Operational Conditions.** Depending on the nature and scope of the project, the analyst may review the available data to identify a representative set of operational conditions.

Assessing Data Gaps

Data Sources and Limitations

- Available data come from different sources
- Understand how data was collected
- Check if data resolution is sufficient

Temporal and Spatial Consistency

- Data from different sources are collected in different time periods, locations
- Supplementary estimation feasible?

Emerging Trends in Operational Data

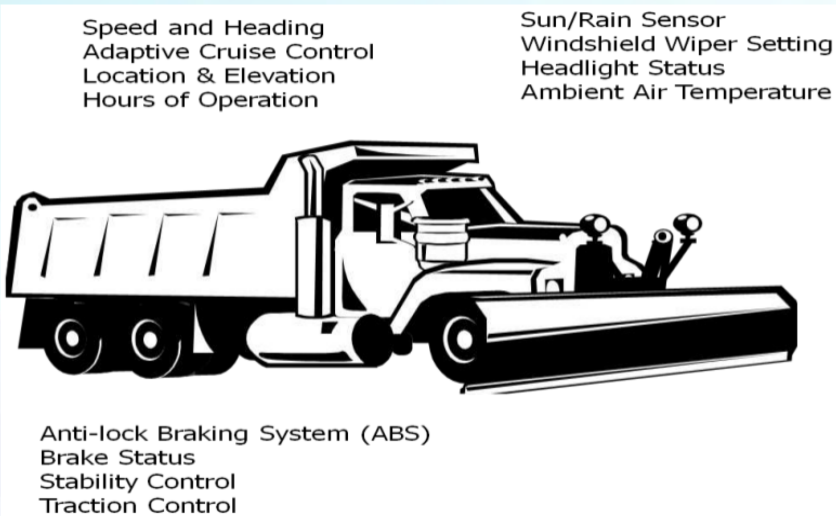
- First-generation probe data
- Connected vehicle data
- Crowd-sourced data

Documentation of Data Gaps

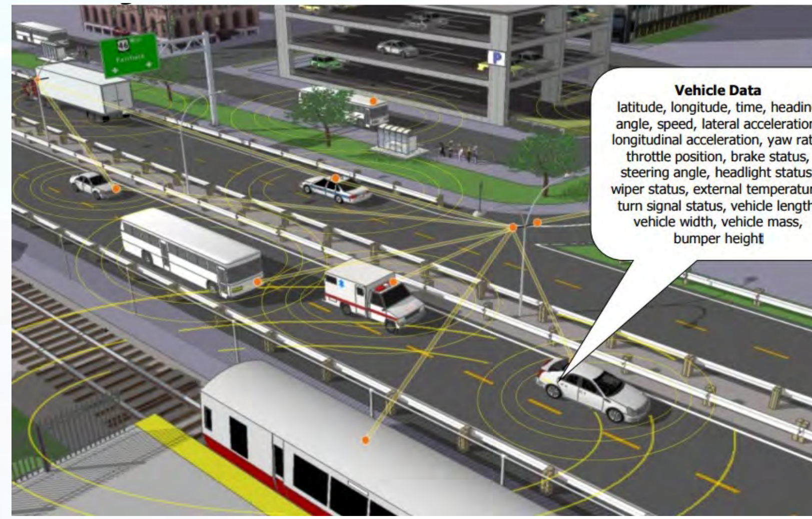
- At the end of the data assessment task, the analysis team should develop a summary of what data needs are covered by in-house or available data and what primary data collection may be needed.
  - This is critical because data collection is going to be costed out.
  - Estimates for data collection, quality control, and analysis will need to be developed separately from tool acquisition, from base model development and calibration, and from alternatives analysis.

