# Transportation Data Collection Program for a Large MPO – General Practice and Some Innovative Study Examples

**Presented by:**

Vladimir Livshits, Ph.D., MAG

Wang Zhang, Ph.D., MAG

Sreevatsa Nippani, Ph.D., MAG

Krishnan Viswanathan, CDM Smith, Inc.

William Kasper, Skycomp, Inc.

# Presentations

1. Vladimir Livshits, Ph.D. - Development of Transportation Data Collection and Management Program in the Context of a Large MPO Business Processes

2. Wang Zhang, Ph.D. – Implementation of a Hybrid Data Collection Approach in the 2012 MAG Occupancy Study

3. Sreevatsa Nippani, Ph.D. and Krishnan Viswanathan - Review of Freight Data Sources for the Development of a Behavior-based Freight Model

4. William Kasper and Wang Zhang, Ph.D., Innovative Data Collection and Analysis for MAG Bottleneck Study

# Presentation #1

## Development of Transportation Data Collection and Management Program in the Context of a Large MPO Business Processes

Vladimir Livshits, Ph.D.
System Analysis Program Manager
Maricopa Association of Governments

# Lets get on the same page

- Data Management – a set of activities, processes and technologies that manages all of the data utilized in an organization
- Data Management includes the following functions: data collection, data acquisition, data storage, data security, data archiving, data analysis and processing, data forecasting, data QA/QC, data maintenance, data access, data integration
- A data management program – a planned coordinated set of activities and procedures (a program) for the purpose of data management
- Some of the information in this presentation was presented by the author at various conferences and other professional events

# So how your program might look like?

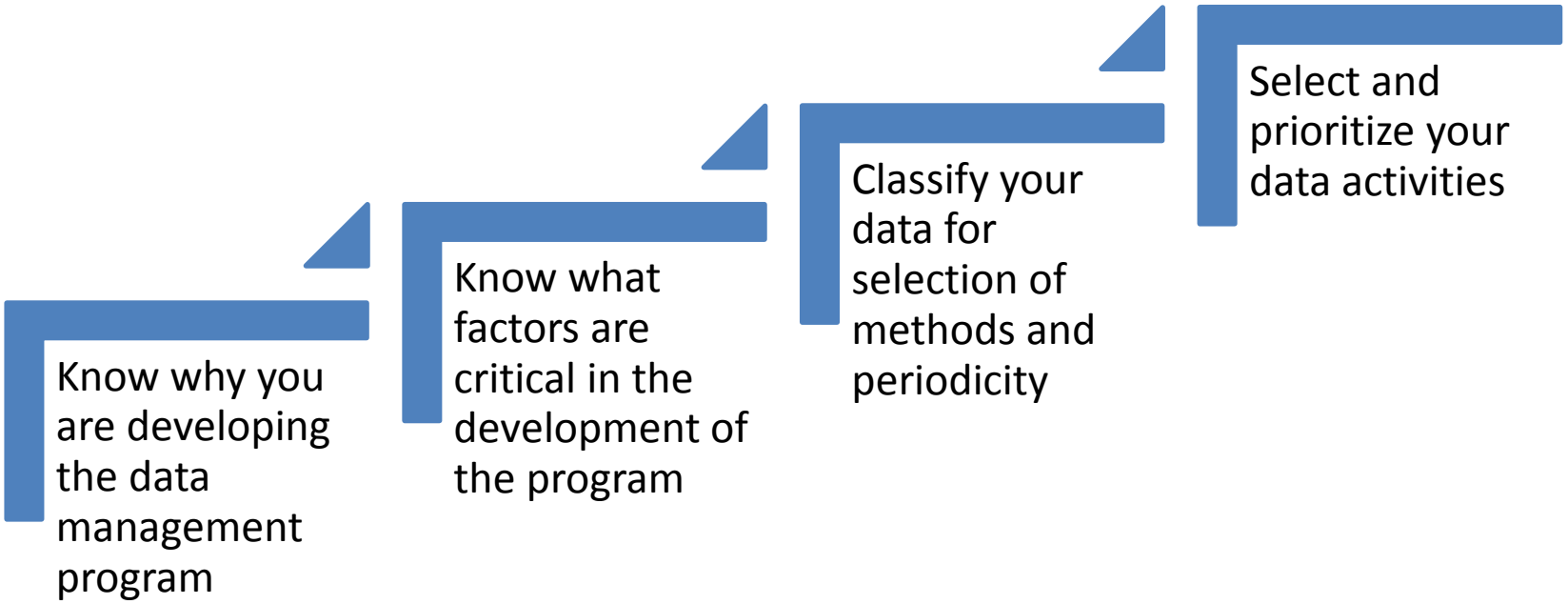
It can be a simple list like this

| FY20XX | Budget | In-house Or Consultant | Start | End | Preferred Periodicity |
|---|---|---|---|---|---|
| Project 1 | | | | | |
| Project 2 | | | | | |

or like this

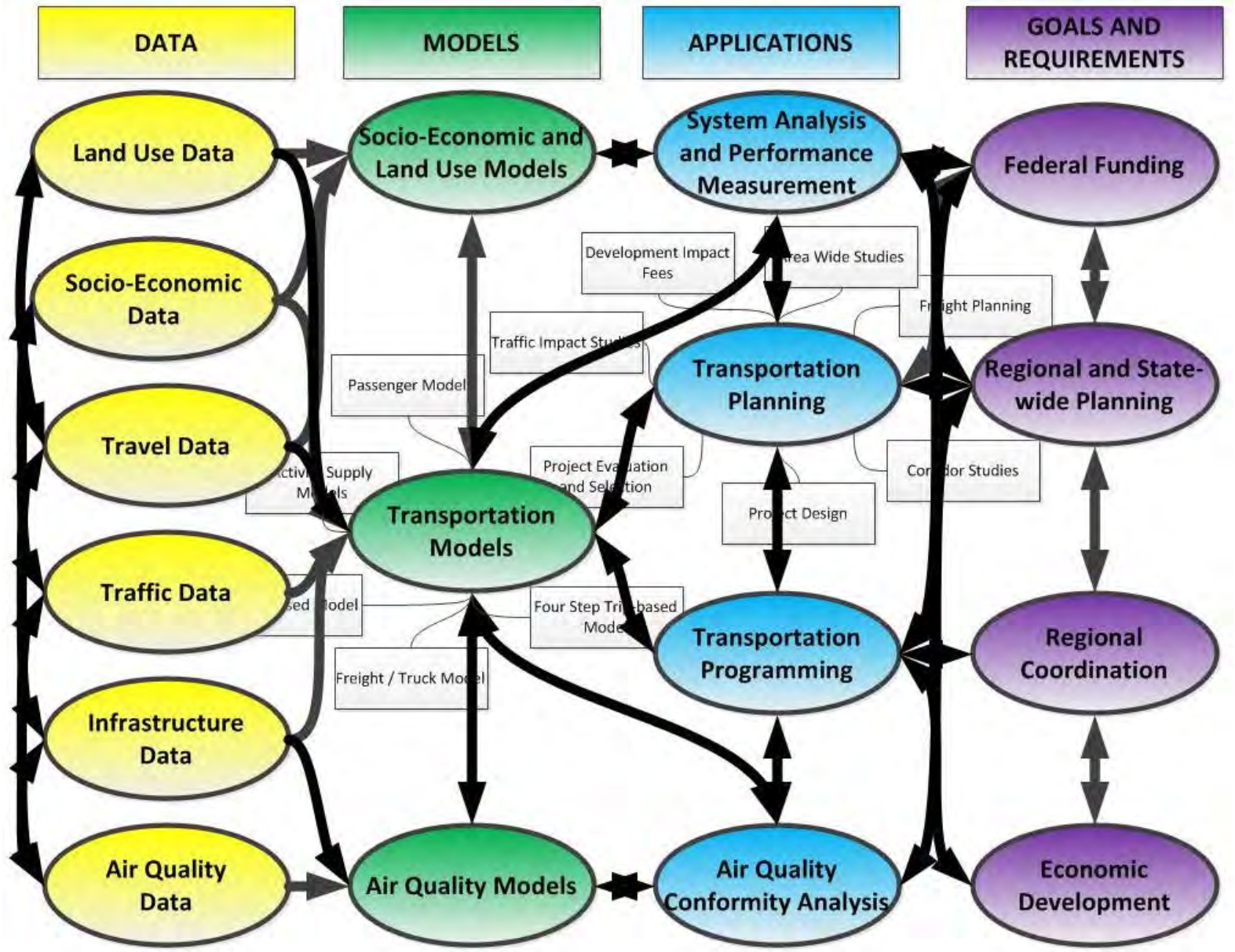
| | FY | 2015 | 2016 | 2017 |
|---|---|---|---|---|
| **DATA Collection** | | | | |
| Household Survey | | | $300,000 | |

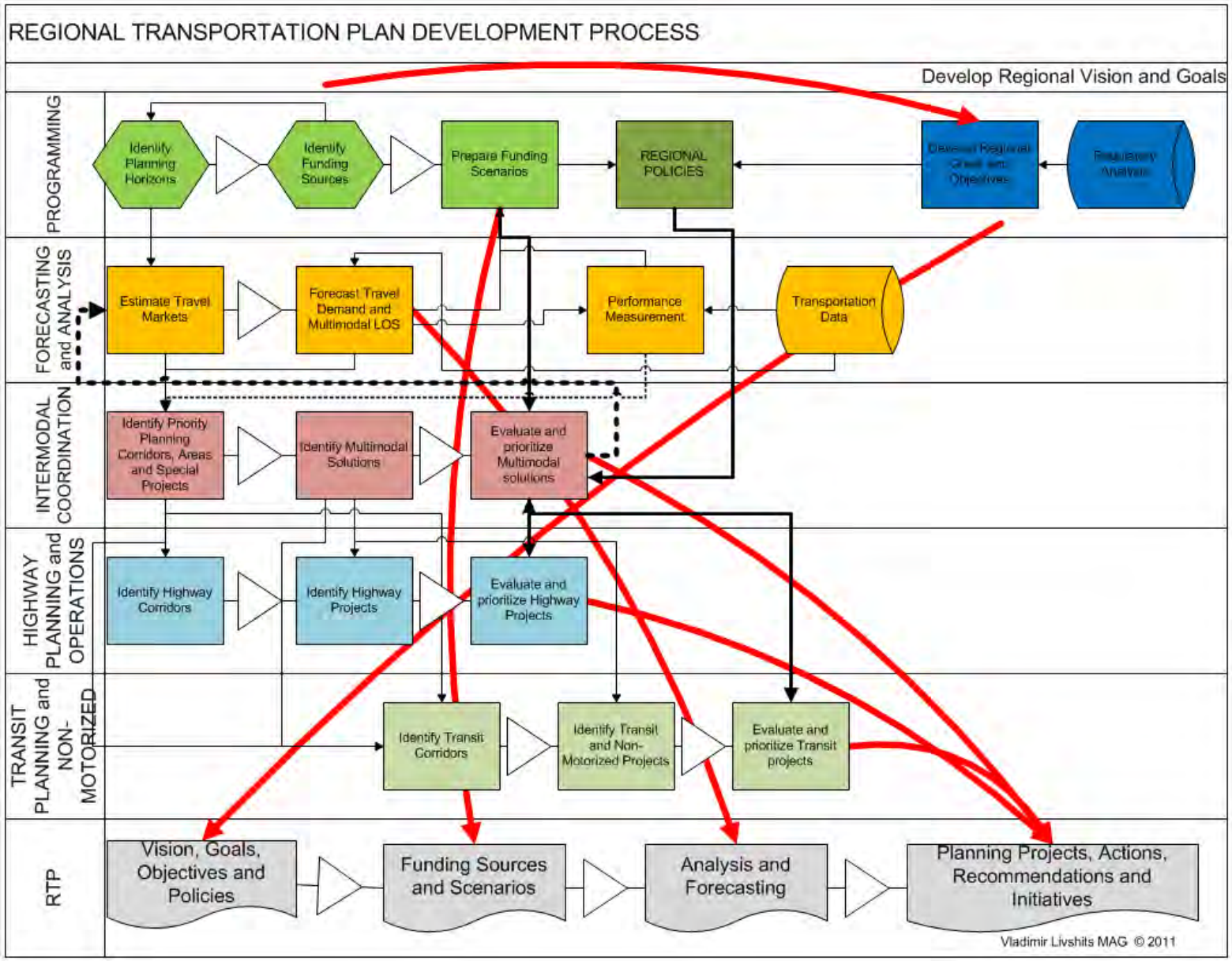
or it can be a 100 page document. In any case the question is how you decide what to collect/develop and when and how.


Know why you are developing the data management program
Know what factors are critical in the development of the program
Classify your data for selection of methods and periodicity
Select and prioritize your data activities

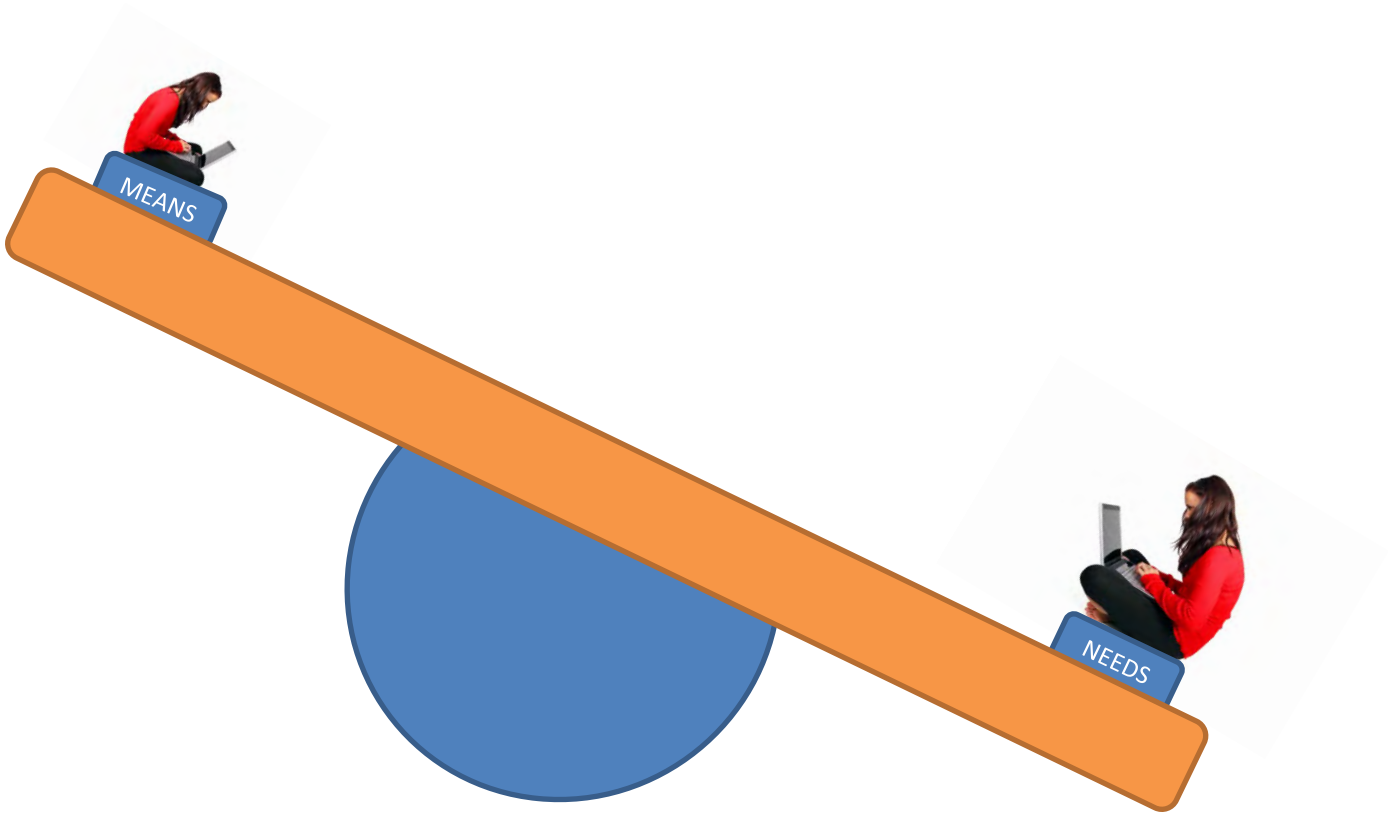
# Why do we need to have a data management program?

- Because transportation data is a critical component in successful regional planning and informed decision making
- Because transportation data management requires complex and expensive projects – So we need to carefully plan and budget for these activities
- Because key business processes of COGs and MPOs rely on timely supply of transportation data

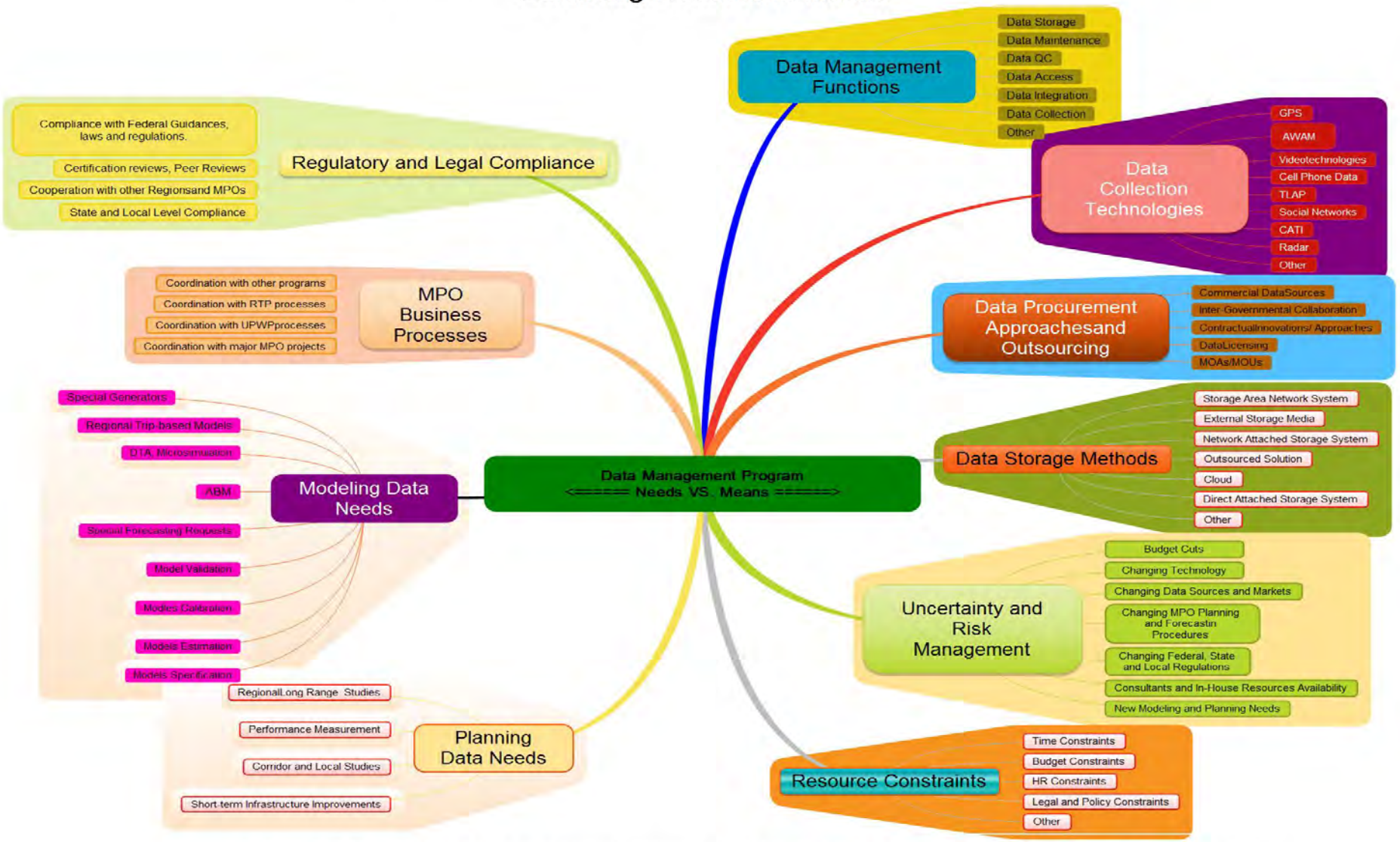

DATA
MODELS
APPLICATIONS
GOALS AND REQUIREMENTS
Land Use Data
Socio-Economic Data
Travel Data
Traffic Data
Infrastructure Data
Air Quality Data
Socio-Economic and Land Use Models
Transportation Models
Air Quality Models
System Analysis and Performance Measurement
Transportation Planning
Transportation Programming
Air Quality Conformity Analysis
Federal Funding
Regional and State-wide Planning
Regional Coordination
Economic Development
Development Impact Fees
Area Wide Studies
Freight Planning
Traffic Impact Studies
Passenger Model
Project Evaluation and Selection
Corridor Studies
Project Design
Four Step Trip-based Model
Freight / Truck Model