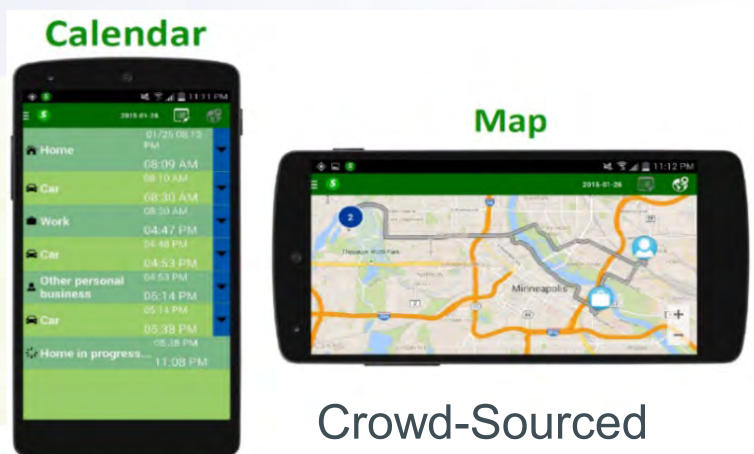
Emerging Trends in Operational Data

Probe Data



Connected Vehicle Data





Crowd-Sourced Data

Emerging Trends in Data

- Evolution into a more data-rich environment.
  - More continuous data.
  - Increasing number of data sources.
  - More rapid data delivery.
  - Broader array of types of data.

- Allows analysts to characterize system performance in new and useful ways.
  - Average delay, travel time reliability, on-time performance, trip predictability, etc.

Data Integration from Multiple Sources

- Make sure that each data set refers to the same clock time when combining data sets.
- Cross validation is a way to ensure the proper temporal and geographical integration of different data sets.
- When preparing data-related procurements, storage, licensing, and ownership issues are also critical.
- Having a common metadata framework across all the systems and using common controlled vocabularies are the keys to ensure the consistency and reliability of metadata applied to the information and data assets.

Quality Control

- The analyst needs to find a balance between setting quality control thresholds and preserving outliers while working around errors.
- Focus on:
  - Element-level checks (e.g. speeds should be 0-99 mph).
  - ***Relationships among data.***
    - Geographic inconsistencies (e.g., location of bottlenecks).
    - Temporal inconsistencies (e.g., time of day when congestion states transition).

Tenets of Data Collection and Data Management

- The type of analysis being conducted (detailed design vs planning) should dictate the quantity of data collected.
- The required accuracy (micro- vs meso-level) should drive the quantity of data collected.
- Since the quality of the analysis and the resulting decisions depend on the data used, it is important to use data that are recent, internally consistent, and relevant.
- Collection of transportation data should capture the temporal variations in travel demand and system performance.

Challenges with Data

Data Comprehensiveness

- Traffic counts should be taken at key locations in the study area.
- If data collection cannot be done simultaneously, it should be done during similar timeframes with similar demand patterns and weather conditions.

Data Reliability

- Automated data sources are preferred.
- Many existing data collection systems lack robustness or reliability needed to compile relevant data sets.