REGIONAL TRANSPORTATION PLAN DEVELOPMENT PROCESS
Develop Regional Vision and Goals
PROGRAMMING
Identify Planning Horizons
Identify Funding Sources
Prepare Funding Scenarios
REGIONAL POLICIES
Regional Goals and Objectives
Regulatory Analysis
FORECASTING and ANALYSIS
Estimate Travel Markets
Forecast Travel Demand and Multimodal LOS
Performance Measurement
Transportation Data
INTERMODAL COORDINATION
Identify Priority Planning Corridors, Areas and Special Projects
Identify Multimodal Solutions
Evaluate and prioritize Multimodal solutions
HIGHWAY PLANNING and OPERATIONS
Identify Highway Corridors
Identify Highway Projects
Evaluate and prioritize Highway Projects
TRANSIT PLANNING and NON-MOTORIZED
Identify Transit Corridors
Identify Transit and Non-Motorized Projects
Evaluate and prioritize Transit projects
RTP
Vision, Goals, Objectives and Policies
Funding Sources and Scenarios
Analysis and Forecasting
Planning Projects, Actions, Recommendations and Initiatives
Vladimir Livshits MAG © 2011

# What factors are critical in the development of the program?



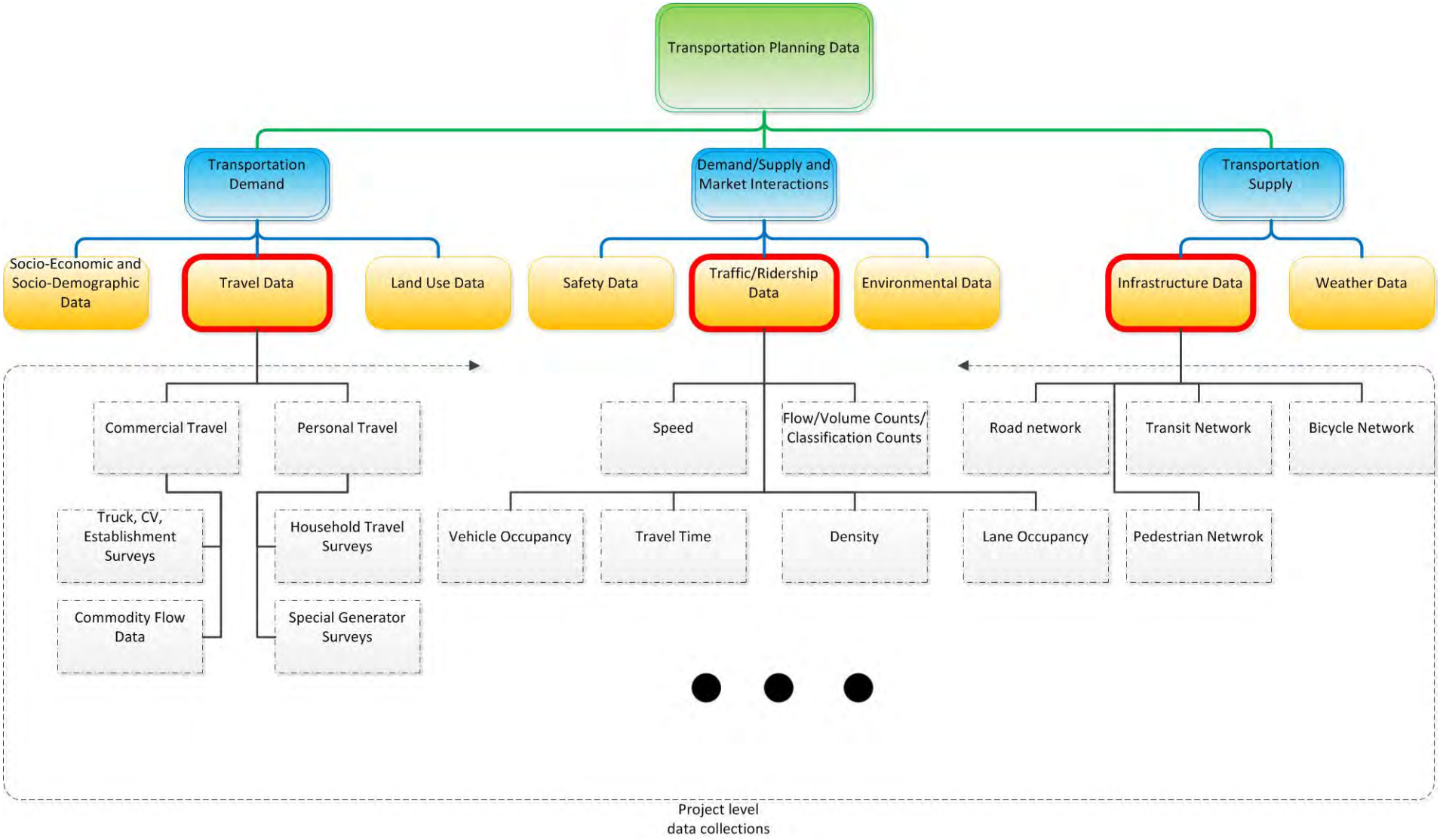
# Factors Affecting Data Management Program Development - Balancing Needs and Means

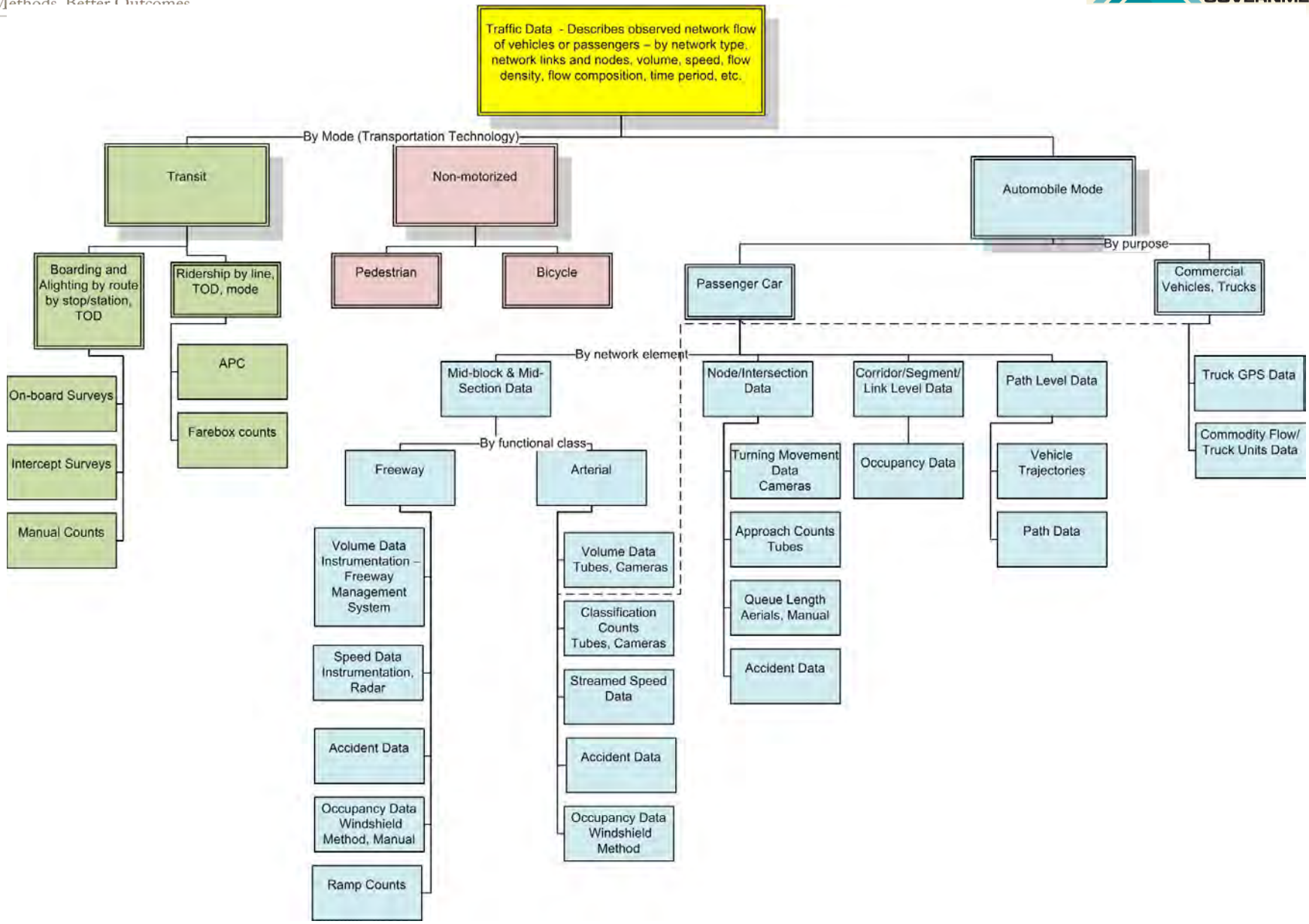


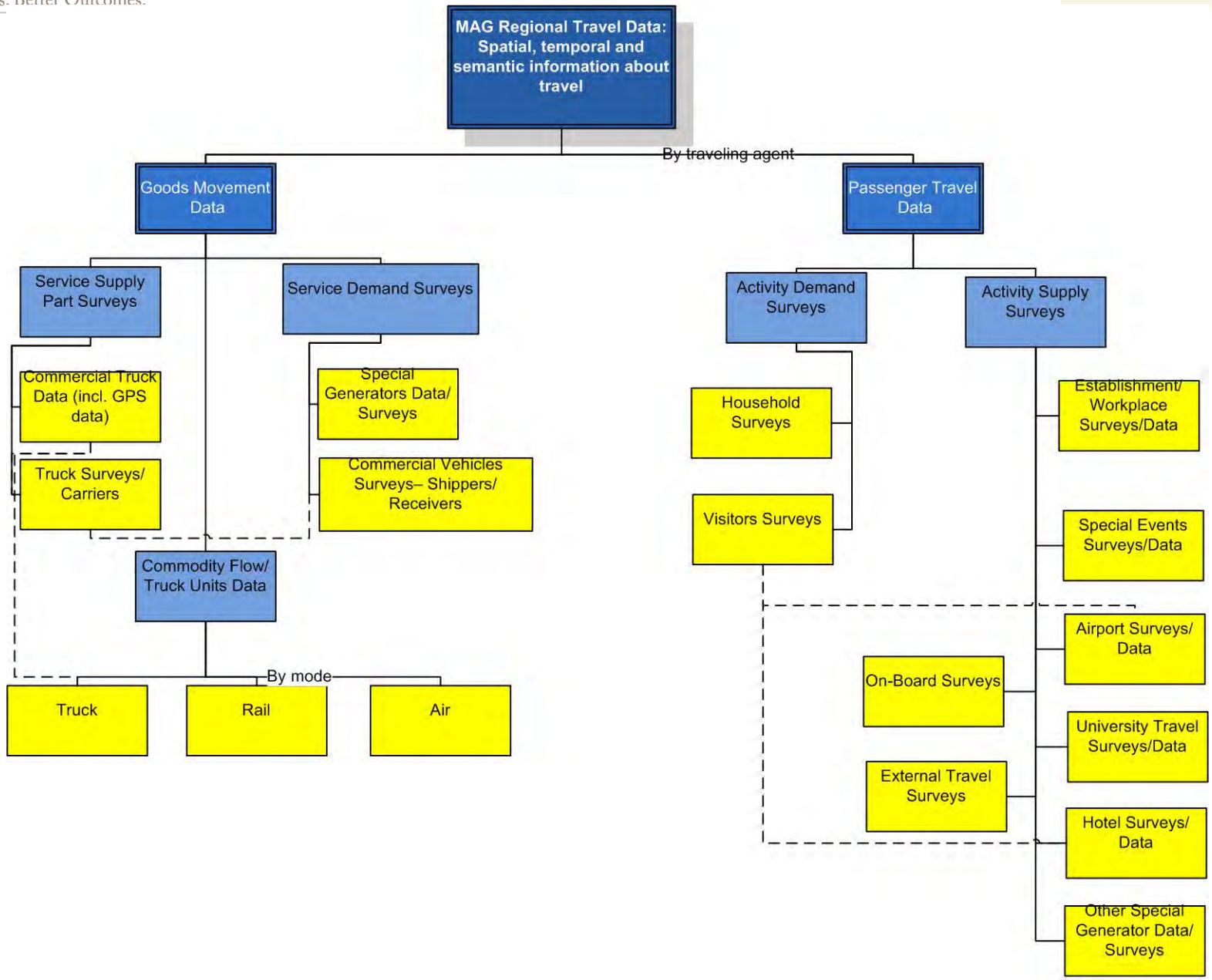

Not all factors affecting data management program development shown, not all data management functions shown

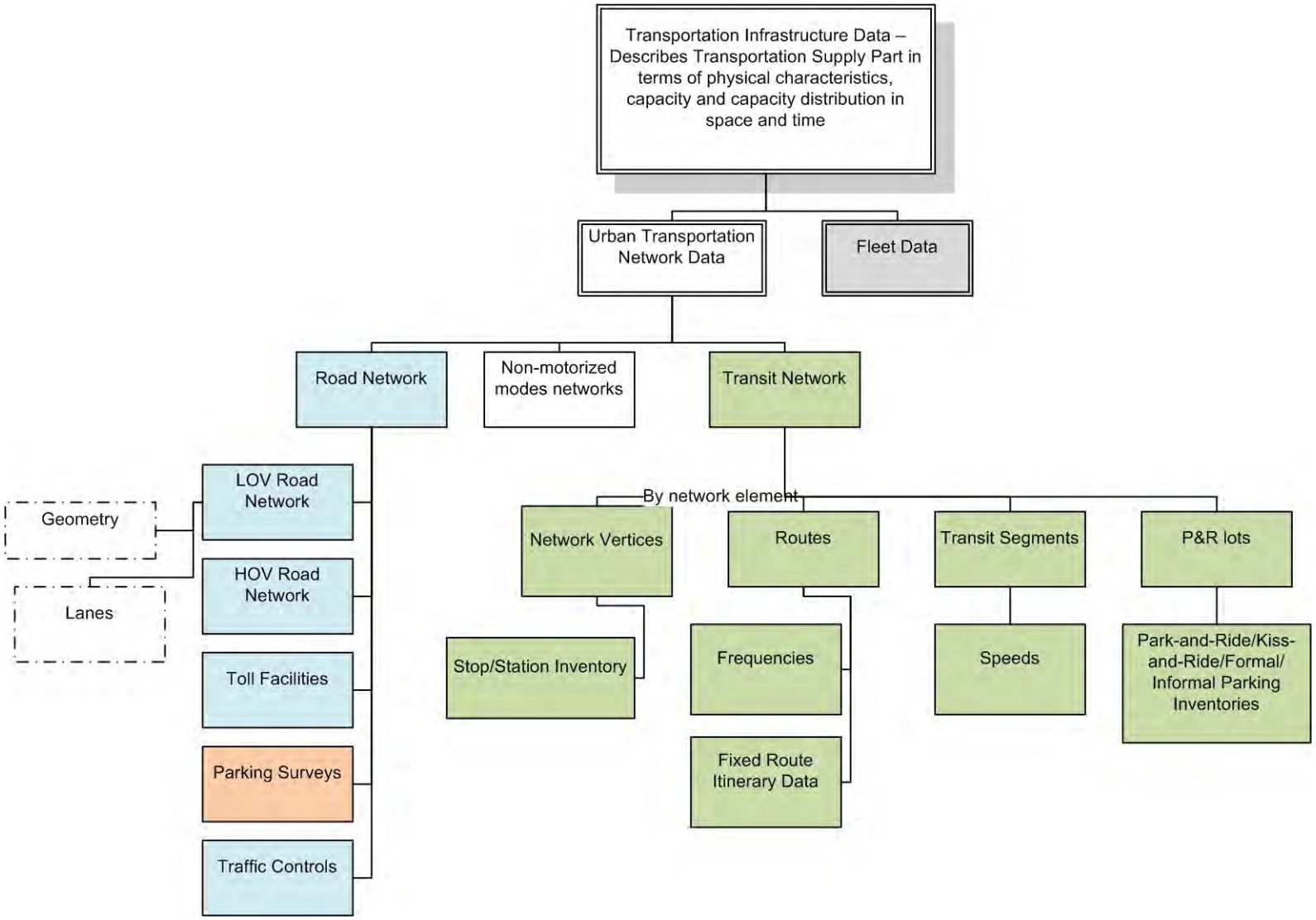
# Too many factors - How we can facilitate project selection?

- Classification is a tool for organizing the set of data management activities and making sure we have as complete picture as possible
- Suitable data *classification is the basis for selection*
- Classification is the Key Element in the Program Development – Classify your data and your organizational business processes and projects for decisions on data collection/acquisition, methods and periodicity
- Remember: There is no such thing as a perfect classification – customize to your needs


Transportation Planning Data
Transportation Demand
Demand/Supply and Market Interactions
Transportation Supply
Socio-Economic and Socio-Demographic Data
Travel Data
Land Use Data
Safety Data
Traffic/Ridership Data
Environmental Data
Infrastructure Data
Weather Data
Commercial Travel
Personal Travel
Speed
Flow/Volume Counts/ Classification Counts
Road network
Transit Network
Bicycle Network
Truck, CV, Establishment Surveys
Household Travel Surveys
Vehicle Occupancy
Travel Time
Density
Lane Occupancy
Pedestrian Netwrok
Commodity Flow Data
Special Generator Surveys
Project level data collections

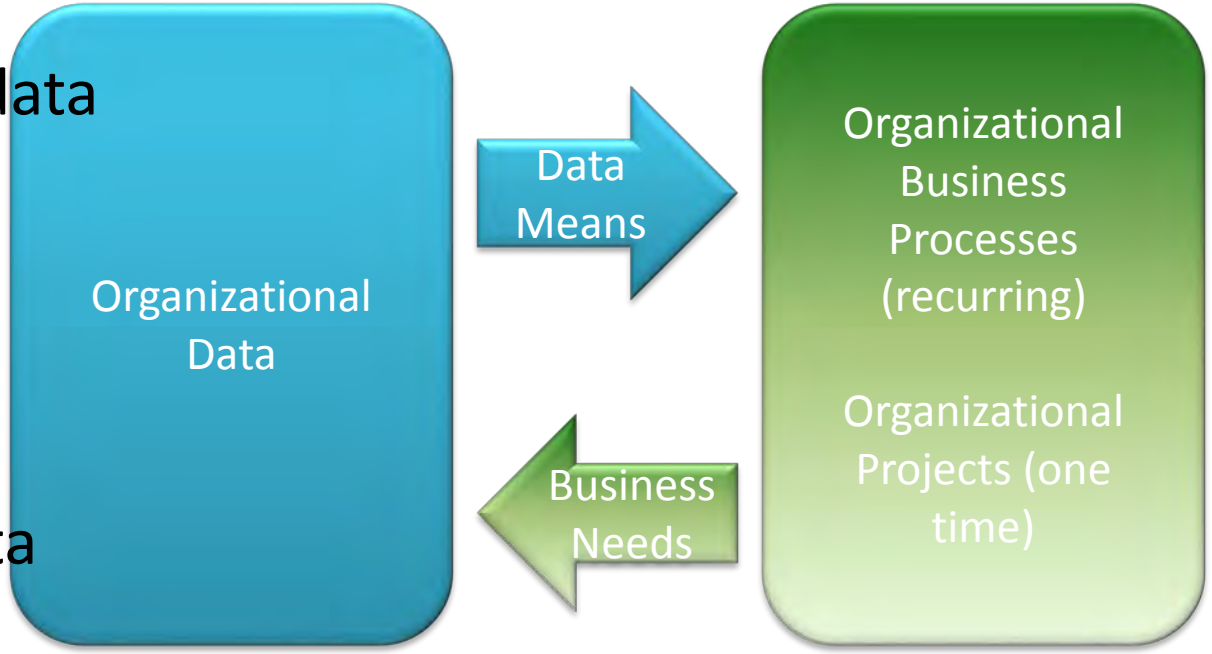

Traffic Data - Describes observed network flow of vehicles or passengers – by network type, network links and nodes, volume, speed, flow density, flow composition, time period, etc.
By Mode (Transportation Technology)
Transit
Non-motorized
Automobile Mode
Boarding and Alighting by route by stop/station, TOD
Ridership by line, TOD, mode
Pedestrian
Bicycle
By purpose
Passenger Car
Commercial Vehicles, Trucks
On-board Surveys
Intercept Surveys
Manual Counts
APC
Farebox counts
By network element
Mid-block & Mid-Section Data
Node/Intersection Data
Corridor/Segment/ Link Level Data
Path Level Data
Truck GPS Data
Commodity Flow/ Truck Units Data
By functional class
Freeway
Arterial
Turning Movement Data Cameras
Occupancy Data
Vehicle Trajectories
Approach Counts Tubes
Path Data
Queue Length Aerials, Manual
Accident Data
Volume Data Instrumentation – Freeway Management System
Speed Data Instrumentation, Radar
Accident Data
Occupancy Data Windshield Method, Manual
Ramp Counts
Volume Data Tubes, Cameras
Classification Counts Tubes, Cameras
Streamed Speed Data
Accident Data
Occupancy Data Windshield Method


MAG Regional Travel Data: Spatial, temporal and semantic information about travel
By traveling agent
Goods Movement Data
Passenger Travel Data
Service Supply Part Surveys
Service Demand Surveys
Activity Demand Surveys
Activity Supply Surveys
Commercial Truck Data (incl. GPS data)
Special Generators Data/ Surveys
Household Surveys
Establishment/ Workplace Surveys/Data
Truck Surveys/ Carriers
Commercial Vehicles Surveys– Shippers/ Receivers
Visitors Surveys
Special Events Surveys/Data
Commodity Flow/ Truck Units Data
Airport Surveys/ Data
On-Board Surveys
By mode
University Travel Surveys/Data
External Travel Surveys
Hotel Surveys/ Data
Truck
Rail
Air
Other Special Generator Data/ Surveys

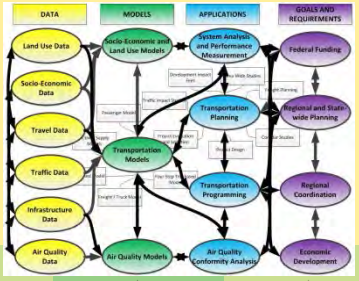

Transportation Infrastructure Data – Describes Transportation Supply Part in terms of physical characteristics, capacity and capacity distribution in space and time
Urban Transportation Network Data
Fleet Data
Road Network
Non-motorized modes networks
Transit Network
LOV Road Network
HOV Road Network
Toll Facilities
Parking Surveys
Traffic Controls
Geometry
Lanes
By network element
Network Vertices
Routes
Transit Segments
P&R lots
Stop/Station Inventory
Frequencies
Fixed Route Itinerary Data
Speeds
Park-and-Ride/Kiss-and-Ride/Formal/ Informal Parking Inventories

# We classified the data side (the means) - We need to classify business processes (the needs) and develop parallel classification using two classification bases

- For selection of the data projects
- For prioritizing data projects
- For establishing periodicity of the data projects



| Example Utilization of Transportation Planning Data by Planning Functions and Applications | Applications | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Transportation System Analysis | Performance Measurement | Transportation Modeling and Forecasting | Transportation Planning | Regional Plans TIP, RTP | Air Quality Modeling and Analysis | Transportation Programming | Regional Coordination |
| Transportation Planning Data Sets | | | | | | | | |
| Traffic: Collected | | | | | | | | |
| Traffic: Projected | | | | | | | | |
| Travel: Collected | | | | | | | | |
| Travel: Projected | | | | | | | | |
| Safety: collected | | | | | | | | |
| Safety: projected | | | | | | | | |
| Socio-Economic & Demographic: Collected | | | | | | | | |
| Socio-Economic & Demographic: Projected | | | | | | | | |
| Land Use: Collected | | | | | | | | |
| Land Use: Projected | | | | | | | | |
| Transportation Infrastructure: Collected | | | | | | | | |
| Transportation Infrastructure: Projected or Programmed | | | | | | | | |
| Environmental: Observed | | | | | | | | |
| Environmental: Projected | | | | | | | | |




Less Frequent Use

# Is this all there is? – Of course not! But it might be just enough if you want to keep it simple.

**Periodicity of the Data Management Tasks and Projects**

MPO Business Processes: Transportation Modeling: Planning Mod

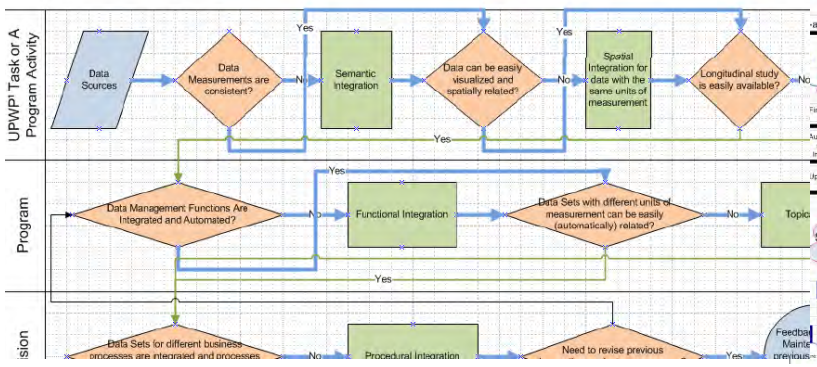
| Data Management Projects | Sub-Model X Estimation | Sub-Model X Re-Calibration | Model Application | Model Development | Mo Valid |
|---|---|---|---|---|---|
| Traffic: Collected: Commercial Speed Data Acquisition | Every 3-5 years or as needed | Every 2-3 years or as needed | Every 2-3 years or as needed | Annual or as needed | Annu ne |
| Traffic: Collected: Volume Counts: Screenlines | Every 3-5 years or as needed | Every 2-3 years or as needed | Every 2-3 years or as needed | Every 5 years or as needed | Annu ne |
| Traffic: Collected: Volume Counts Region-wide | Every 3-5 years or as needed | Ever or | | | |
| Traffic: Collected: Classification Counts: Screenlines | Every 2-3 years or as needed | Ever or | | | |
| Traffic: Collected: Intersection Counts: Region-wide | Every 5 years or as needed | Ever a | | | |
| Traffic: Collected: Bottleneck: Region-wide | Every 5 years or as needed | Ever a | | | |
| Travel: Demand: Household Travel Survey: Region-wide | Every 5 years or as needed | Ever a | | | |
| Travel: Supply: Establishment Travel Survey: Region-wide | Every 5 years or as needed | Ever a | | | |
| Travel: Supply: On-board Survey: Region-wide | Every 3-5 years or as needed | Ever or | | | |

**Estimated Budget of the Data Management Tasks and Projects for Specific Model Requirements**

MPO Business

| Data Management Projects | Model Estimation | M Cal |
|---|---|---|
| Traffic: Collected: Commercial Speed Data Acquisition | | |
| Traffic: Colle Counts: Scre | | |
| Traffic: Colle Counts Regi | | |
| Traffic: Colle Counts: Scre | | |
| Traffic: Colle Counts: Regi | | |
| Traffic: Colle Region-wide | | |
| Travel: Dema | | |

Example Urban Data Integration Framework for Regional Planning Agencies




3rd TRB Innovations in Travel Modeling Conference – May 10-12, 2010, Tempe, Arizona, USA

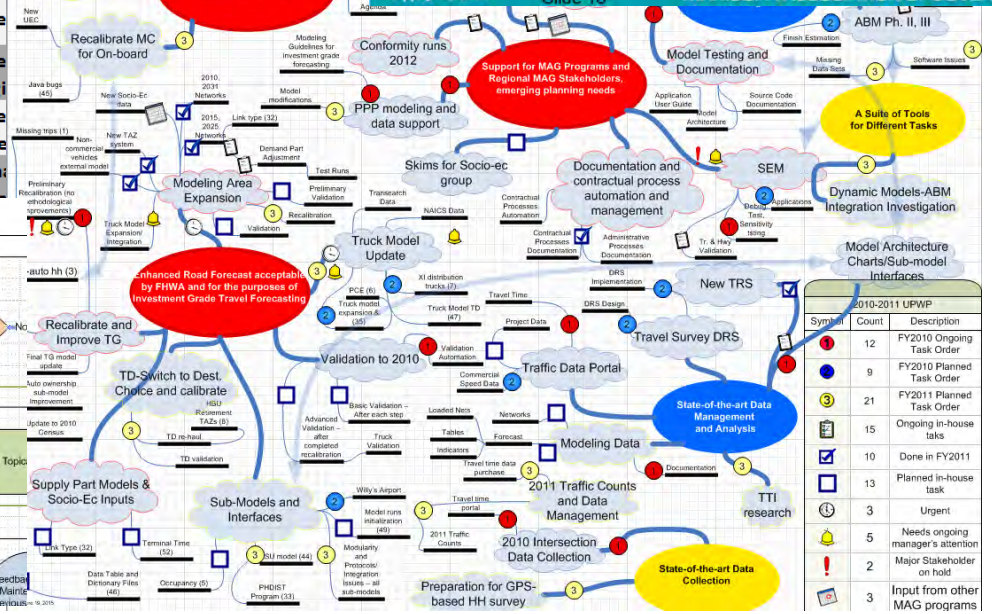
**Data Collection and Management Innovation Decision Matrix**

| | Threats | Opportunities |
|---|---|---|
| Strengths | Urgent Not Important e.g. innovative capitalization on another ongoing project where the need can be addressed with traditional tools as well | Not Urgent Not Important e.g. opportunity to improve data disposal |
| Weaknesses | Urgent Important e.g. innovative approach to address unmet data needs from a major project or stakeholder | Not Urgent Important Best Time to introduce innovations |

- data collection
- data acquisition
- data analysis
- data storage
- data security
- data retrieval
- data access and dissemination
- data archiving
- data disposal

Arrows indicate results of example project level decisions on data management innovations

Copyright © 2010 Slide 18 MARICOPA ASSOCIATION OF GOVERNMENTS

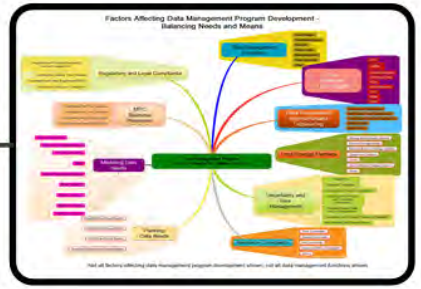


START Data Management Program Development

Identify and Classify Factors Affecting Data Management Program

Federal, State and Local laws and regulations, Internal Policies

Requests from Key Stakeholders, Internal Key Planning Studies

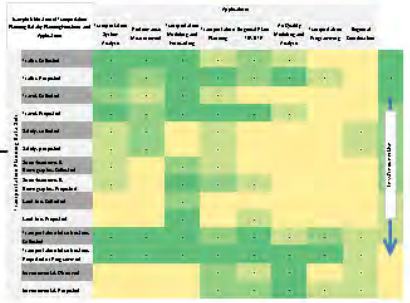


Classify Data, Data Management Activities and Organizational Business Processes

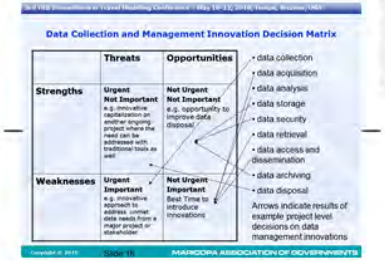
Example Critical Projects and Processes

- RTP
- TIP
- AQ Conformity Analysis
- FTA New/Small Starts Applications
- Federal Grants

Identify Critical Business Processes and Applications



Identify Critical Data Management Activities




Resources Sufficient?

NO

Ask for more

Yes

Address more "needs"?

Yes

Identify Not Urgent but Important Data Needs and add corresponding activities to the program

Resources Sufficient?

YES

NO

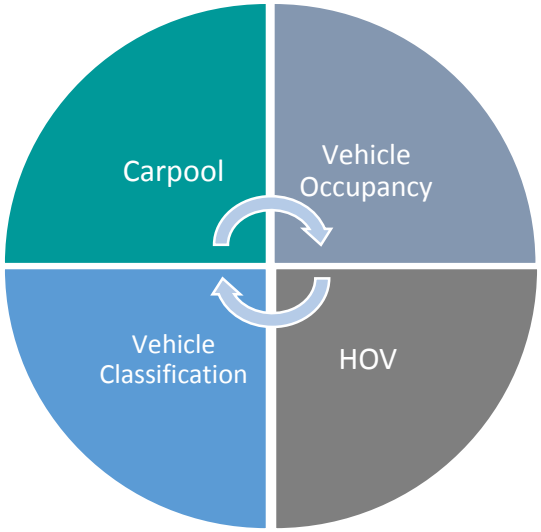
NO

PROCEED with Data Management Program Implementation

# Presentation 2

## Implementation of a Hybrid Data Collection Approach in the 2012 MAG Occupancy Study

Wang Zhang, MAG

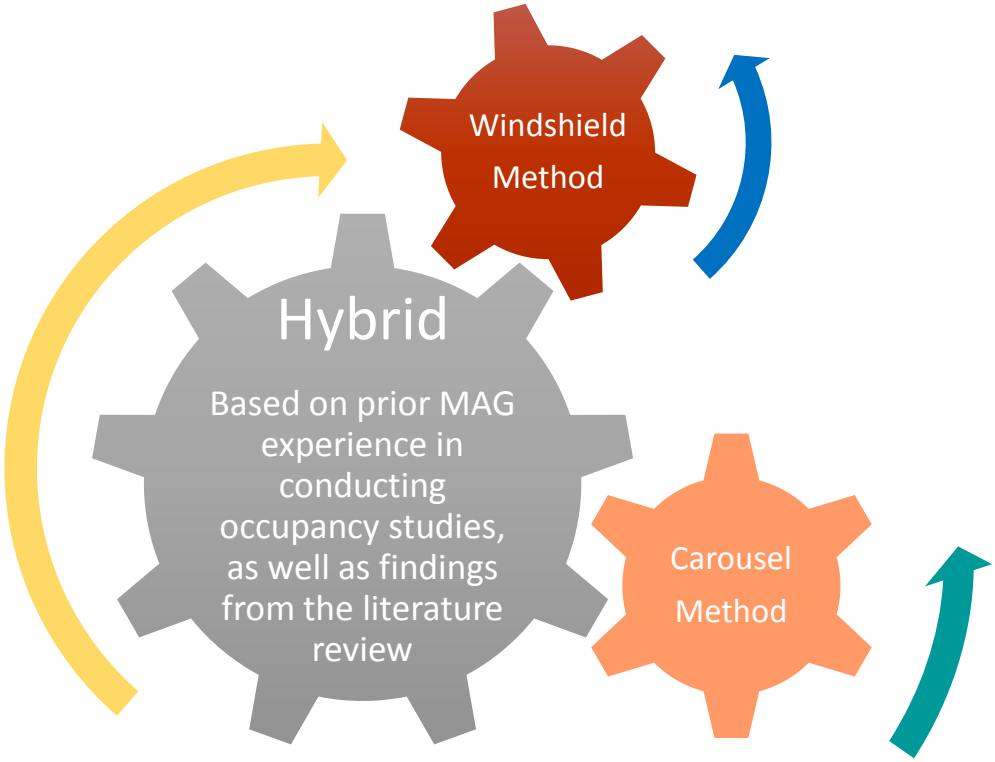



Acknowledgement:

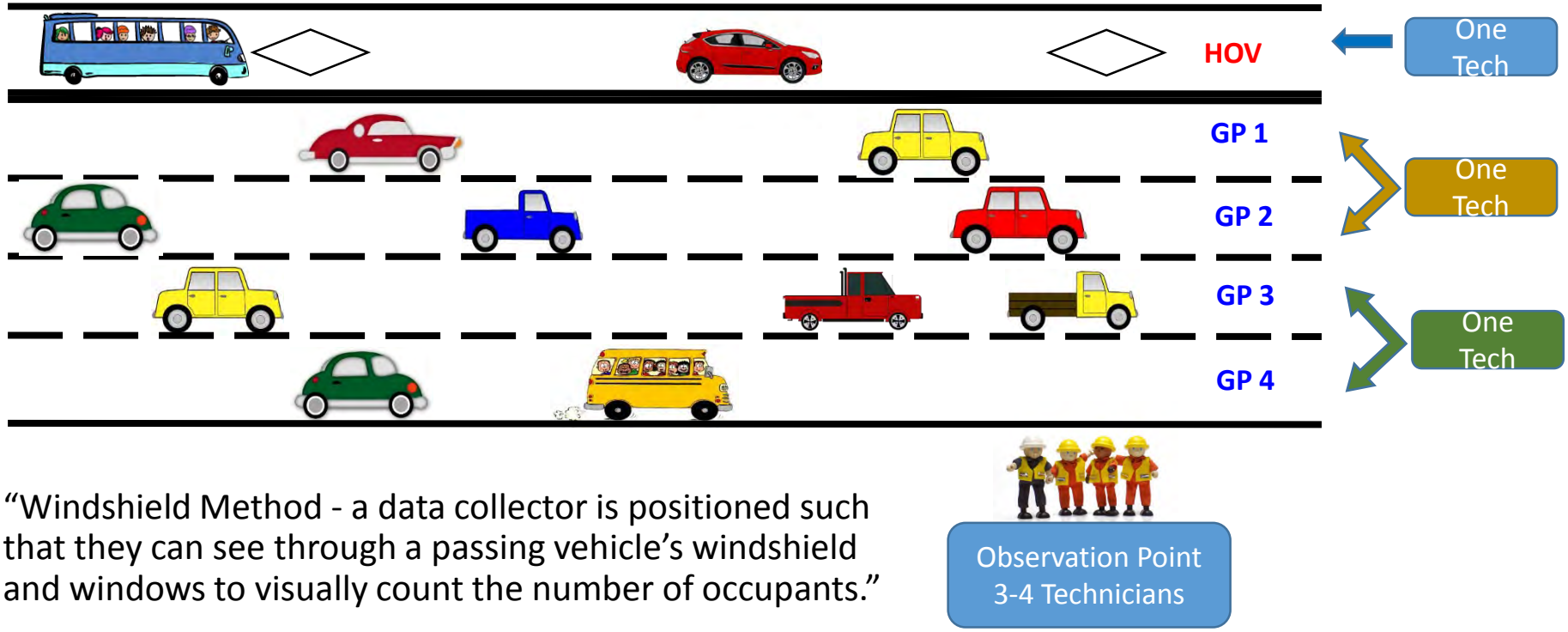
Consultant: CK Group, Inc., PM Mohammad Rehman

Sub-Consultant: Traffic Analysis and Research, Inc., PM Robert Medland

# Occupancy Survey - Hybrid Method



# Windshield Method




"Windshield Method - a data collector is positioned such that they can see through a passing vehicle's windshield and windows to visually count the number of occupants."