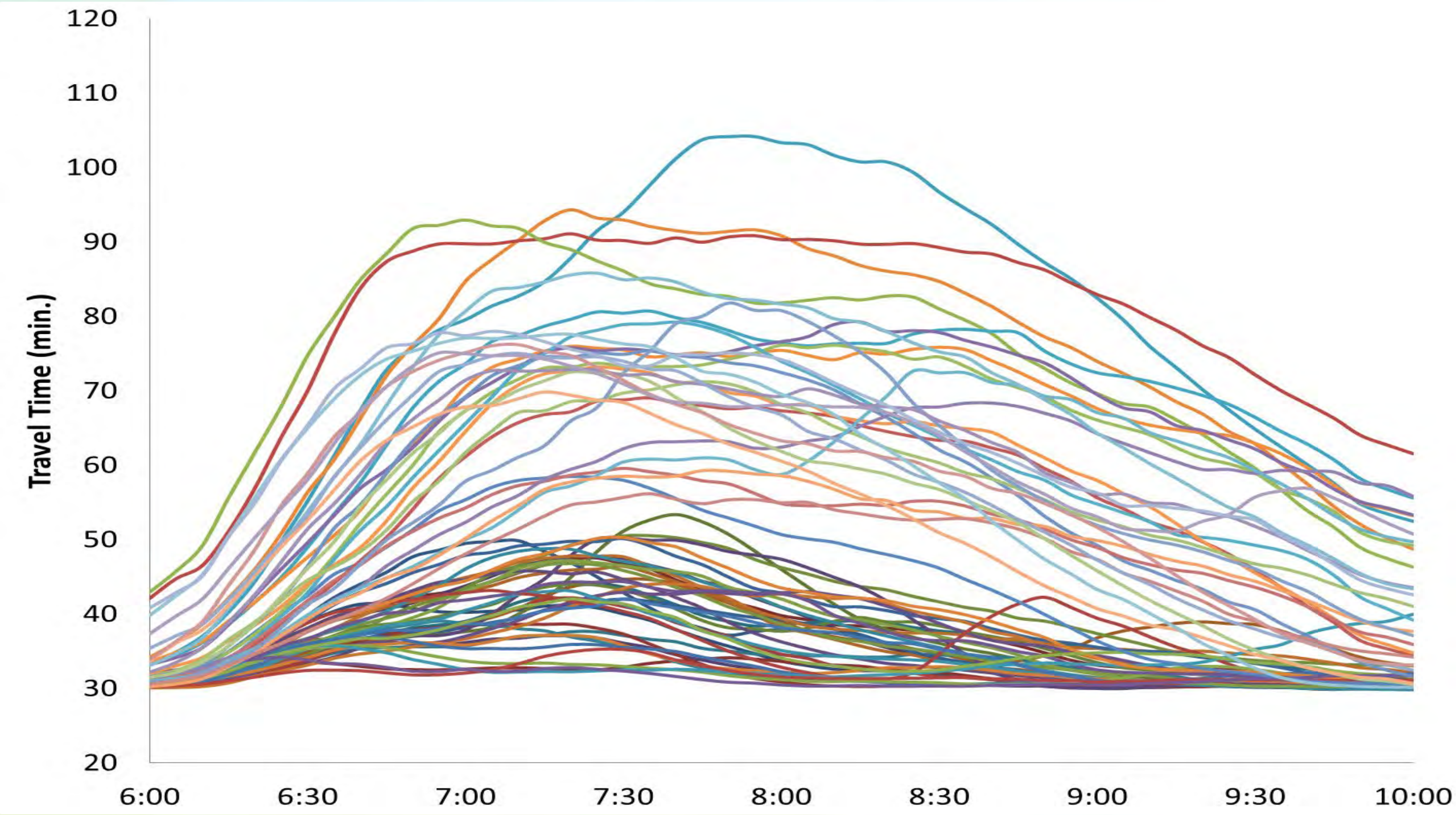
Accuracy

- It is important to have accurate, internally consistent, and recent data.
- Estimations of future traffic conditions is critical.
- Necessary to adopt standard ways to accept/reject field data and address data gaps and missing data.

Operational Conditions

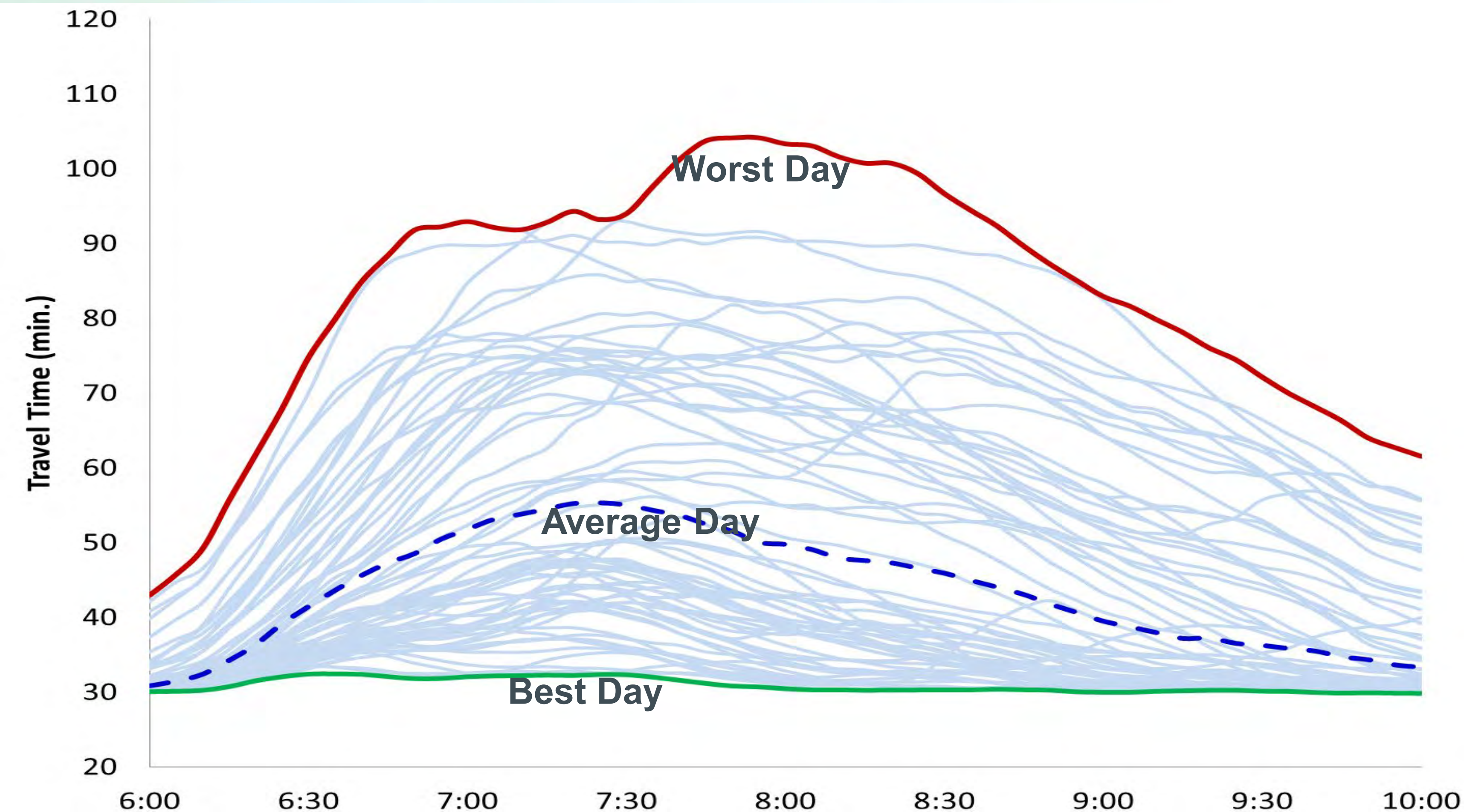
Real Systems Have Good Days and Bad Days

2012 South Bound AM Peak Travel Times, I-405 Corridor



Source: FHWA & Noblis "TAT Volume III Guidelines for Microsimulation" presentation

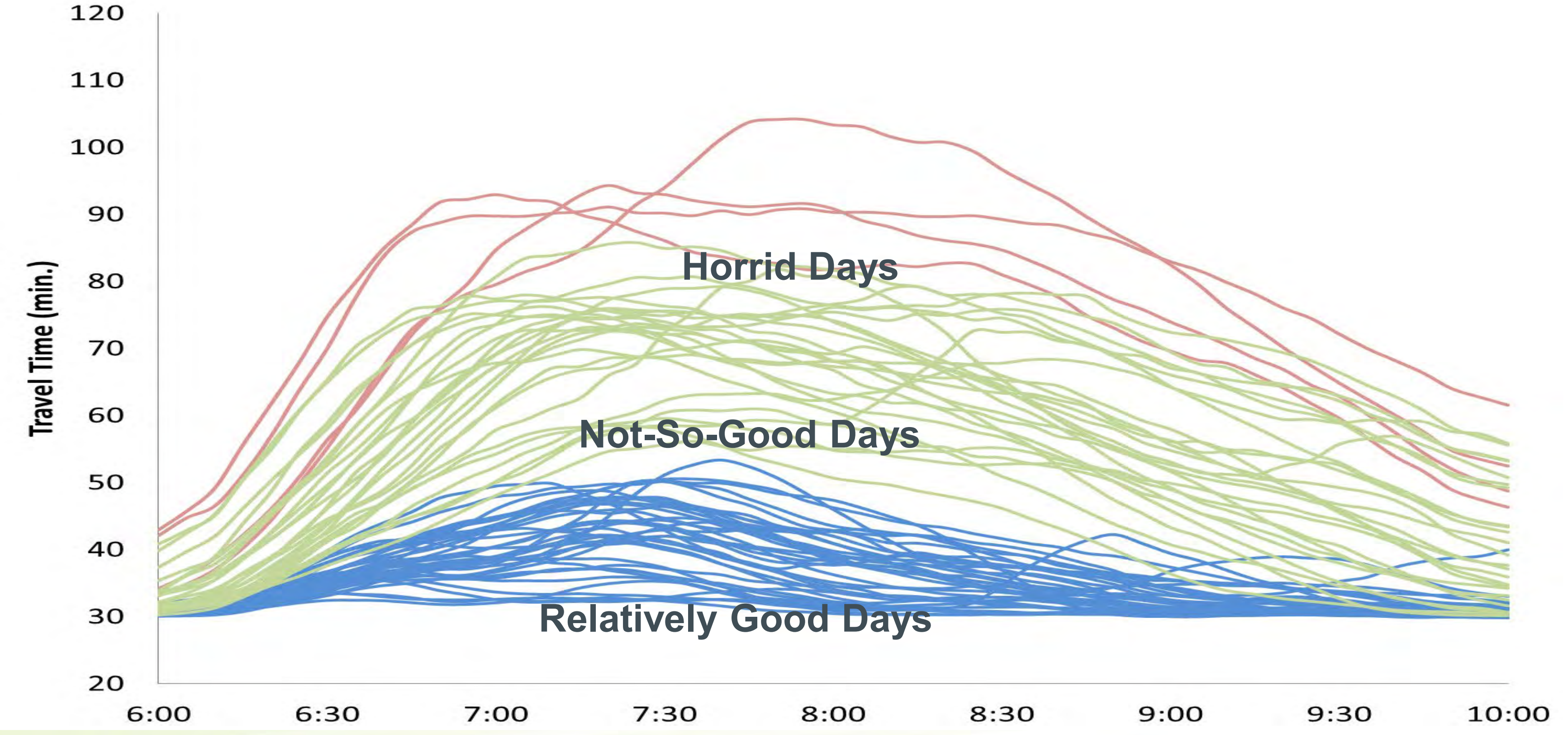
Even An Average Day Captures Only a Fraction of System Dynamics