# Windshield Method Equipment

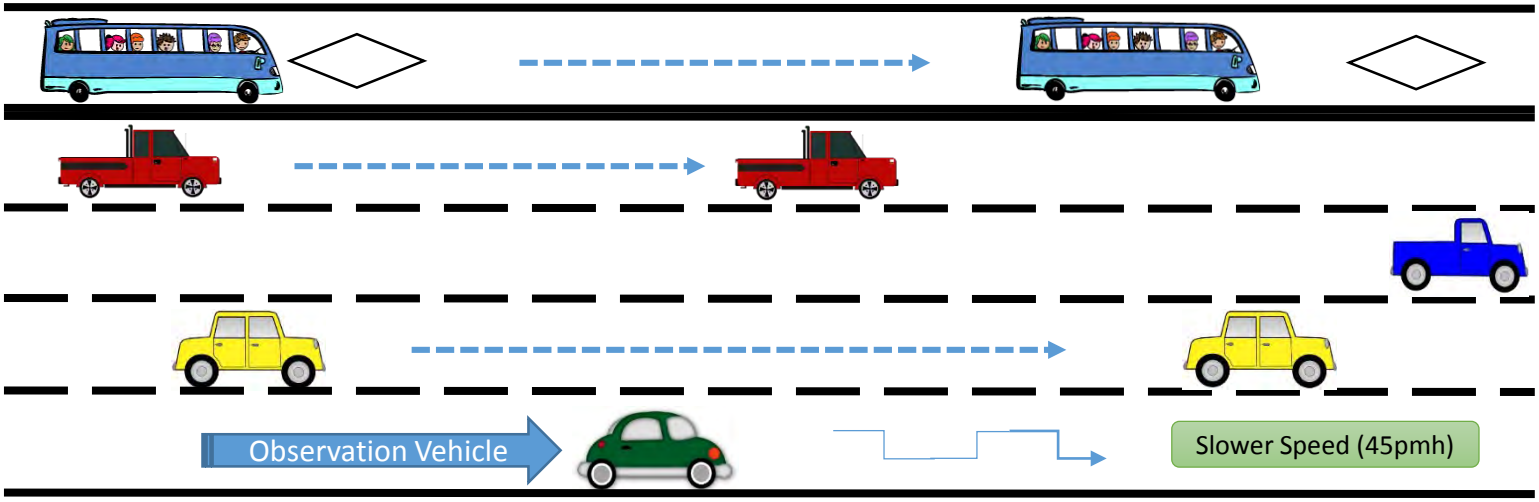
13 Categories of Vehicle Occupancy and Classification

- One person auto (Passenger Vehicle)
- Two person auto (Passenger Vehicle)
- Three person auto (Passenger Vehicle)
- Four and four plus person auto (Passenger Vehicle)
- Unknown occupancy auto (Passenger Vehicle)
- Unknown 2+ occupancy auto (Passenger Vehicle)
- Motorcycles (Motorcycle)
- Marked autos and light trucks (business related) (Delivery Vehicle)
- Medium trucks (single-unit trucks) (Delivery Vehicle)
- Heavy trucks (multi-unit trucks) (Heavy Vehicle)
- Commercial passenger vans (Other)
- Recreational vehicles (RV) (Other)
- Buses (Bus)


Ergonomically designed counter board for windshield method

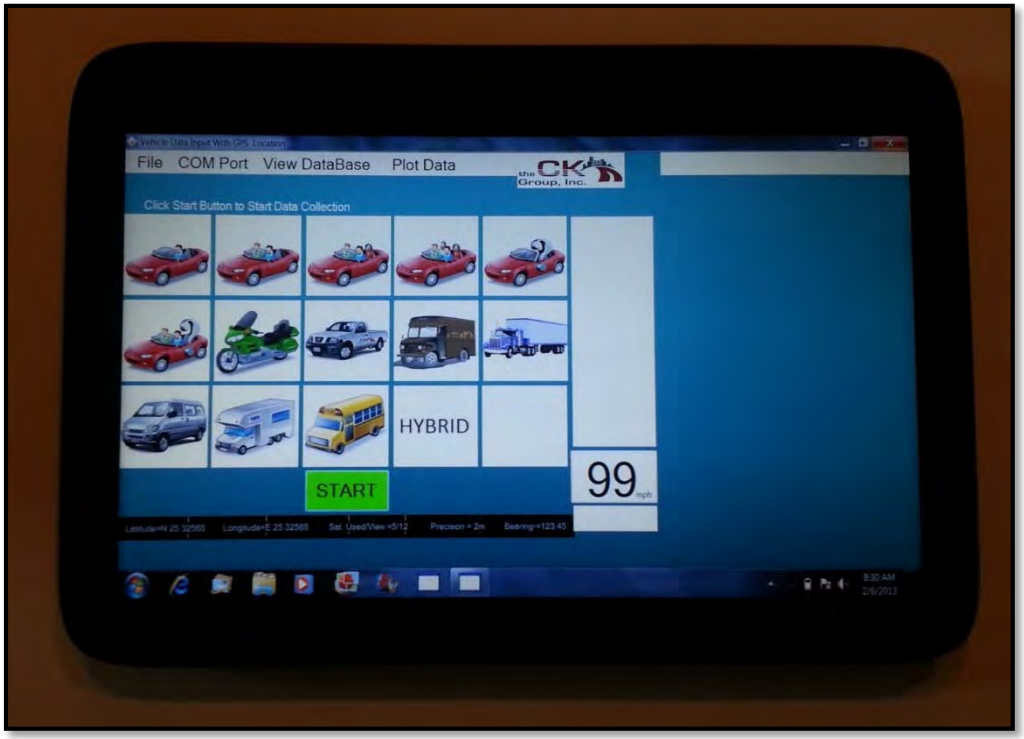
# Carousel Method

- Definition: Observers travel at slower than prevailing speeds on multi-lane highways and collect occupancy data from passing vehicles.
- Developed an application to collect the occupancy data using GPS-enabled pad.



# Data Collection Device - Carousel Method

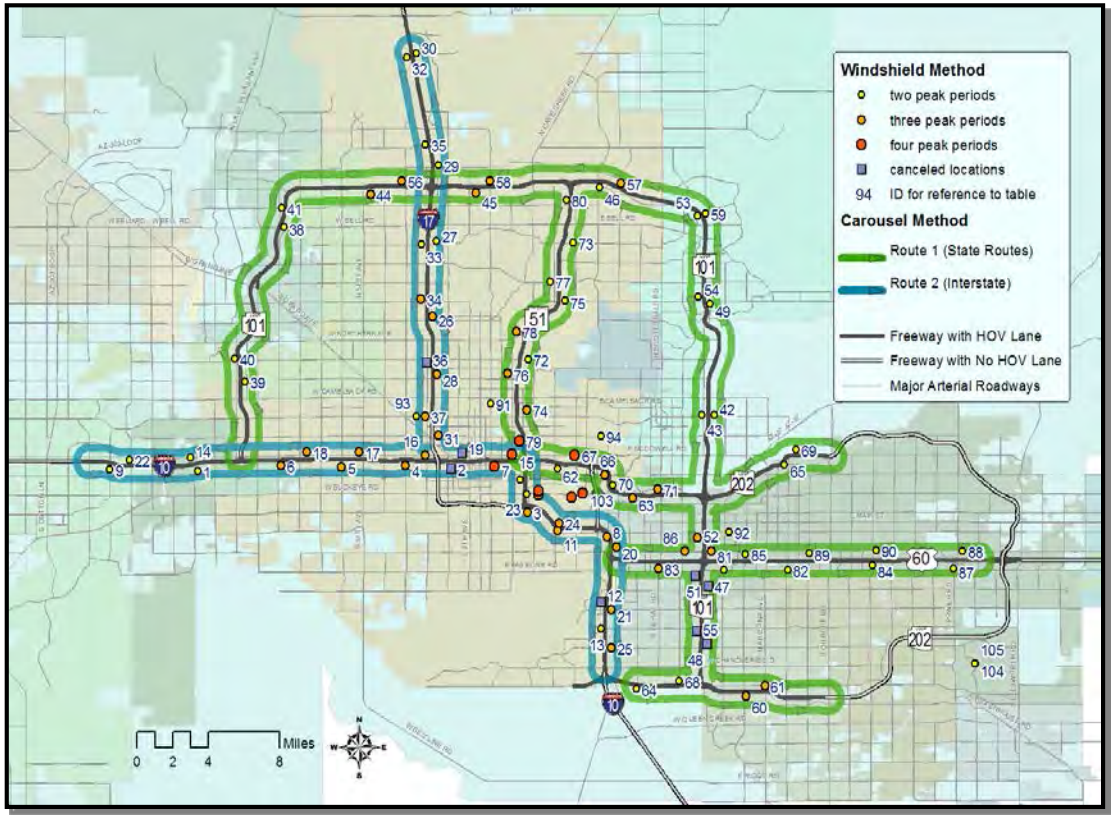
- Pad-based app with external GPS unit
- Recording on the go:
  - Vehicle Occupancy
  - Vehicle Type
  - Latitude/longitude
  - Time
  - Speed
- Two technicians in one car



# Location and Route – Hybrid Method

- Windshield – 88 locations
- AM and PM Peaks (HOV hours)
- Late spring and early fall (subject to sunrise and sunset time)
- Achieving 99% confidence level within ±0.5% confidence interval.

- Carousel - two routes:
  - Interstate freeways
  - Regional freeways
- Mid-day only (9am to 3pm);
- 10 runs (10 days). Each segment is surveyed 6 - 8 times in average.
- Achieving 95% confidence level within ±7.5% confidence interval.



# Pros and Cons – Windshield Method

## Pros

- Complete coverage - comprehensive temporal and spatial coverage
- Lane specific data
- Minimum equipment requirement
- Observation period – good for both peak and non-peak hours
- More effective when traffic is at lower speeds

## Cons

- Labor intensive, and extensive training required
- Limited observation time to observe occupancy under high speeds and/or high volumes condition
- Excessive observation distance may impede capability to accurately identify occupants in the HOV lane
- Conspicuous to travelling public and potential safety protocol violations to freeway traffic
- Weather exposure and human fatigue issue
- Always slightly under-count vehicle occupancy

# Pros and Cons – Carousel Method

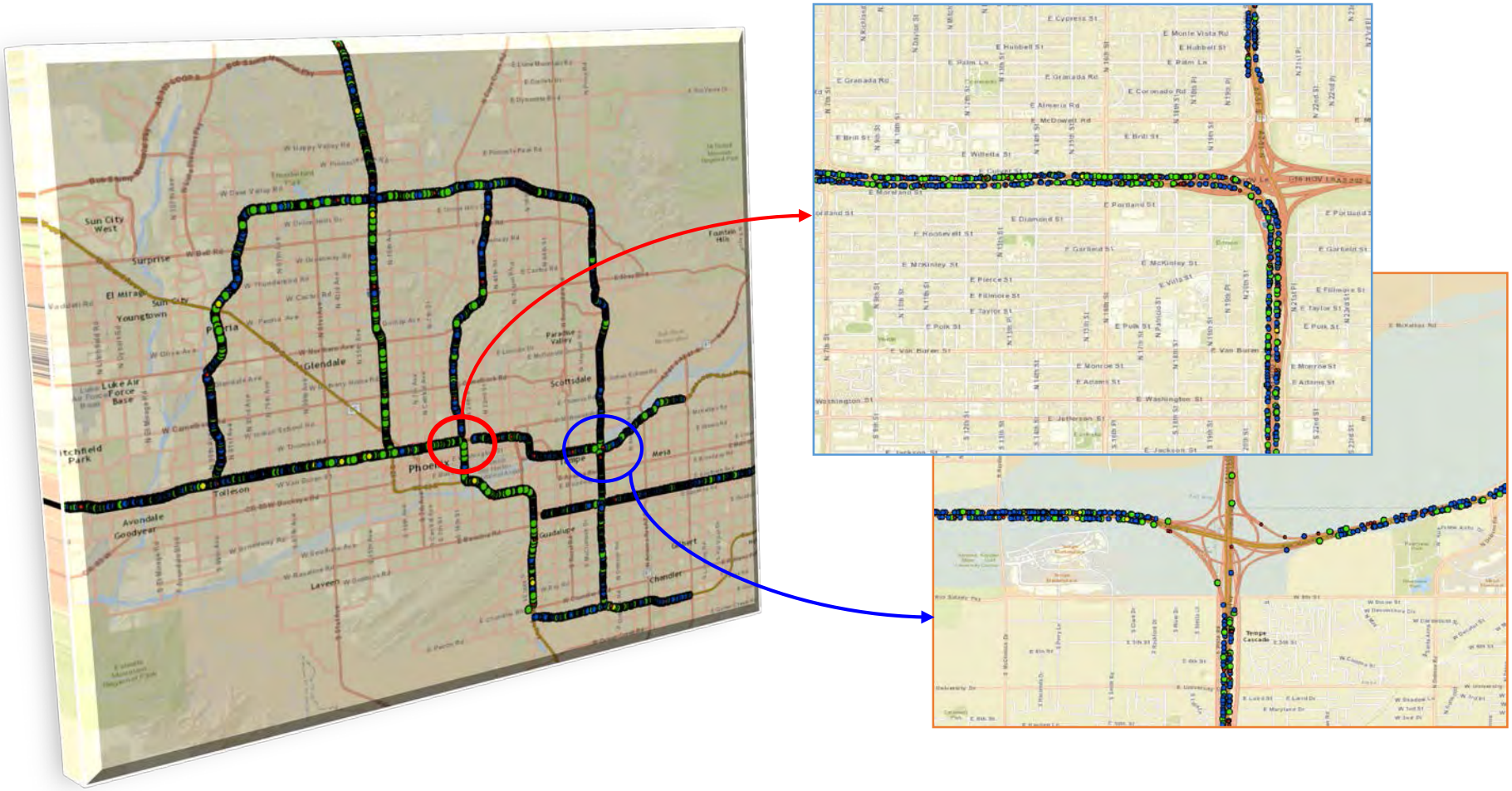
## Pros

- Ideal observation position and adequate observation period
- Flexible and efficient coverage, spatially and temporally
- Less labor force required
- Safe and inconspicuous to travelling public
- Ideal for survey on multi-lane facilities under non-peak hours

## Cons

- Fewer vehicles observed
- Does not work in congested traffic where the observation vehicle cannot reasonably go slower than adjacent traffic. Or it may lead to the same vehicles being counted multiple times
- Observer motion sickness

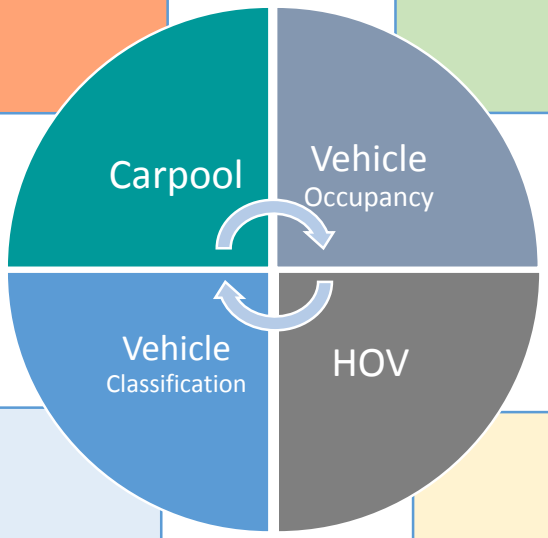
# Data Processing – Carousel Method



# Data Analysis

- Percentage of traveler and vehicle by occupancy
- Carpool Characteristics

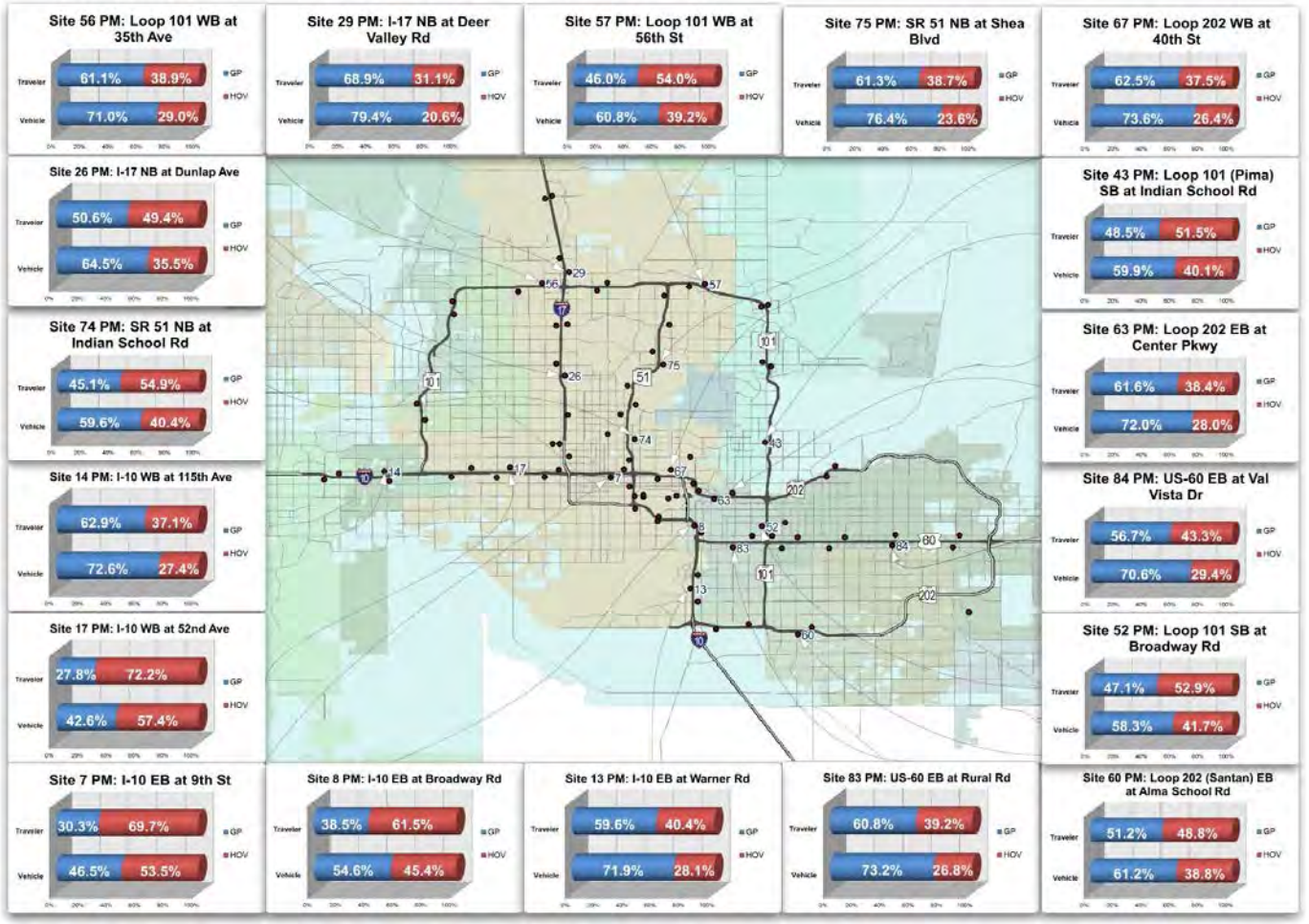
- Auto and Vehicle Occupancy
- By location, by time, and by functional class
- Occupancy trend (compared to historical data)



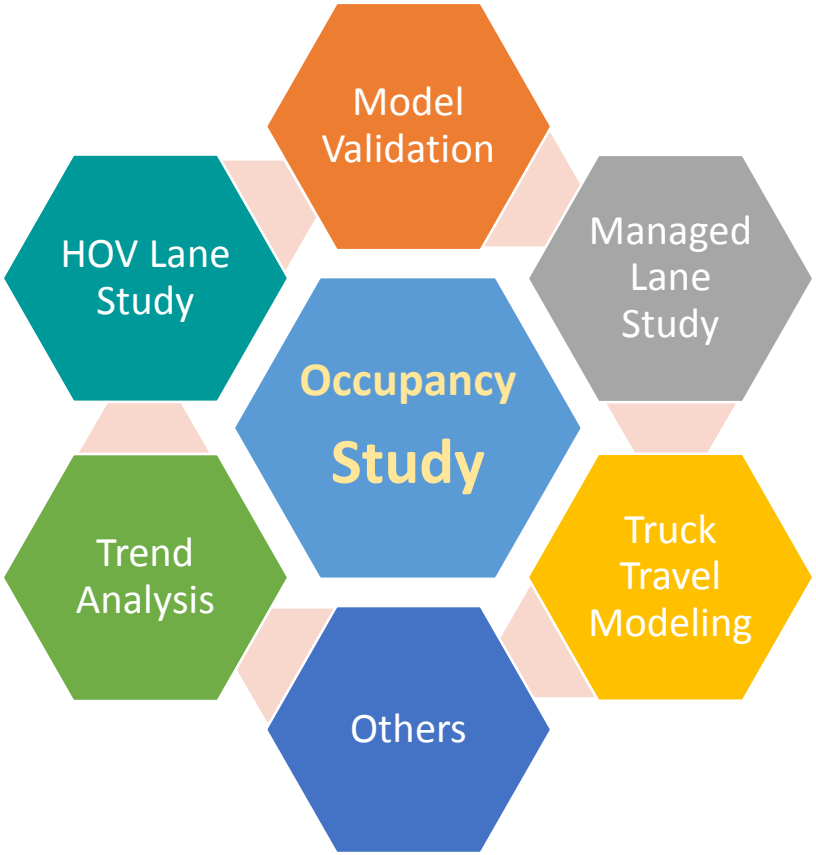

- Vehicle classification
- Commercial vehicle distribution

- HOV efficiency
- HOV violation
- Blue-Sky license plate vehicle

# HOV Efficiency




- Vehicle and Traveler throughput comparison between a GP lane (blue) and HOV lane (red)
- Interstate freeway's HOV is highly utilized while regional freeway's HOV is under-utilized.


Model Validation
HOV Lane Study
Managed Lane Study
Occupancy Study
Trend Analysis
Truck Travel Modeling
Others

# Presentation 3

# Review of Freight Data Sources for the Development of a Behavior-Based Freight Model

Sreevatsa Nippani, MAG

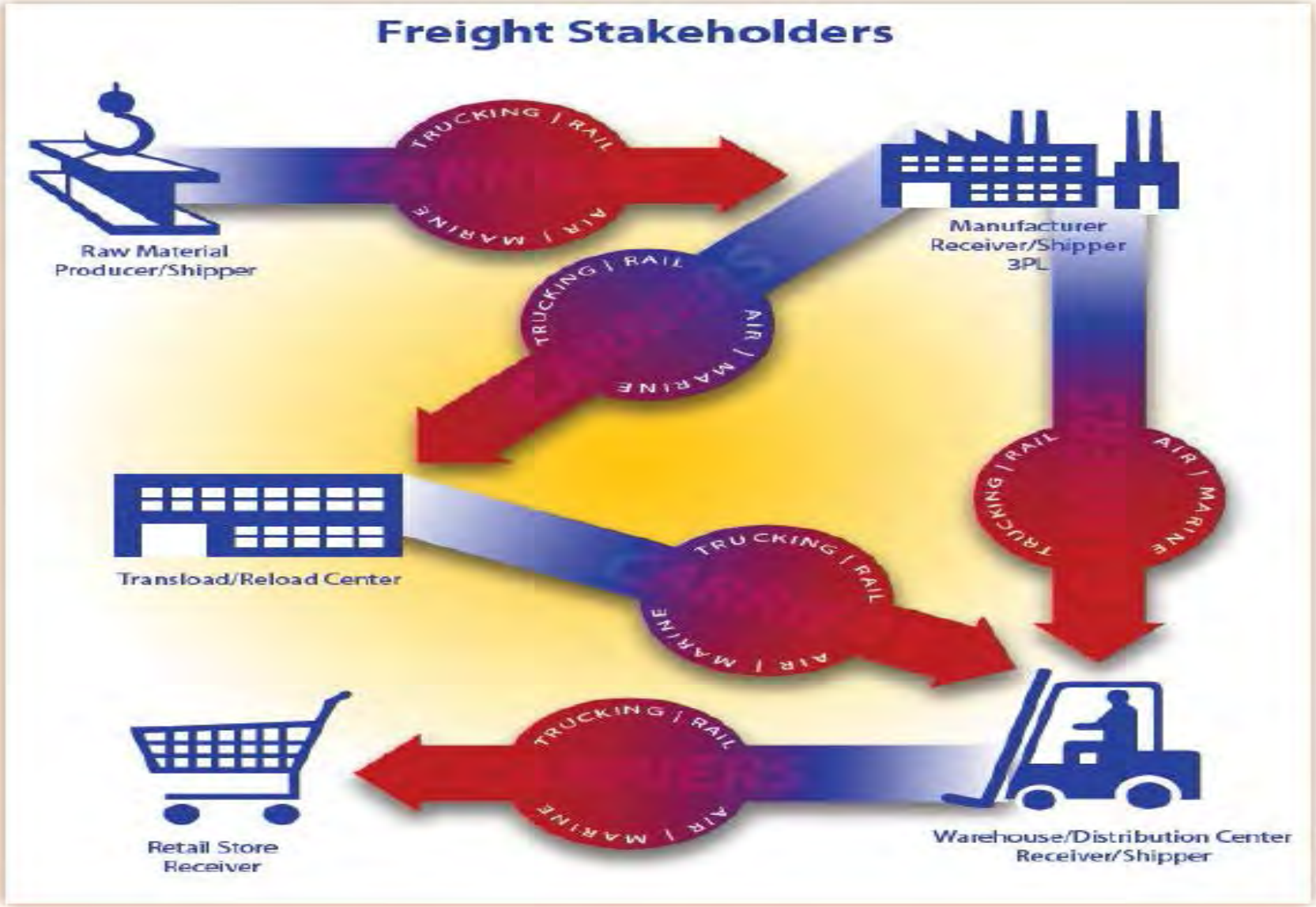
Krishnan Viswanathan, CDM Smith

# Introduction

- Successful joint application from ADOT, MAG and PAG for the SHRP2 C20 IAP Grant for the behavior based freight model development
- New modeling framework is envisioned to capture behavioral aspects of freight agents
- Captures Supply Chain and Logistics decisions of Firms including Shippers, Carriers and Receivers
- Framework is envisioned to include Input-Output flow, Firm Synthesis, Supply Chain and Logistics, Truck Tour and other sub-models; a multi-disciplinary effort
- Overall model should provide detailed outputs by economic sectors, industry class, temporal resolutions, etc.

# Data Needs

- Robust Freight Data is needed to build such models
- Capturing a range of Freight Movements, Supply Chain Related Choices for different commodities, types and size of firms, transportation modes, etc.
- Primary and Secondary Data Sources
- Primary – ATRI, TRANSEARCH, NETS, etc.
- Secondary – BEA I/O tables, FAF, LBD, CBP, etc.




Supply Chain Network - Arizona DOT, Multi Modal Freight Analysis Study (2008)

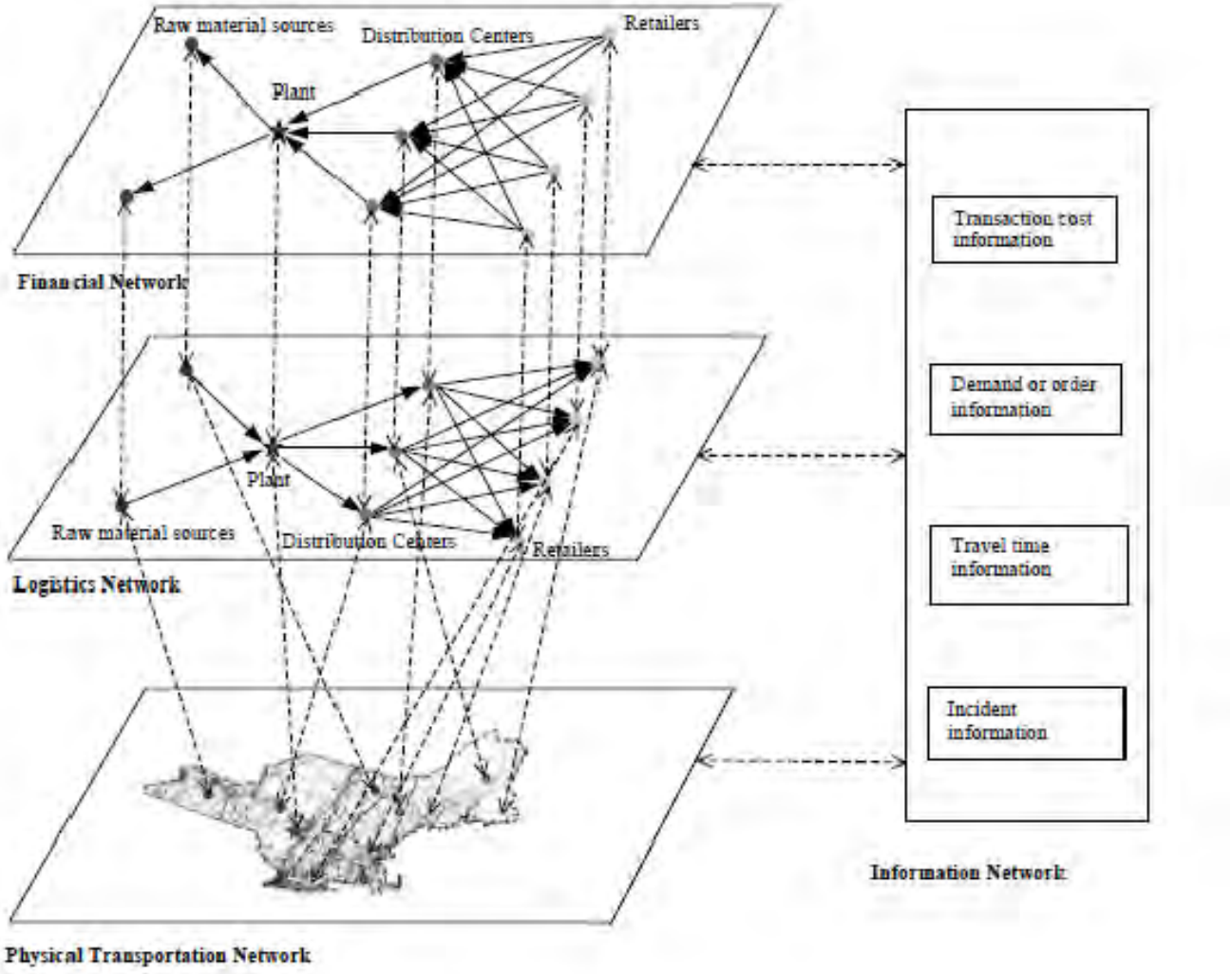
# Freight Models with Supply Chain Components

- Definition of Supply Chain: *"The network created amongst different companies producing, handling and/or distributing a specific product".*

  *(Source: Investopedia.com)*

- Logistics refers to "*the management of the way resources are obtained, stored and moved to the locations where they are required*".

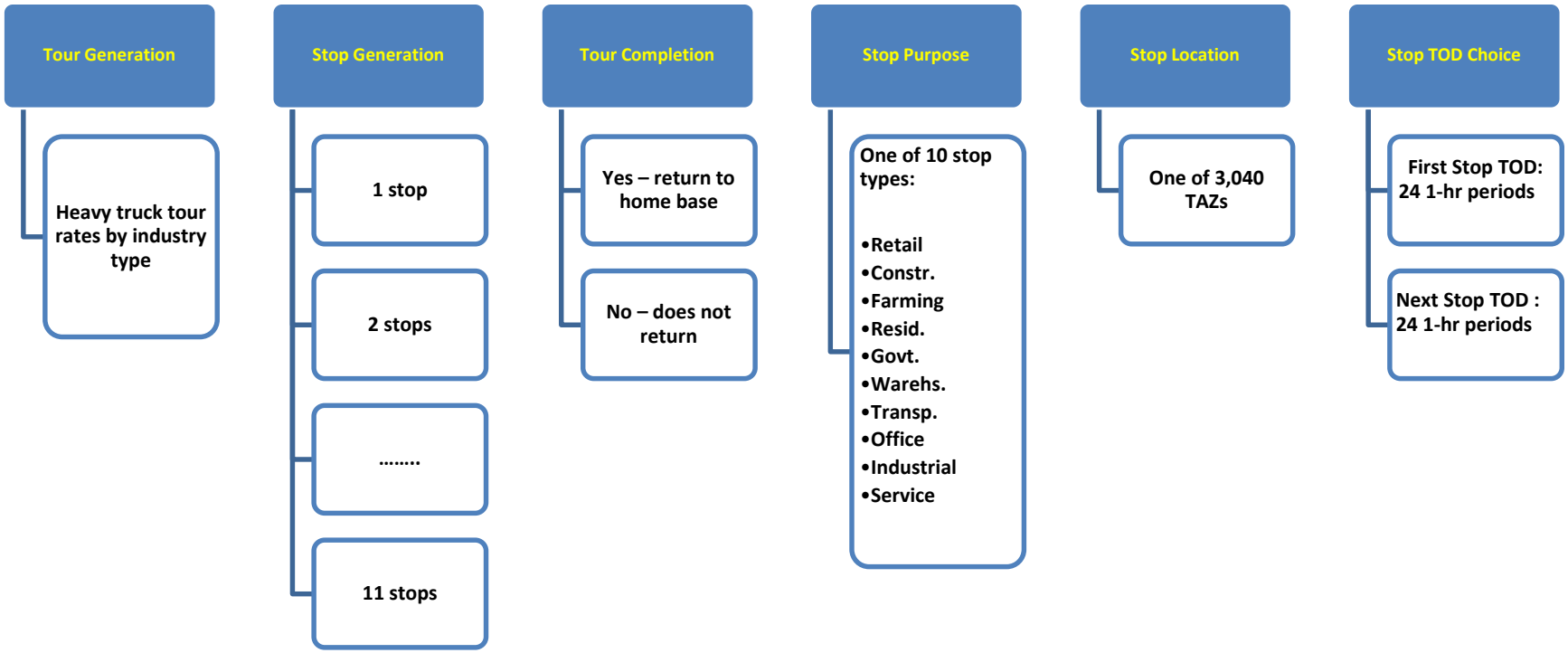
  *(Source: Investopedia.com)*




## Three Main Layers in the Proposed Model

Source: Xu, J., K. L. Hancock, and F. Southworth. "Simulation of Regional Freight Movement with Trade and Transportation Multi-networks", TRR 1854, 2003

# Truck Tour-Based Model Structure (MAG Tour-Based Truck Model)




Courtesy: CSI

# Task Order Scope

- Data integration is one of the main challenges in developing a Behavior-based Freight Model
- Lack of research → Lack of modeling tools to assist policy makers
- MAG's Consultant worked with MAG Modeling team to understand data requirements for the model
- Consultant identified advantages and deficiencies of each dataset
- Consultant recommended datasets appropriate for each sub-model

# Task Order Approach

- The main challenge - data sources are fragmented and incompatible (example, STCC vs. SCTG)
- Review of data sources leading to classification into major groups
- Data was organized as part of the model structure
  - Firm Synthesis
  - Logistics Chain
  - Transportation Chain
  - Truck Touring Models
- Data collection for deployment in model estimation, calibration and/or validation phase

# Some Definitions

- **Trade Statistics** – Statistics studying the quantitative patterns of mass phenomena in commodity circulation, patterns that characterize the movement of consumer goods from the production to the consumption sphere.
- **National Account Data** - National accounts broadly present output, expenditure, and income activities of the economic actors (households, corporations, government) in an economy
- **Transportation Statistics** - Provides information about movement of goods and people by mode and between origin/destination pairs
- **Shipper surveys** - Survey of shippers to determine the decisions made to move goods from one place to another
- **Consignment Bills and RFID data** - Helps determine the type of commodity that is being carried
- **Terminal data** - Information about ports, intermodal facilities etc. which help determine the transportation chain

TMIP FMIP
Better Methods. Better Outcomes.

CDM Smith

MARICOPA ASSOCIATION of GOVERNMENTS

# Data Source by Type

| | Data Type | | | | | | | | | | Spatial (Smallest Geography) | Temporal |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Data Source | Trade Statistics | National Account Data | Transportation Statistics | Shipper surveys | Stated preference surveys | Consignment Bills and RFID data | Traffic Count data | Weight Data | Network data with cost functions | Terminal data | | |
| Bureau of Economic Analysis (BEA) Input/Output Tables | | ✓ | | | Project Specific | | | | | | National | Annual |
| County Business Patterns (CBP) | ✓ | | | | | | | | | | County | Annual |
| National Establishment Time-Series (NETS) | ✓ | | | | | | | | | | County | Annual |
| Longitudinal Business Dynamics (LBD) | ✓ | | | | | | | | | | State | Annual |
| Annual Survey of Manufacturers (ASM) | ✓ | | | | | | | | | | State | Annual |
| Business Dynamics Statistics | ✓ | | | | | | | | | | MSA | Annual |
| Business Employment Dynamics | ✓ | | | | | | | | | | County | Quarterly |
| Commodity Flow Survey (CFS) | | | ✓ | ✓ | | | | | | | CSA or MSA | Every 5 years |
| Freight Analysis Framework (FAF) | | | ✓ | | | | | | | | CSA or MSA | Every 5 years |
| Transearch | | | ✓ | | | | | | | | County/TAZ available on demand | Annual |
| Surface Transportation Board (STB) Carload Waybill Sample | | | ✓ | | | | | | | | BEA | Annual |
| Air Carrier Statistics | | | ✓ | | | | | | | | Airport | Monthly |
| North American Transborder Freight Database | | | ✓ | | | | | | | | State and Port of Entry/Exit | Monthly |
| PIERS | | | ✓ | | | ✓ | | | | ✓ | Port | Annual |
| National Highway Planning Network (NHPN) | | | | | | | ✓ | | ✓ | | State | Unknown |
| National Performance Management Research Dataset (NPMRDS) | | | | | | | ✓ | | ✓ | | Traffic Message Channel | Every 5 minutes |
| ATRI | | | | | | | ✓ | | ✓ | | Truck Lat/Long | Second |
| MAG Roadway Network | | | | | | | ✓ | | ✓ | | Unknown | Unknown |
| Vehicle Inventory and Use Survey (VIUS) | | | | | | | | ✓ | | | State | Every 5 years |
| ORNL Rail Network | | | | | | | | | ✓ | | Unknown | Unknown |
| VTRIS | | | | | | | | ✓ | | | Weight Station | Unknown |
| Establishment Surveys | | | ✓ | ✓ | | | | | | | Establishment | Varies by Sponsor |

✓ - Applies

TMIP FMIP
Better Methods. Better Outcomes.

CDM Smith

MARICOPA ASSOCIATION of GOVERNMENTS

# Data Sources by Modeling Needs

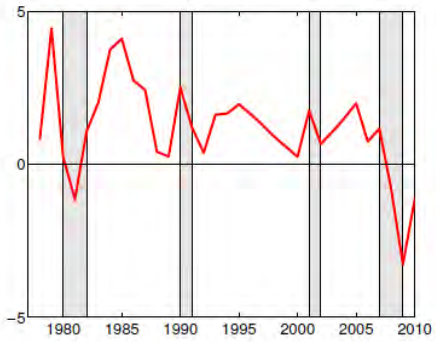
| Data Source | Model | Data Type | Spatial | Temporal | Mode | Commodity | Traffic Count | Data Use | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Estimation | Calibration | Validation |
| Bureau of Economic Analysis (BEA) Input/Output Tables | Firm Synthesis | IO | National | Annual | | | | ✓ | ✓ | ✗ |
| County Business Patterns (CBP) | Firm Synthesis | TS | County | Annual | | | | ✓ | ✓ | ✓ |
| National Establishment Time-Series (NETS) | Firm Synthesis | TS | County | Annual | | | | ✓ | ✓ | ✓ |
| Longitudinal Business Dynamics (LBD) | Firm Synthesis | TS | State | Annual | | | | ✗ | ✗ | ✓ |
| Annual Survey of Manufacturers (ASM) | Firm Synthesis | TS | State | Annual | | | | ✗ | ✗ | ✓ |
| Business Dynamics Statistics | Firm Synthesis | TS | MSA | Annual | | | | ✗ | ✓ | ✓ |
| Business Employment Dynamics | Firm Synthesis | TS | County | Quarterly | | | | ✓ | ✓ | ✓ |
| Commodity Flow Survey (CFS) | Supply Chain | TrS | CSA or MSA | Every 5 years | Truck, Rail, Air, Water, Pipeline, Other | SCTG commodities | | ✗ | ✓ | ✓ |
| Freight Analysis Framework (FAF) | Supply Chain | TrS | CSA or MSA | Every 5 years | Truck, Rail, Air, Water, Pipeline, Other | SCTG commodities | | ✓ | ✓ | ✓ |
| Transearch | Supply Chain | TrS | County/TAZ available on demand | Annual | Truck, Rail, Air, Water, Pipeline, Other | STCC commodities | | ✓ | ✓ | ✓ |
| Surface Transportation Board (STB) Carload Waybill Sample | Supply Chain | TrS | BEA | Annual | Rail | STCC commodities | | ✗ | ✓ | ✓ |
| Air Carrier Statistics | Supply Chain | TrS | Airport | Monthly | Air | None | | ✗ | ✓ | ✓ |
| North American Transborder Freight Database | Supply Chain | TrS | State and Port of Entry/Exit | Monthly | Truck, Rail, Air, Water, Pipeline, Other | SITC | Yes | ✗ | ✓ | ✓ |
| PIERS | Supply Chain | TrS | Port | Annual | Water | HS | | ✓ | ✓ | ✓ |
| National Highway Planning Network (NHPN) | Transportation Chain | TC, Net | State | Unknown | | | Yes | ✓ | ✓ | ✓ |
| National Performance Management Research Dataset (NPMRDS) | Truck Touring | TC, Net | Traffic Message Channel | Every 5 minutes | Trucks | Unknown | | ✓ | ✓ | ✓ |
| ATRI | Truck Touring | TC, Net | Truck Lat/Long | Second | Trucks | Unknown | | ✓ | ✓ | ✓ |
| MAG Roadway Network | Transportation Chain | TC, Net | | | | | | | | |
| Vehicle Inventory and Use Survey (VIUS) | Transportation Chain | WD | State | Every 5 years | Freight Trucks and Commercial Vehicles | None | | ✗ | ✓ | ✓ |
| ORNL Rail Network | Transportation Chain | TC, Net | Unknown | Unknown | Rail | | | ✓ | ✓ | ✓ |
| VTRIS | Transportation Chain | WD | Weight Station | Unknown | Freight Trucks and Commercial Vehicles | None | | ✗ | ✓ | ✓ |
| Establishment Surveys | TrS, SS | Establishment | Establishment | Varies by Sponsor | | | | | | |

✓ - Applies ✓ - May apply ✗ - Does not apply

# Firm Synthesis

- Key component of Financial Layer
- Simulation of regional firms by industry and by size
- Data Requirement – Longitudinally linked establishment level database - industrial classification, employee size, ownership structure, legal status, current and previous location, first and last year of business operations, etc.
- Facilitates Establishment Life Cycle Events : Births, Expansion, In-migration, Dissolutions, Contraction and Out-migration

Figure 1: **Percent Change in Number of Firms in the U.S. Economy, 1978-2010**




*Notes:* The figure shows the percentage change in the number of firms in the economy. Gray shaded areas indicate NBER recession episodes. *Source:* Business Dynamics Statistics (BDS).