Source: FHWA & Noblis "TAT Volume III Guidelines for Microsimulation" presentation

Use Cluster Analysis to Identify Distinct, Dissimilar Operational Conditions

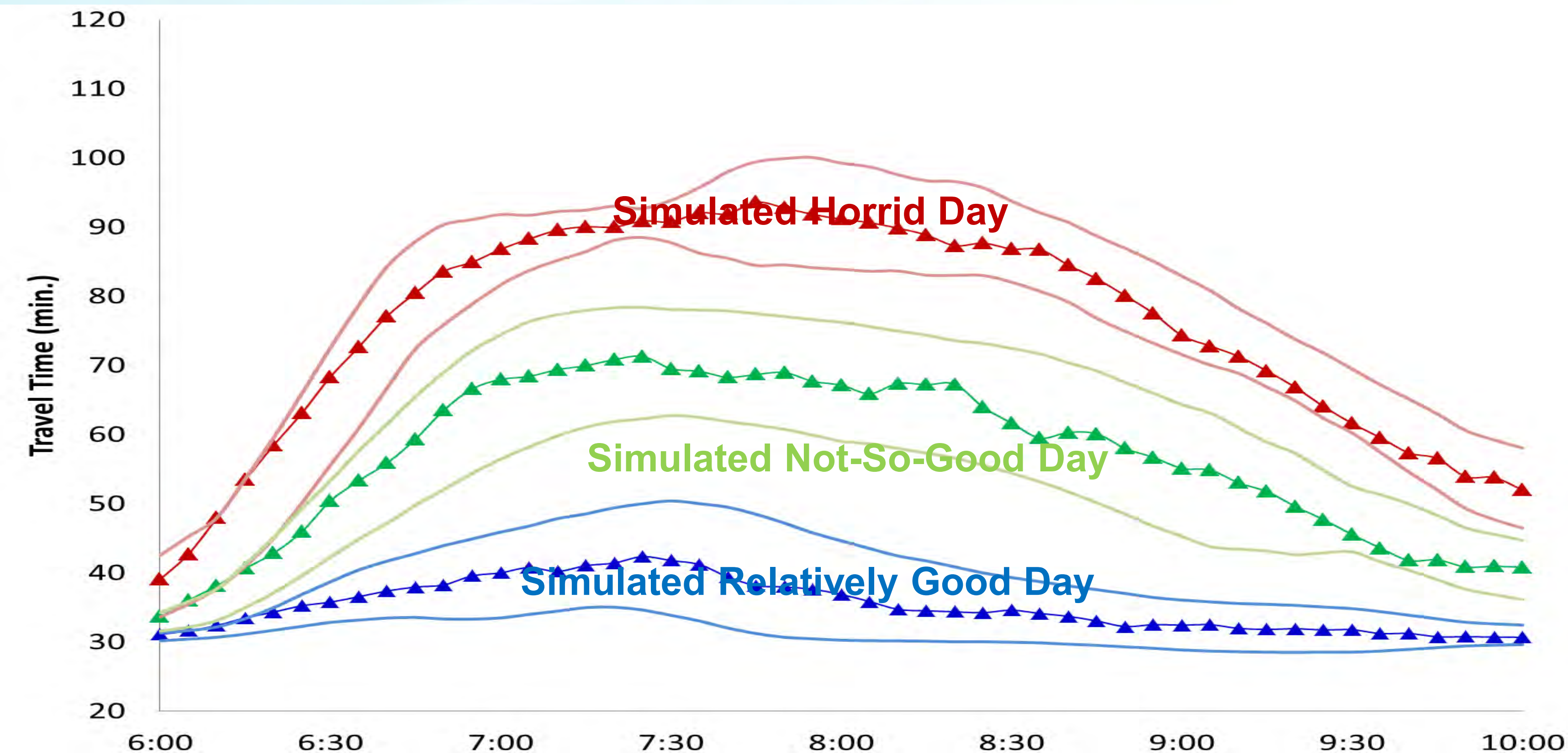
Cluster Analysis Done for Many Attributes, Not Just One Measure… (But We Can Only Show So Much In 2-Dimensions)