Table 1: **Number of Firms: 2007-2009**

| Size | (1) Number of Firms 2007 | (2) % Change Number of Firms 2007-2009 |
|---|---|---|
| 1-49 | 5,059,512 | -3.96 |
| 50-499 | 219,845 | -4.98 |
| 500+ | 20,658 | -1.95 |

*Notes:* Number of firms by size class. The first column provides the total number of firms in each firm size class in 2007. The second column provides the percent change in the number of firms between 2007 and 2009 by size class. Source: Business Dynamic Statistics (BDS).

Reference: M. Siemer, "Firm Entry and Employment Dynamics in the Great Recession", Federal Reserve Board (2014)

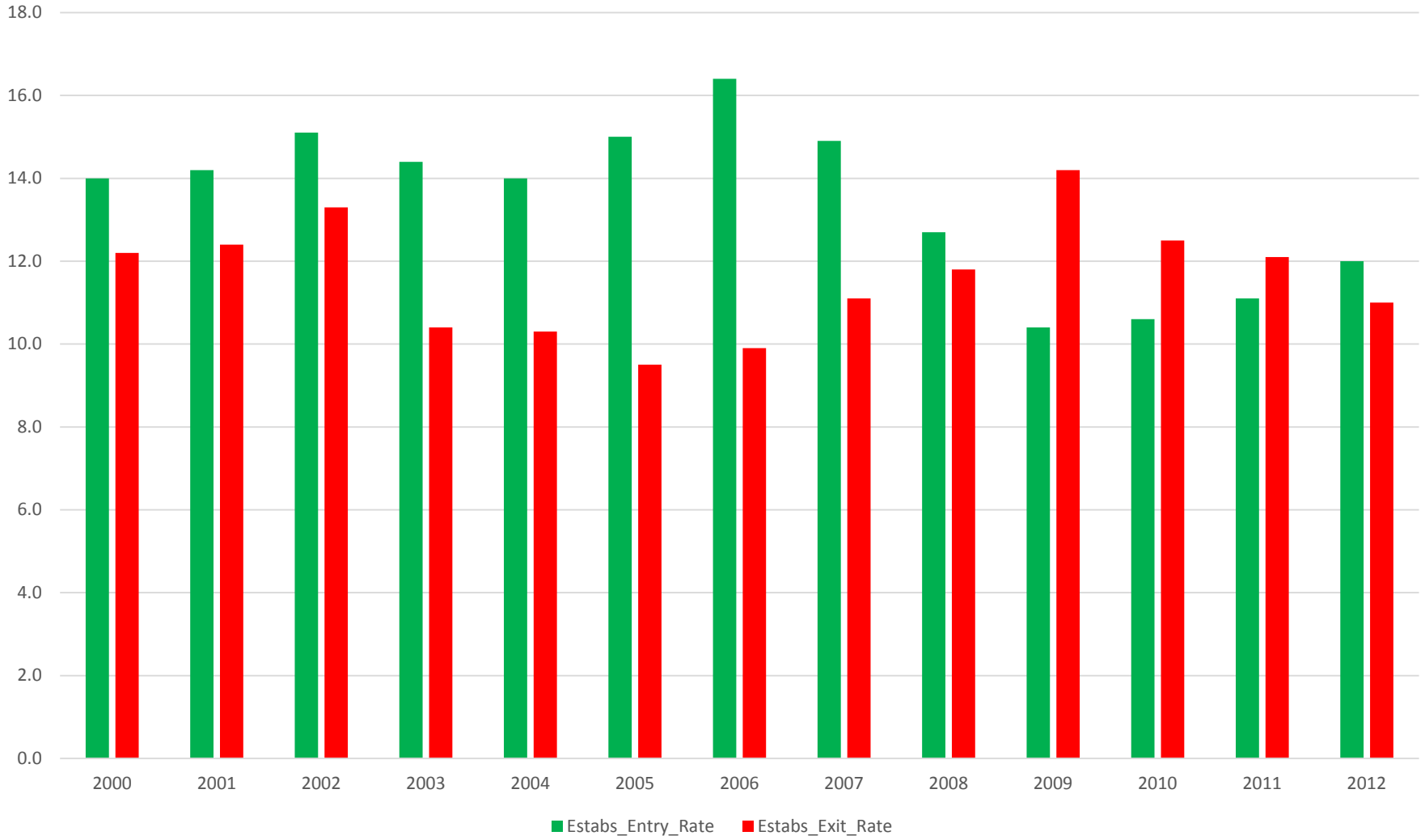
# Firm Synthesis – Diverse Data Sources

- Bureau of Economic Analysis (BEA) Input/Output Tables
- County Business Patterns (CBP)
- Longitudinal Business Dynamics (LBD)
- Annual Survey of Manufacturers (ASM)
- Business Dynamics Statistics (BDS)
- Business Employment Dynamics (BED)
- Statistics of US Businesses (SUSB)
- Non Employer Statistics (NES)
- National Establishment Time-Series (NETS)

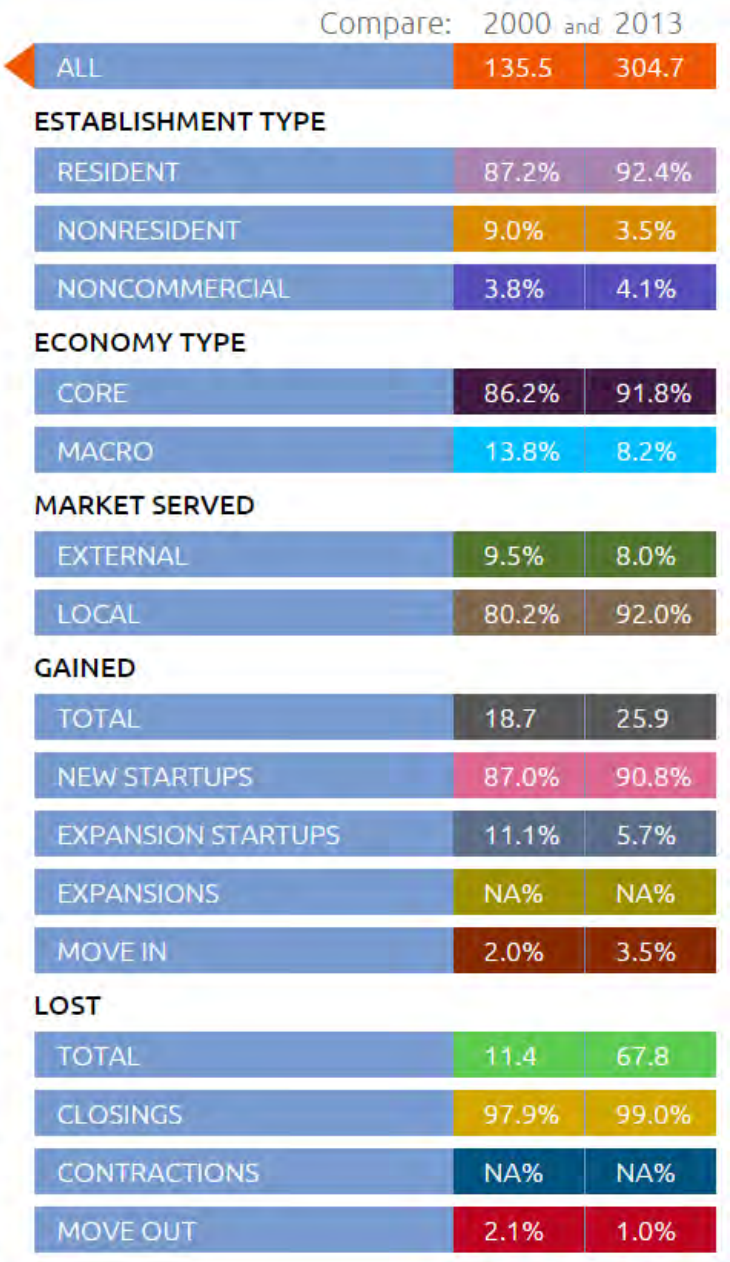
# Data Utility with BEA Input-Output Tables

- Input-Output tables show how industries interact
- These tables provide detailed information on how goods and services explain the production process of industries
- Four types of tables – Make, Use, Direct Requirements, Total Requirements; Matrix of Industries and Commodities
- Make Table – Shows commodities produced by each industry
- Use Table – Shows inputs to industry production and commodities consumed by final users

# Establishment Annual Entry and Exit Rate in Arizona - 2000 to 2012 (Source: LBD)



## NETS Maricopa County



| Compare: | 2000 | and 2013 |
|---|---|---|
| ALL | 135.5 | 304.7 |
| **ESTABLISHMENT TYPE** | | |
| RESIDENT | 87.2% | 92.4% |
| NONRESIDENT | 9.0% | 3.5% |
| NONCOMMERCIAL | 3.8% | 4.1% |
| **ECONOMY TYPE** | | |
| CORE | 86.2% | 91.8% |
| MACRO | 13.8% | 8.2% |
| **MARKET SERVED** | | |
| EXTERNAL | 9.5% | 8.0% |
| LOCAL | 80.2% | 92.0% |
| **GAINED** | | |
| TOTAL | 18.7 | 25.9 |
| NEW STARTUPS | 87.0% | 90.8% |
| EXPANSION STARTUPS | 11.1% | 5.7% |
| EXPANSIONS | NA% | NA% |
| MOVE IN | 2.0% | 3.5% |
| **LOST** | | |
| TOTAL | 11.4 | 67.8 |
| CLOSINGS | 97.9% | 99.0% |
| CONTRACTIONS | NA% | NA% |
| MOVE OUT | 2.1% | 1.0% |

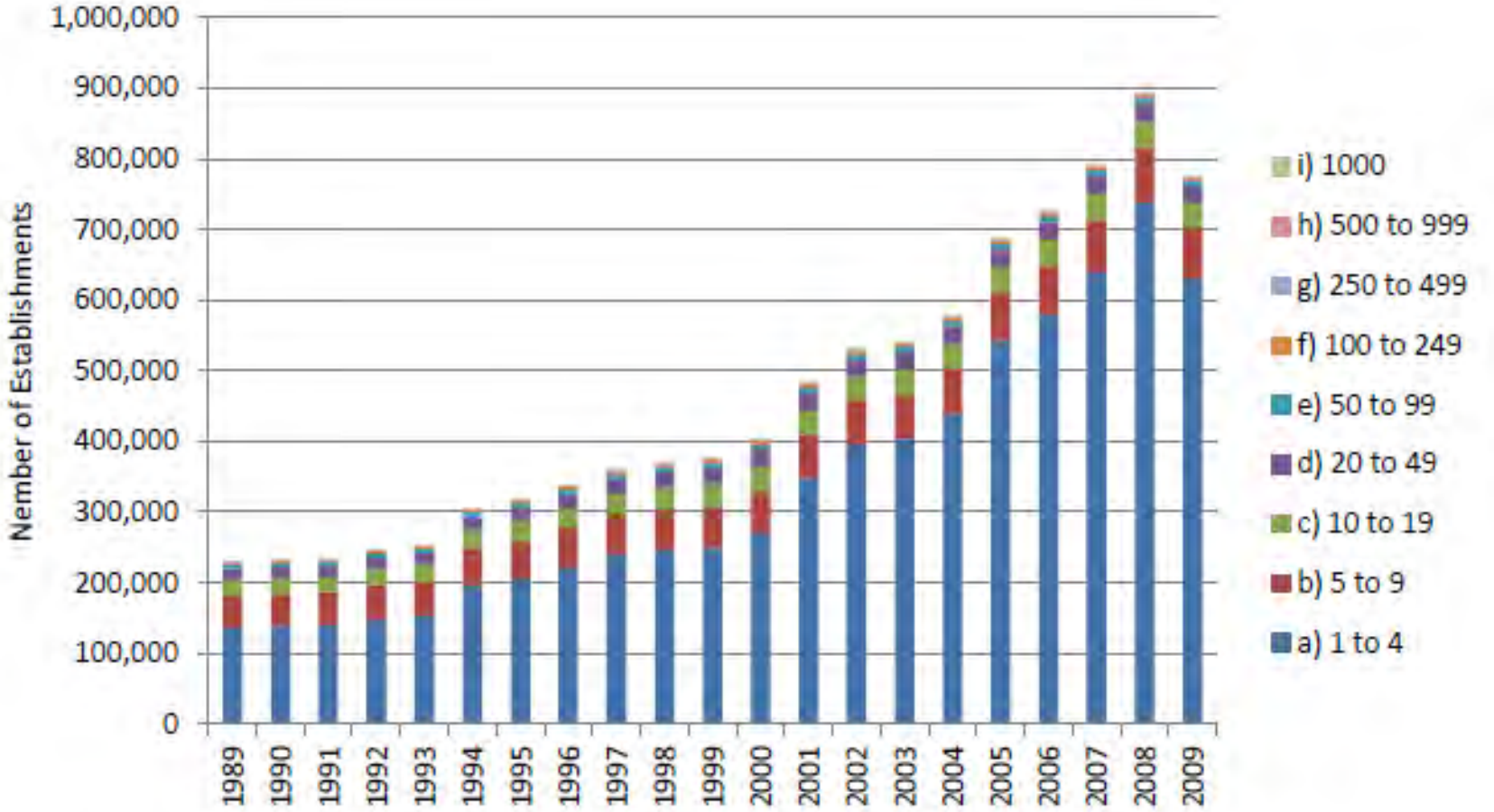
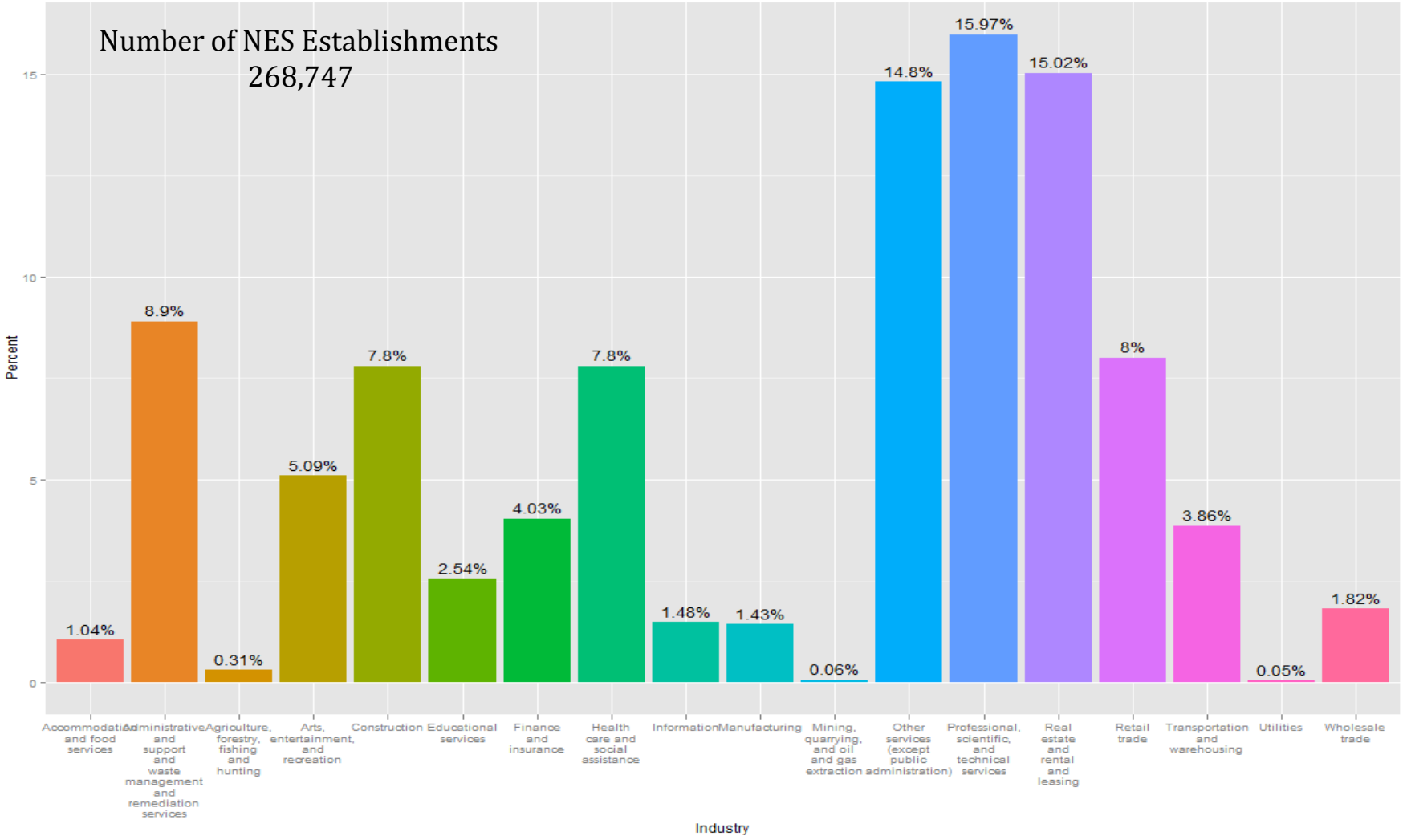



Figure 2: Number of Establishments by Size in Georgia (Excluding Government Sector)
*(Source: NETS and Authors' Calculation)*

Source: Taelim Choi, et. al (2013); Federal Reserve Bank in Georgia

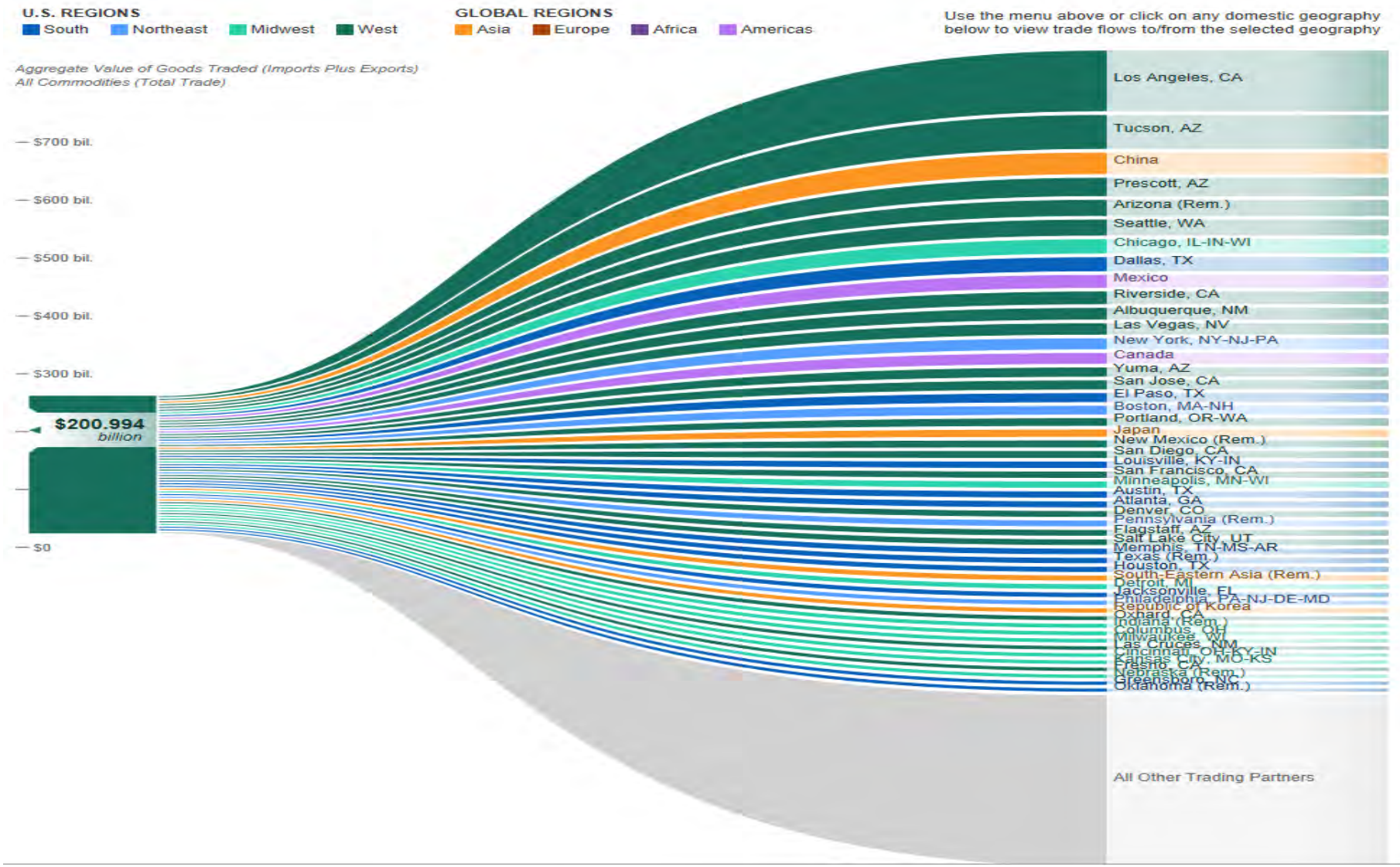
# Non-Employer Statistics



# Logistics Chain Models - Data Sources

- Commodity Flow Survey (CFS)
- Freight Analysis Framework (FAF)
- TRANSEARCH
- Surface Transportation Bureau (STB) Carload Waybill Sample
- Air Carrier Statistics
- North American Trans-Border Freight Database
- Port Import/Export Reporting Service (PIERS)