Source: FHWA & Noblis "TAT Volume III Guidelines for Microsimulation" presentation

Simulations Are Calibrated to Lie Within the Statistical Envelope

We Perform Statistical Testing to Determine if the Simulated Day Falls in the Envelope Under Many Trials



Source: FHWA & Noblis "TAT Volume III Guidelines for Microsimulation" presentation

San Diego ICM - AMS Scenarios

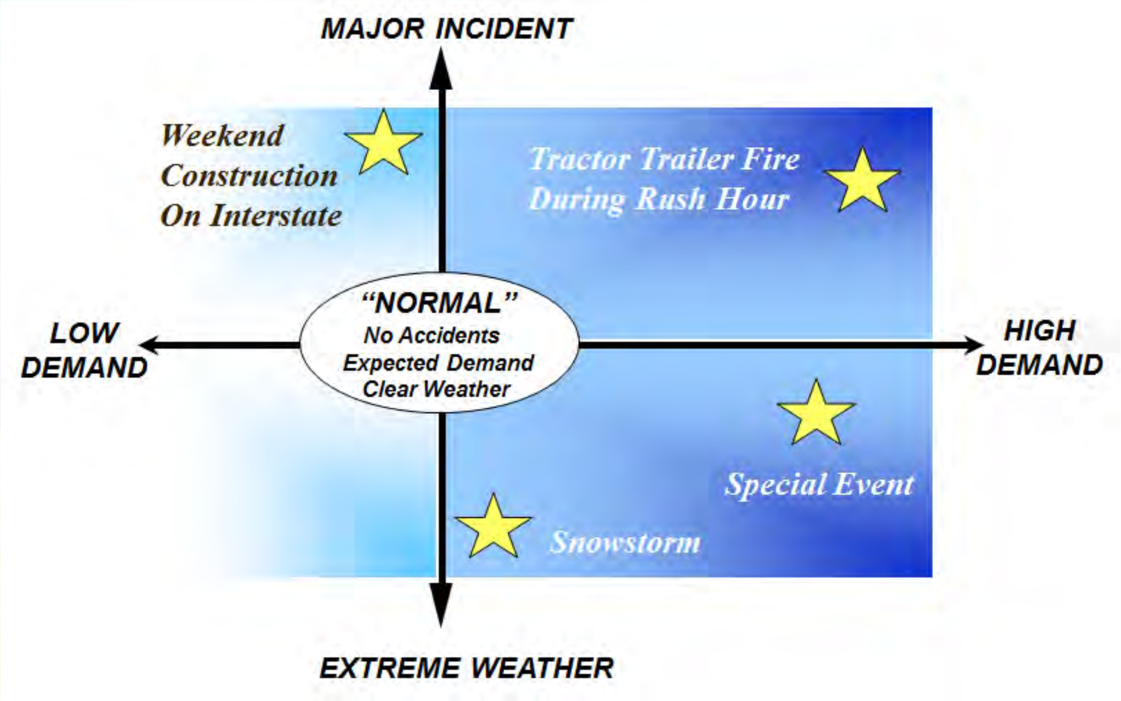
Summary of Best Matching Incident Results

#	Baseline Cluster by Direction and Time Period	Information from Baseline Cluster Analysis			Baseline Period	Post-Deployment Period			
		Days in Cluster	Total Cluster Day Impact (min.)	% of Total Analysis Time Period	Date	Date	DSS Event ID	DSS Plan Type Implemented	DSS Response ID
1	NB PM 4	25	63.25	24.0	10/12/12	7/7/14	639956	Ramps, Signals, ATIS	19536
2	SB AM 2	39	108.03	37.5	10/2/12	2/9/15	754666	Signals, ATIS	27929
3	NB PM 5	3	18.75	2.9	11/21/12	2/19/15	760369	Signals, ATIS	28292
4	SB AM 3	8	34.64	7.7	10/1/12	5/7/15	804238	Ramps, Signals, ATIS	30028
5	n/a, hypothetical	-	-	-	-	5/26/15		None. Managed lanes opened.	
6	SB AM 1	29	49.88	27.9	1/30/13	5/27/15	817649	Signals	30332
7	NB PM 2	8	23.36	7.7	1/15/13	6/9/15	842085	Ramps, Signals	30451
8	NB PM 1	17	41.82	16.3	1/28/13	6/16/15	845922	Ramps, Signals, ATIS	30617
9	NB PM 3b	36	99.72	34.6	1/30/13	5/5/14	853963	Ramps, Signals, ATIS	31039

Key Challenge for Analytical Projects

To fully leverage and use available data sources in the design and execution of meaningful analyses that properly represent and test the competing investment alternatives.

Various Operational Conditions



Analysis Techniques Used to Identify Representative Operational Conditions

- Cluster analysis
- Unit of observation
- Selecting attributes
- Travel time and bottleneck throughput attributes
- Enumerative or attribute stratification approaches
- Data-driven statistical methods
- Objective-focused operational conditions analyses
- Reliability analyses
- Rare events

Variables Used in Cluster Analysis

- Traffic flow rate (vehicles per hour) – Temporal and directional traffic flow rate
- Day of the incident
- Day-of-week
- Time of the incident
- Direction of traffic
- Duration of incidents (minutes)
- Travel time (minutes) – The calculated temporal average directional travel time along the corridor

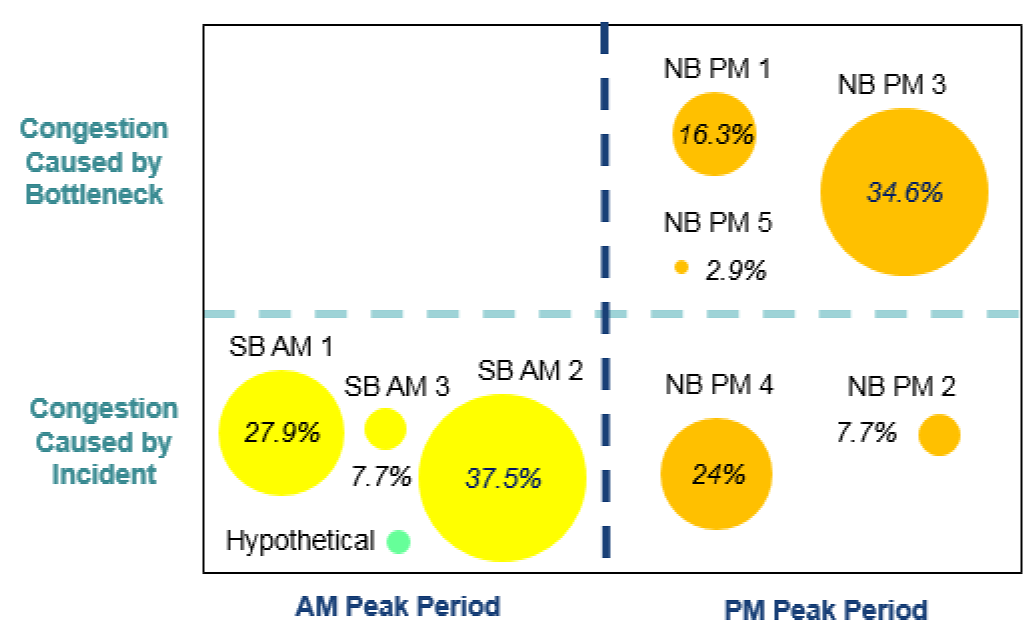
Experimental Design for Analysis of Different Operational Conditions

Highest Priority
- Scenarios with greatest frequency and impact

Lower Priority
- Scenarios with low likelihood but major impact
- Scenarios with frequent occurrence but limited impact

Lowest Priority
- Scenarios with low frequency and low impacts

Operational Condition Dartboard
Scenario Frequency



Note: The size of each circle represents the percent of total analysis time period.