Trade of All Commodities (Total Trade in 2010) between Phoenix, AZ and Its Largest Trading Partners – Brookings Institution Study



# Transportation Layer - Data Sources

- National Highway Performance Network (NHPN)
- ORNL Rail Network
- Vehicle Inventory and Use Survey (VIUS)
- Vehicle Travel Information System (VTRIS)
- MAG Roadway Network

# Characteristics of the Task Order Effort

- Identified high level categories of data components
- Summaries were developed at County, Regional and State Level
- Urban Freight Data were captured across all Geographic Dimensions:
  a. Neighborhood level - Land Use Data at parcel level
  b. Node level – Rail yards, Intermodal terminals and Warehouses
  c. Networks – Highway and Rail
  d. Flows – Origins/Destinations, Markets, Modes and Gateways

# Characteristics of the Task Order Effort

- Local Characteristics – Unique data for the region is captured including location of freight facilities (MAG and PAG regions)
- Freight Flows into, out of, or through the region are summarized
- Data facilitates tying economic activity to freight flows -Flows can be assigned geographically through an economic I/O model that links commodity flows to land use and employment activity in TAZs
- Truck activity can be modeled with a direct link to the economic activity that creates demand for each commodity

# Summary

- Freight Data are scattered across several business processes; disparate data sources; multi-disciplinary in nature
- Estimation dataset for Firm Synthesis was finalized
- Various data attributes are noted (coverage, limitations, etc.)
- Shipment Cost information for all sectors could not be obtained
- A few data summaries were not shared in the Final Report (Carload Waybill Sample summaries from 2009 to 2040) – data confidentiality

# Summary (continued)

- Data capturing interaction among agents (shippers, receivers, carriers, freight forwarders, etc.) could not be obtained – Either MAG Commercial Establishment Survey or Supply Chain Consortium data may be the alternatives
- Data supporting role of technological innovations in transport and IT on urban goods movement was unavailable

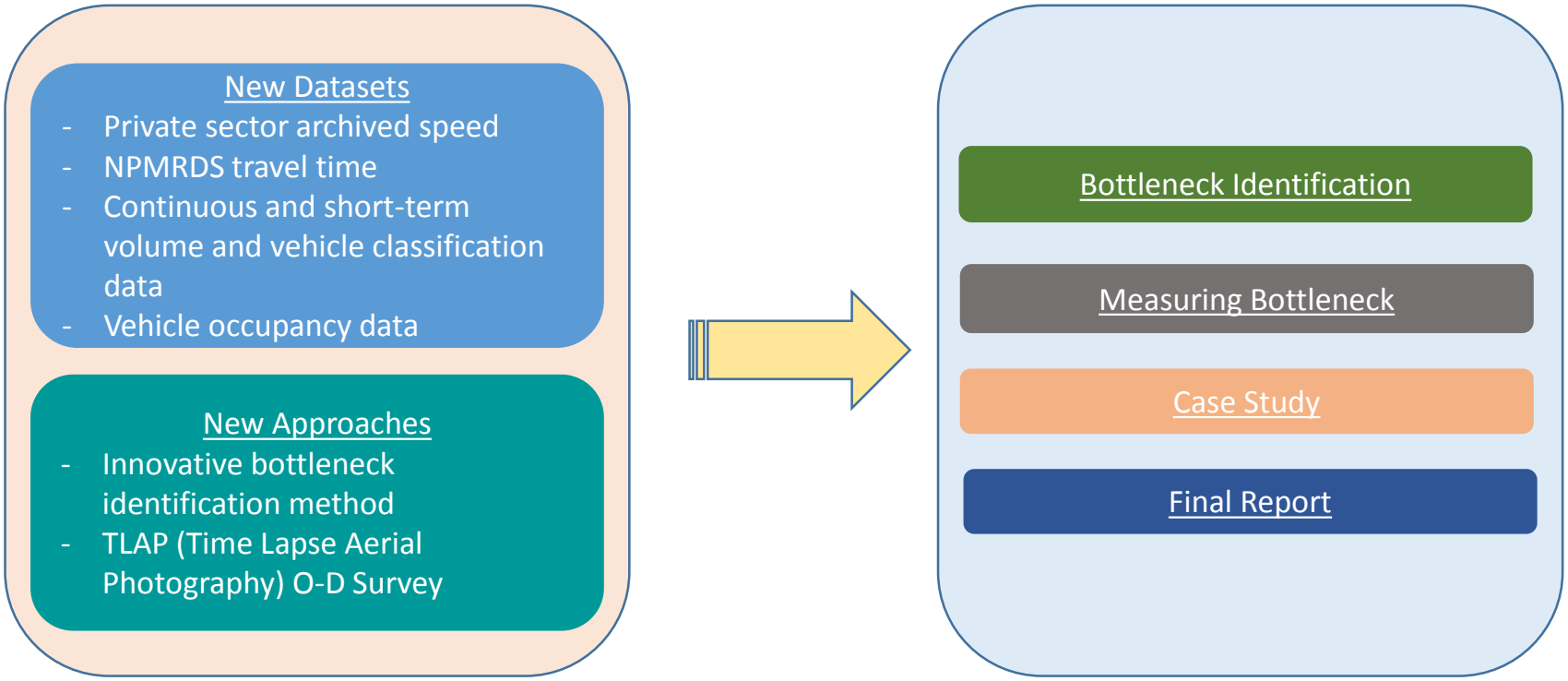
# Presentation 4
# Innovative Data Collection and Analysis for MAG Bottleneck Study

Wang Zhang, MAG
Will Kasper, Skycomp

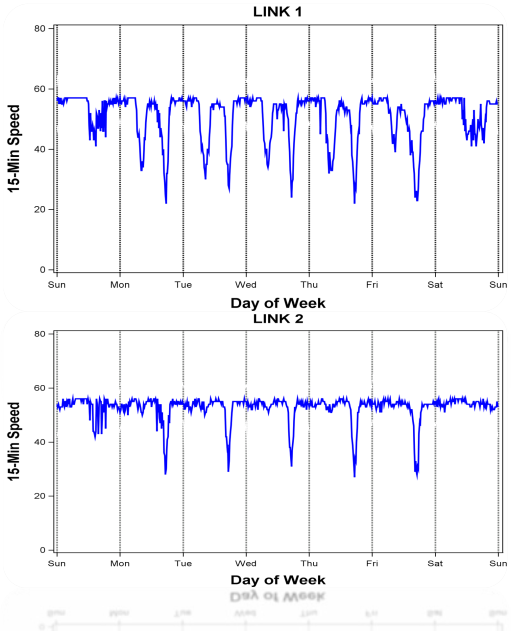
# Need and Purpose

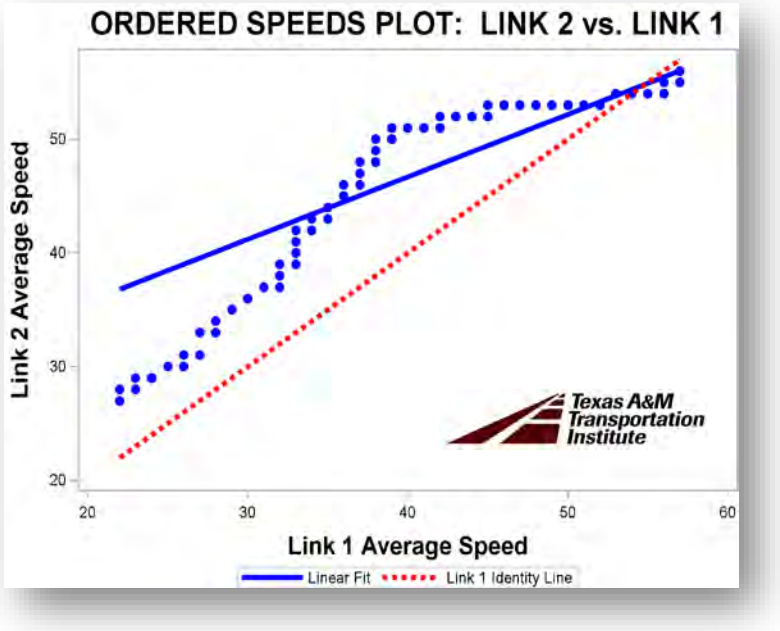
- This study is required to develop planning and operational solutions for mitigating congestion at regional bottlenecks.
- Commercial speed data facilitates a new generation of bottleneck identification and measurement.
- Time-Lapse Aerial Photography (TLAP) survey provides unique insight into origin-destination patterns, vehicle behavior, path choices and vehicle trajectories in bottleneck areas.
- TLAP is the only data source for calibrating vehicle behavior at bottlenecks in the MAG regional micro-simulation model.

# What's New - Bottleneck Study



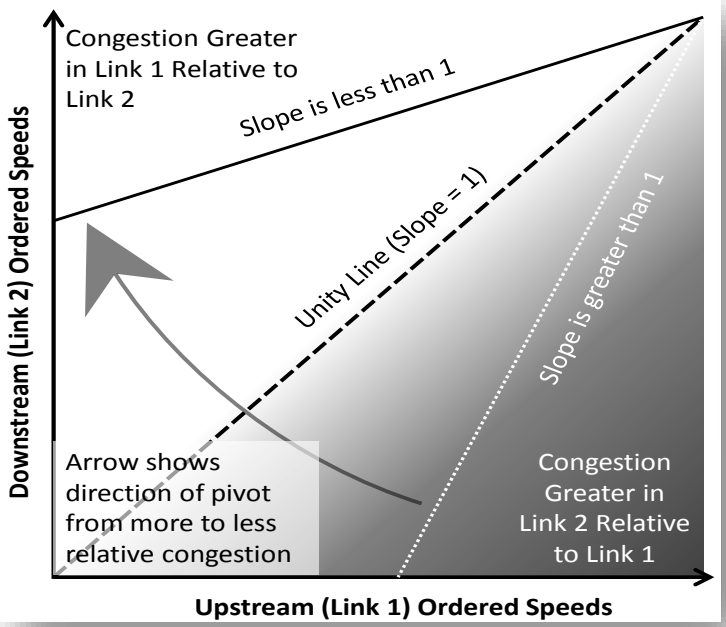
# Bottleneck Identification Algorithm

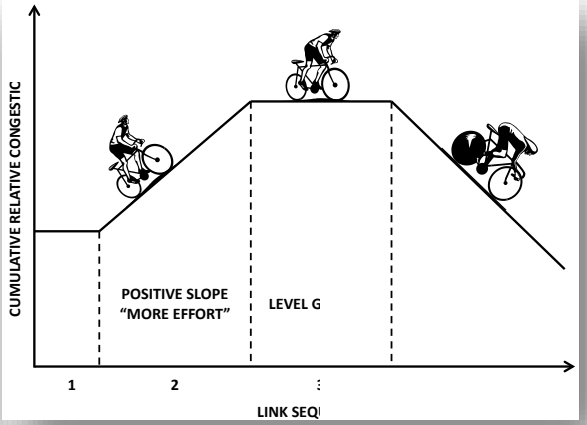



"Auto-Segmentation Method for MAP-21 Performance Measure Reporting Using Large Statewide Speed Datasets, J. Wikander, W. Eisele, D. Shrank, the 93rd TRB Annual Meeting, 2014, Washington, D.C."

# Bottleneck Identification Algorithm



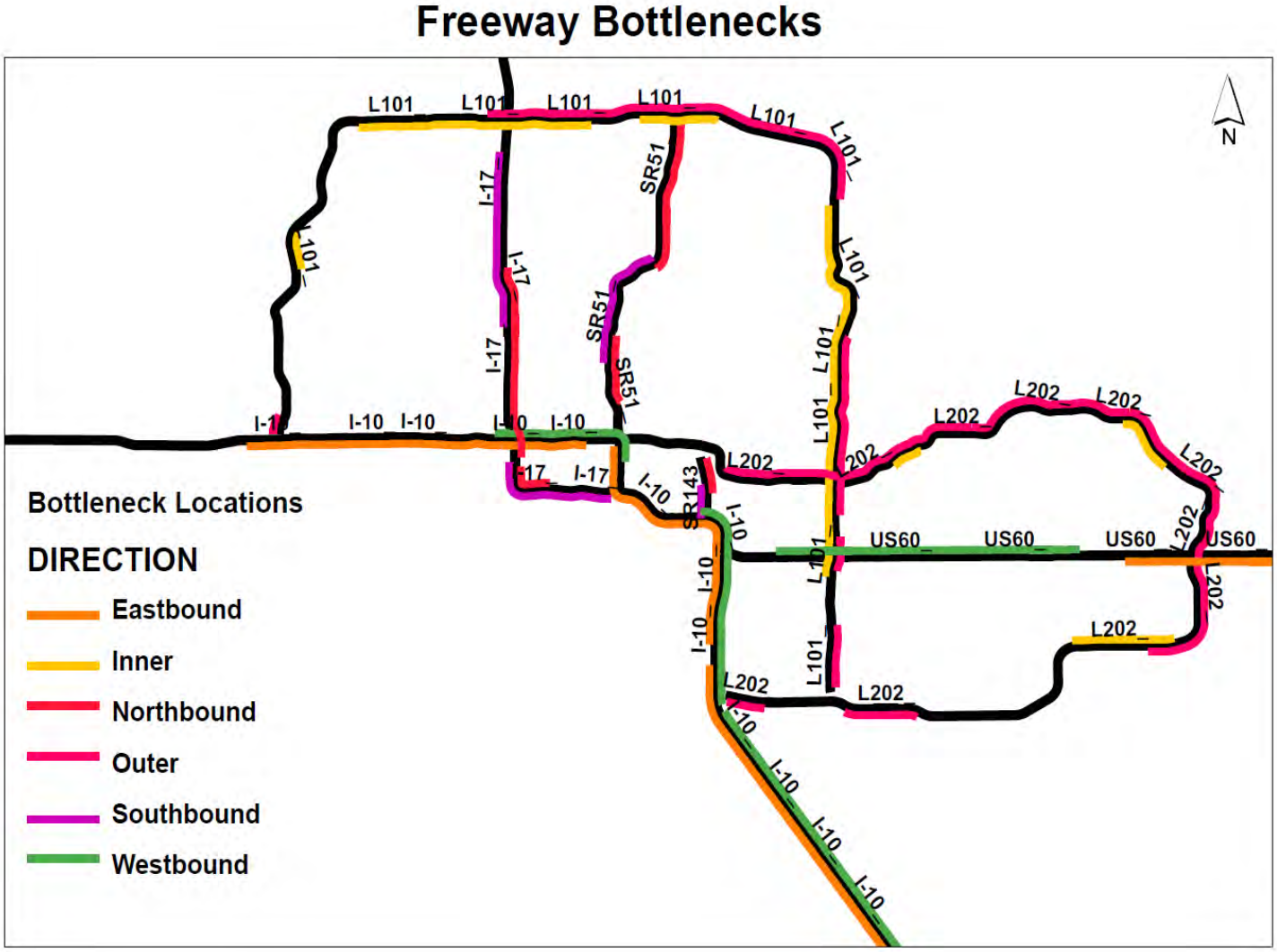




- Slope as relative congestion measure:
- Positive values indicate congestion is going up;
- Negative values indicate congestion is going down; and
- Zero values indicate no change, or "level ground."

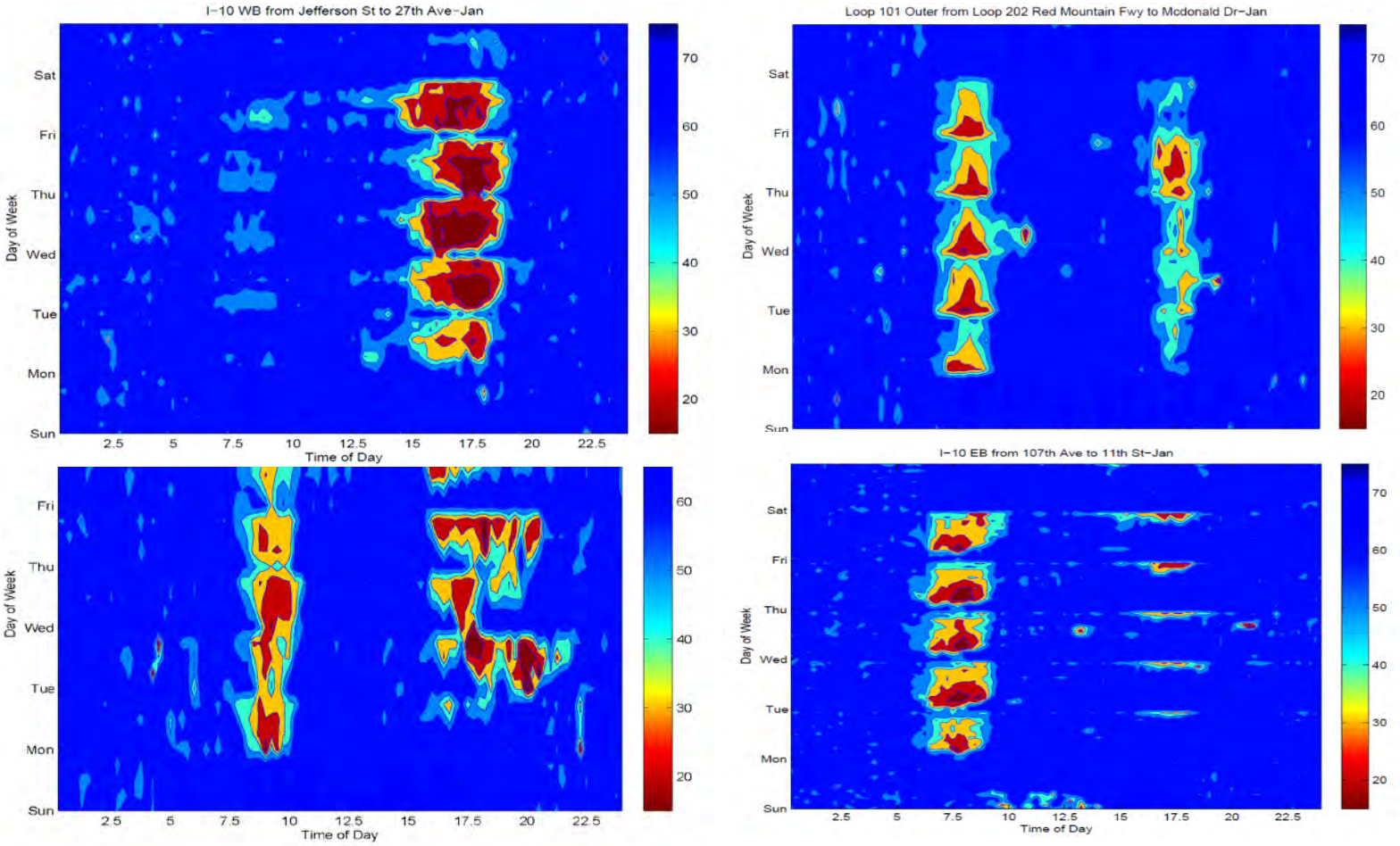
Texas A&M Transportation Institute

"Auto-Segmentation Method for MAP-21 Performance Measure Reporting Using Large Statewide Speed Datasets, J. Wikander, W. Eisele, D. Shrank, the 93rd TRB Annual Meeting, 2014, Washington, D.C."