Cluster Analysis and Operational Conditions Summary

Data Summary	All	Op. Con. 1	Op. Con. 2	Op. Con. 3	Op. Con. 4	Op. Con. 5	Op. Con. 6
Periods/Days	196	40 (20%)	25 (13%)	6 (3%)	41 (21%)	28 (14%)	56 (29%)
Operational Condition Characterization		Low Demand	Low Visibility	Weather + Incidents	Many Incidents	Bottleneck Trouble	Few Incidents
Representative Day		9/6/2014	7/18/2014	2/15/2014	8/19/2014	11/1/2014	9/15/2014
Attributes	**Avg.**	**Op. Con. 1**	**Op. Con. 2**	**Op. Con. 3**	**Op. Con. 4**	**Op. Con. 5**	**Op. Con. 6**
North Bound Bottleneck Duration (minutes)	74.46	21.0	71.4	55.0	69.1	128.0	93.2
South Bound Bottleneck Duration (minutes)	113.6	39.4	127.2	112.5	149.3	190.7	95.9
North Bound Maximal Travel Time (minutes)	54.9	48.8	57.0	69.2	58.7	57.5	52.6
South Bound Maximal Travel Time (minutes)	63.2	45.5	69.7	90.3	67.6	74.7	61.0
Number of Incidents (count)	1.64	1.63	1.60	2.67	2.98	1.21	0.79
Maximal Incident Duration (minutes)	22.8	27.7	21.1	62.3	28.5	20.0	13.2
Visibility (miles)	8.45	9.53	2.25	3.33	9.48	9.03	9.96

Note: Operational Condition is denoted as “Op. Con.”

Task Order Process

Task Order Request Template

Information we need from you:

- Task Description
- Deliverable
- Task Initiation Date
- Task Completion Date
- District Task Order Manager
- Names of Staff Members Receiving Training
- Project(s) for which training is required
- Functional unit(s) that will benefit from this Task Order
- Comments/Justification
- Cost *(your best estimate)*

Task Order Request Template

Task Description	Deliverable	Task Initiation Date	Task Completion Date	District Task Order Manager	Names of Staff Members Receiving Training	Project(s) for which training is required	Functional unit(s) that will benefit from this Task Order	Comments/Justification	Cost
Train staff to build a simulation network (districts may request classroom training, but side-by-side, project-based	The in-house expertise necessary to: • Understand and follow all aspects of FHWA Traffic Analysis Tools Guidelines (http://ops.fhwa.dot.gov/trafficanalysistools/tat_vol3/vol3_guidelines.pdf) • Extract a sub-area model from a travel demand model for use in a microsimulation • Turn a one hour OD matrix from a TDM into fifteen minute matrices for multiple hours (extrapolation)	$42,979	$43,115	Petyr Baelish	Petyr Baelish, Arya Stark, Tyrion Lannister, Daenerys Targaryen	Kings Landing Freeway Managed Lanes Study	Traffic Operations (North)	King's Landing Freeway is a major commuter route from all points west of the city. In recent years it has become very congested, especially during the morning peak period. This study proposes using Vissim microsimulation software to test the viability of extending the existing HOV lanes for approximately six miles toward Tumbleton and converting them to HOT lanes. The freeway has good coverage with loop detectors, all are functioning well, and Kings Landing COG has purchased StreetLight speed data that we can use for calibration puposes. In addition, Kings Landing COG has recent traffic counts from adjacent urban streets and most interchanges.	$35,000 (estimate to be adjusted by Consultant as necessary)
Train staff about the criticality of good data and how to use	The in-house expertise necessary to: • Collect good data • Determine how much data is necessary • Check data • Use Big Data	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	Staff will learn how to determine what data is required for the base year model, how to identify appropriate data sources, and how to check the data. Staff will learn to use StreetLight data.	Same as above
Assist the districts in using PeMS (and TOPL if it is ready).	The in-house expertise necessary to: • Program/code PEMS sensors into microsimulation networks for calibration/validation • Program/code PEMS sensors into microsimulation networks to seed OD matrices for freeways and arterials (mid-block or stop bar/advance detection)	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	Staff will use PeMS data from relevant mainline and ramp locations.	Same as above
Train staff to calibrate and validate models	The in-house expertise necessary to: • Understand the significance of parameters for each software package • Determine appropriate parameter settings, vehicle mix, etc. by location • Determine calibration targets	Same as above	Same as above	Same as above	Same as above	Same as above	Same as above	Staff will learn to adjust Vissim parameters to match existing driver behavior in and around King's Landing.	Same as above