# Bottleneck Candidates



# Bottleneck Contour Map

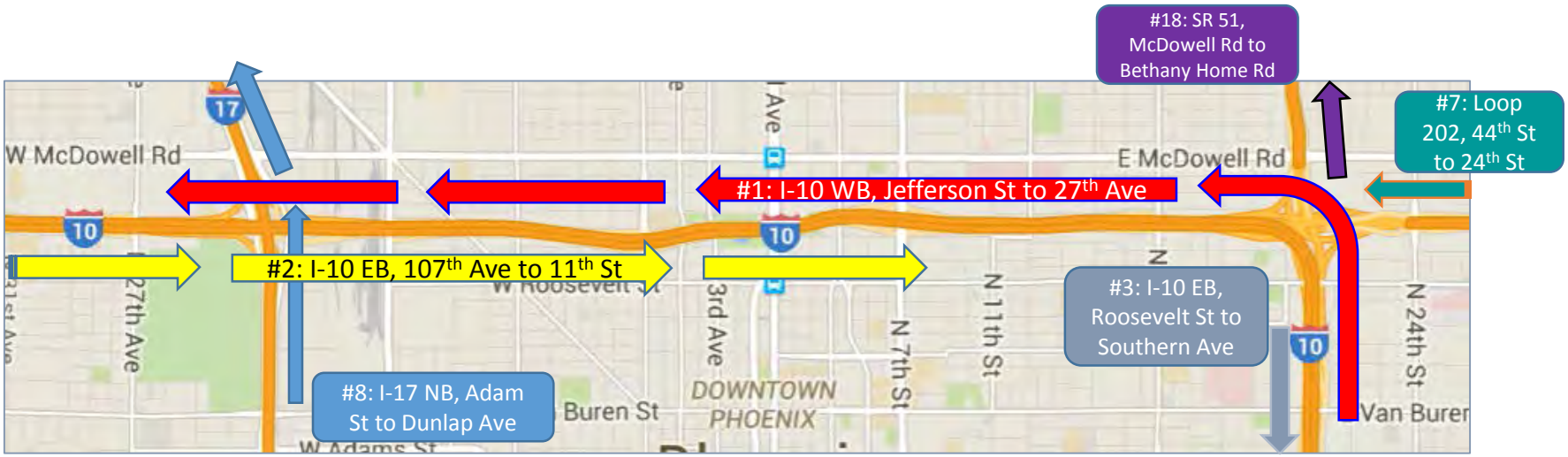


| Dimension | Definition | Typical Measure | Itemized Measure | Calculating Measure | Stage |
|---|---|---|---|---|---|
| Duration | The quantity of time that congestion affects the travel system. | Hours of daily congestion | Hours of daily normal congestion (<50mph) | Total time when avg speed is lower than 50mph | 1 |
| | | | Hours of daily severe congestion (<35mph) | Total time when avg speed is lower than 35mph | 1 |
| Extent | The quantity of persons, vehicles, or roadways affected by congestion. | % road-miles with congestion | normal congestion | TMC under 50mph / total TMC | 2 |
| | | | severe congestion | TMC under 35mph / total TMC | 2 |
| | | % travel in congestion | normal congestion | Flow on TMC under 50mph / total flow | 2 |
| | | | severe congestion | Flow on TMC under 35mph / total flow | 2 |
| Intensity | The severity level (or "pain level") of congestion. | Peak period speed | by 15-min | Avg speed on BN (weighted by TMC length) | 1 |
| | | | by peak period | Avg speed on BN (weighted by TMC length) for the entire peak period | 1 |
| | | Travel Time Index | by 15-min | TT/Free-flow TT on BN | 1 |
| | | | by peak period | Average TT/Free-flow TT on BN | 1 |
| | | Travel Time | by 15-min | TT on BN | 1 |
| | | | by peak period | Average TT on BN | 1 |
| Reliability | The degree of consistency (or lack thereof) in congestion, as measured from day-to-day and/or across different times of the day. | Planning time index | by 15-min | 95% Slowest TT/free-flow TT on BN | 1 |
| | | | by peak period | uncertain how to calculate (how to weight?) | 2 |
| | | Buffer index | by 15-min | 95% Slowest TT/free-flow TT-1 on BN | 1 |
| | | | by peak period | uncertain how to calculate (how to weight?) | 2 |
| | | % trips with on-time arrival | by peak period | (1- flow under normal congestion / total flow in that period) % | 2 |
| | | % of days congested | by 15-min | (# of Days BN under normal congestion / total # of weekday) % (<50mph) | 1 |
| | | | by 15-min | (# of Days BN under severe congestion / total # of weekday) % (<35mph) | 1 |
| | | % of days congested | by peak period | (# of Days BN peak period avg speed under normal congestion / total # of weekday) % (<50mph) | 1 |
| | | | by peak period | (# of Days BN peak period avg speed under normal congestion / total # of weekday) % (<35mph) | 1 |
| Multiple Dimentions and Others | Duration, Extent and Intensity | Total delay per mile | | uncertain how to calculate | 2 |
| | | Total delay | by peak period | Sum of delay per vehicle on BN | 2 |
| | | VMT | by peak period | Total VMT under congestion | 2 |
| | | PMT | by peak period | Total PMT under congestion | 2 |
| Freight/Truck | All above measures on medium and heavy trucks | multiple | multiple | multiple | 2 |

# Bottleneck Ranking

| | | | | | Delay per Vehicle | | | Delay per Person | | | Delay Per Heavy Truck V | | | Delay Per Medium Truck V | | | Annual Average Speed | | | Annual Average TTI | | | Annual <50mph interval | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| New BN Number | ROUTE | Direction | From | To | Daily Rank | AM rank | PM rank | Daily Rank | AM rank | PM rank | Daily Rank | AM rank | PM rank | Daily Rank | AM rank | PM rank | Daily Rank | AM rank | PM rank | Daily Rank | AM rank | PM rank | Daily Rank | AM rank | PM rank |
| 26 | I-10 | WB | Jefferson St | 27th Ave | 1 | 19 | 1 | 1 | 19 | 1 | 4 | 18 | 2 | 1 | 23 | 1 | 13 | 25 | 1 | 18 | 30 | 1 | 11 | 25 | 1 |
| 8 | I-10 | EB | 107th Ave | 11th St | 2 | 1 | 9 | 2 | 1 | 8 | 1 | 1 | 5 | 2 | 1 | 6 | 4 | 1 | 21 | 2 | 1 | 21 | 1 | 1 | 13 |
| 7 | I-10 | EB | Roosevelt St | Southern Ave | 3 | 18 | 2 | 3 | 18 | 2 | 2 | 15 | 1 | 3 | 18 | 2 | 11 | 21 | 3 | 4 | 20 | 2 | 8 | 20 | 3 |
| 37 | I-10 | WB | L202 | 48th St | 4 | 2 | 20 | 4 | 2 | 19 | 3 | 2 | 13 | 4 | 2 | 18 | 9 | 4 | 22 | 7 | 2 | 22 | 6 | 3 | 20 |
| 11 | Loop 101 | Inner | Thunderbird Rd | Loop 202 Red Mount | 5 | 16 | 3 | 5 | 16 | 3 | 13 | 23 | 7 | 10 | 19 | 5 | 26 | 31 | 11 | 15 | 24 | 9 | 7 | 18 | 4 |
| 106 | Loop 101 | Inner | Loop 202 Red Mount | Baseline Rd | 6 | 22 | 4 | 6 | 22 | 5 | 10 | 20 | 11 | 13 | 21 | 8 | 19 | 27 | 7 | 3 | 17 | 4 | 18 | 28 | 6 |
| 112 | Loop 202 (Red Mt) | Outer | 44th St | 24th St | 7 | 12 | 5 | 7 | 12 | 4 | 11 | 12 | 10 | 15 | 14 | 9 | 3 | 11 | 5 | 1 | 8 | 3 | 2 | 12 | 10 |
| 20 | I-17 | NB | Adams St | Dunlap Ave | 8 | 23 | 6 | 8 | 23 | 6 | 8 | 22 | 4 | 7 | 22 | 3 | 7 | 20 | 4 | 21 | 28 | 6 | 9 | 21 | 2 |
| 5 | SR-51 | SB | Shea Blvd | Indian School Rd | 9 | 4 | 27 | 10 | 4 | 27 | 19 | 8 | 26 | 14 | 6 | 28 | 16 | 9 | 24 | 25 | 9 | 29 | 12 | 5 | 25 |
| 2 | I-17 | SB | Union Hills | Camelback | 10 | 3 | 23 | 12 | 3 | 23 | 7 | 4 | 22 | 16 | 8 | 25 | 5 | 3 | 18 | 9 | 5 | 25 | 10 | 2 | 24 |
| 25 | Loop 101 | Outer | Loop 202 Red Mount | Mcdonald Dr | 11 | 7 | 18 | 11 | 6 | 18 | 17 | 10 | 23 | 17 | 9 | 22 | 14 | 10 | 23 | 5 | 7 | 16 | 4 | 6 | 16 |
| 110 | I-10 | WB | 27th Ave | 59th Ave | 12 | 30 | 7 | 9 | 30 | 7 | 5 | 28 | 3 | 6 | 30 | 4 | 17 | 25 | 6 | 17 | 27 | 5 | 26 | 30 | 5 |
| 105 | Loop 101 | Inner | I 17 Fwy | Tatum Blvd | 13 | 5 | 29 | 14 | 5 | 29 | 16 | 6 | 30 | 12 | 5 | 30 | 20 | 5 | 30 | 20 | 3 | 31 | 16 | 4 | 28 |
| 1 | I-17 | SB | Van Buren St | I 10 Fwy | 14 | 10 | 12 | 13 | 10 | 12 | 6 | 3 | 6 | 9 | 7 | 11 | 2 | 2 | 10 | 14 | 14 | 17 | 3 | 7 | 15 |
| 23 | SR-51 | NB | Mountain View Rd | L101 | 15 | 29 | 8 | 15 | 29 | 9 | 24 | 29 | 15 | 8 | 26 | 7 | 28 | 24 | 20 | 28 | 26 | 18 | 22 | 23 | 18 |
| 10 | US-60 | WB | Higley Rd | Dobson Rd | 16 | 6 | 25 | 16 | 7 | 25 | 15 | 5 | 25 | 5 | 3 | 20 | 27 | 16 | 29 | 27 | 12 | 30 | 24 | 9 | 29 |
| 31 | Loop 101 | Outer | L202 | Guadalupe Rd | 17 | 8 | 24 | 17 | 8 | 24 | 18 | 9 | 24 | 24 | 13 | 24 | 15 | 6 | 25 | 13 | 4 | 26 | 13 | 8 | 23 |
| 22 | SR-51 | NB | McDowell Rd | Bethany Home Rd | 18 | 25 | 10 | 18 | 25 | 10 | 20 | 27 | 12 | 18 | 25 | 10 | 10 | 19 | 9 | 10 | 22 | 7 | 15 | 24 | 9 |
| 109 | US-60 | WB | Dobson Rd | Priest Dr | 19 | 9 | 22 | 19 | 9 | 22 | 12 | 7 | 21 | 11 | 4 | 21 | 21 | 13 | 26 | 22 | 10 | 28 | 14 | 10 | 21 |
| 102 | I-10 | EB | Southern Ave | L202 | 20 | 20 | 14 | 20 | 20 | 14 | 9 | 19 | 8 | 19 | 20 | 13 | 24 | 29 | 13 | 19 | 25 | 11 | 23 | 29 | 10 |
| 104 | Loop 101 | Outer | 56th St | 35th Ave | 21 | 27 | 11 | 21 | 27 | 11 | 27 | 30 | 16 | 27 | 29 | 15 | 30 | 32 | 14 | 11 | 21 | 10 | 20 | 27 | 8 |
| 9 | SR-143 | SB | Sky Harbor Blvd | I 10 Fwy | 22 | 24 | 13 | 22 | 24 | 13 | 23 | 25 | 14 | 20 | 24 | 14 | 1 | 8 | 2 | 30 | 31 | 8 | 5 | 13 | 12 |
| 24 | Loop 101 | Outer | US 60 | Loop 202 Red Mount | 23 | 11 | 26 | 23 | 11 | 26 | 22 | 11 | 28 | 22 | 10 | 29 | 22 | 12 | 28 | 6 | 6 | 20 | 21 | 11 | 27 |
| 28 | SR-143 | NB | University Dr | Sky Harbor Blvd | 24 | 17 | 21 | 24 | 17 | 21 | 21 | 21 | 18 | 21 | 17 | 16 | 12 | 14 | 15 | 23 | 19 | 23 | 25 | 19 | 22 |
| 111 | US-60 | EB | Priest Dr | Dobson Rd | 25 | 26 | 16 | 25 | 26 | 16 | 25 | 26 | 17 | 28 | 27 | 17 | 18 | 23 | 12 | 12 | 18 | 12 | 17 | 21 | 14 |
| 39 | Loop 202 | Outer | Alma School | Dobson Rd | 26 | 31 | 17 | 26 | 31 | 17 | 29 | 31 | 19 | 29 | 31 | 19 | 25 | 28 | 17 | 29 | 29 | 14 | 29 | 31 | 17 |
| 19 | I-17 | NB | 16th St | Jefferson St | 27 | 28 | 15 | 27 | 28 | 15 | 14 | 24 | 9 | 23 | 28 | 12 | 6 | 18 | 8 | 31 | 32 | 13 | 19 | 26 | 7 |
| 107 | Loop 202 | Outer | Priest Dr | L101 | 28 | 13 | 28 | 28 | 13 | 28 | 26 | 13 | 27 | 25 | 12 | 26 | 23 | 15 | 27 | 32 | 14 | 32 | 28 | 14 | 30 |
| 114 | Loop 202 (Red Mt) | Inner | Sky Harbor Blvd | L101 | 29 | 32 | 19 | 29 | 32 | 20 | 31 | 32 | 20 | 32 | 32 | 23 | 31 | 30 | 19 | 24 | 23 | 15 | 32 | 32 | 19 |
| 113 | Loop 202 (Santan) | Inner | McQueen Rd | L101 | 30 | 14 | 32 | 30 | 14 | 32 | 30 | 16 | 32 | 31 | 15 | 32 | 32 | 22 | 31 | 8 | 11 | 19 | 31 | 16 | 32 |
| 4 | Loop 101 | Inner | 75th Ave | I 17 Fwy | 31 | 15 | 31 | 31 | 15 | 31 | 28 | 14 | 31 | 26 | 11 | 31 | 29 | 17 | 32 | 16 | 13 | 24 | 30 | 15 | 31 |
| 30 | Loop 101 | Outer | Thomas Rd | I-10 Fwy | 32 | 21 | 30 | 32 | 21 | 30 | 32 | 17 | 29 | 30 | 16 | 27 | 7 | 7 | 16 | 26 | 14 | 27 | 27 | 17 | 26 |

# Case Study Area for TLAP Survey




- The case study area in Phoenix downtown features top 3 bottlenecks in the region and other 3 high-ranking bottlenecks.

# Time-lapse Aerial Photography (TLAP) Traffic Study for the Maricopa Association of Governments (MAG)

Travel Model Improvement Program (TMIP),

Federal Highway Administration

June 24, 2015

William Kasper, Skycomp

# Introduction

- Objective: document peak--period highway traffic flow along the mainline of I-10 and the adjacent street networkin Phoenix, AZ.
- Method: wide-area time-lapse aerial photography (TLAP), captured from hovering helicopters at a rate of one frame per second (1- Hz. TLAP).
- Objectives
  - Enable the counting of ramp volumes or turning movements at any visible site within the covered area
  - Permit an analysis of queue lengths on local streets and traffic densities on I-10 mainline
  - Enable the tracing of specific vehicles to determine classified origin - destination travel patterns between points of interest within the survey area.

# Time-lapse Aerial Photography (TLAP) Overview

- TLAP can capture comprehensive traffic data for large, complex study areas of up to sixteen (potentially up to twenty-five) linear miles or twelve square miles.
- TLAP surveys may include a wide range of verifiable, concurrent metrics to aid in micro simulation model calibration and validation
  - Origin-destination matrices
  - Path information
  - Ramp and mainline volumes
  - Vehicle classification (based on visible characteristics)
  - Turning movement counts (TMCs)
  - Queue lengths
  - Speed and travel times over any segment in the area
  - Densities and LOS

# TLAP and Micro-Simulation Models


**TLAP data and imagery is used by MPOs, DOTs and Engineering Consultants to understand current conditions and to calibrate accurate and defensible microsimulation models.**

# TLAP Strengths and Limitations

## Strengths

- TLAP imagery records everything in sight.
- No matter how complex the study area, most TLAP survey areas can be "closed."
- The imagery can be verified and "re-queried" as questions arise.
- Visible vehicle classification is straightforward.
- Study findings can be clearly demonstrated to survey sponsors, stakeholders or members of the public.
- All metrics can come from one, balanced "calibration day".

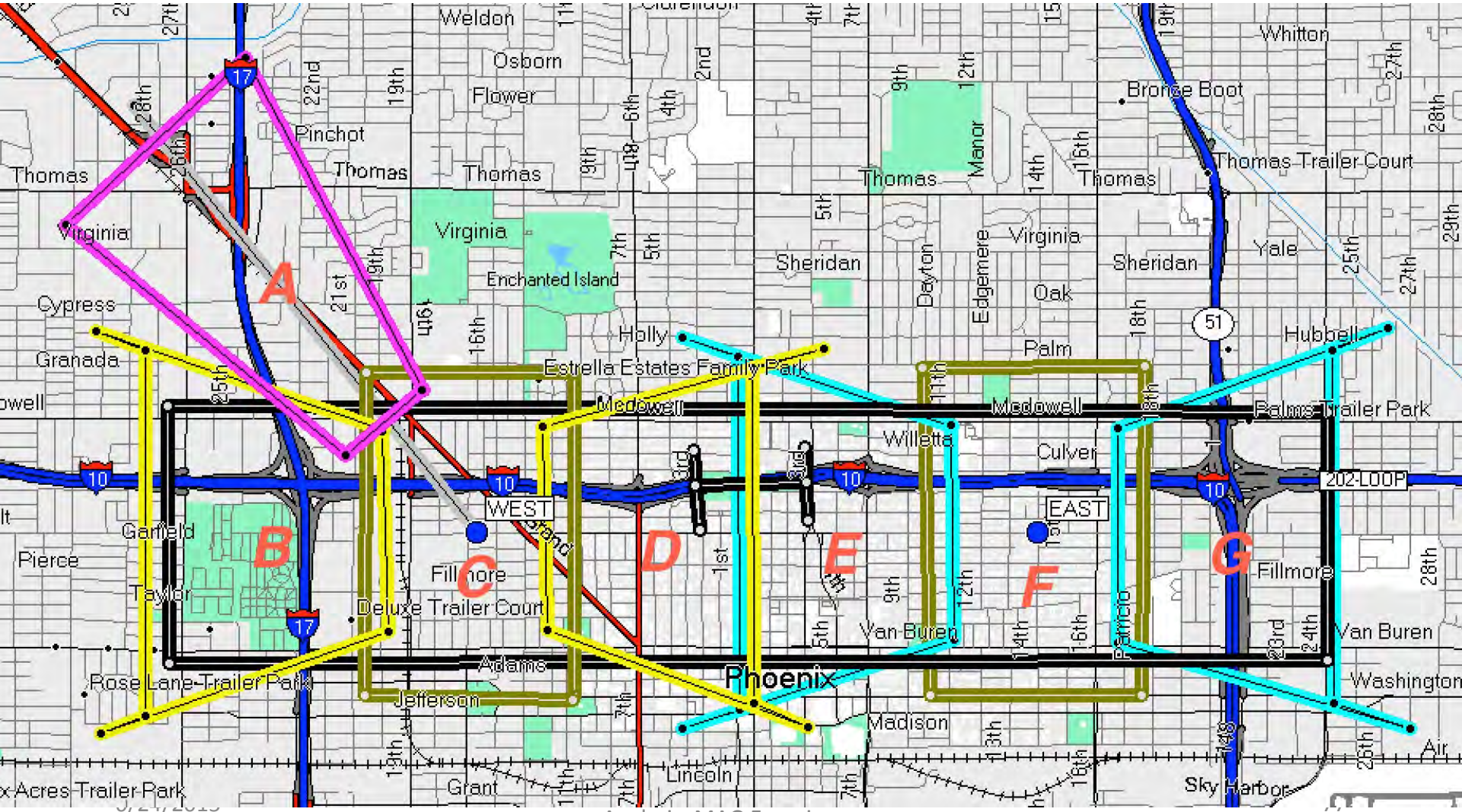
## Limitations

- Limited to areas that can be imaged by 1-4 (possibly 5) helicopters
- Sensitive to clouds and bad weather
- Requires light
- Limited to approximately two hour study periods unless aircraft "tag team"
- Costs can scale quickly for multiple days
- Data extraction is currently labor intensive for O-D

# MAG Survey Planning

- Surveys scheduled for a midweek period in October 2014
  - Based on expected to "normal" seasonal conditions
  - October 15th and 16th (the Wednesday and Thursday after the Columbus Day weekend)
  - Four two-hour survey periods
    - Two AM from 06:30 to 08:30
    - Two PM from 15:45 to 17:45.
- A six-mile section of I-10 was selected for study, bounded by
  - 24th Street to the east
  - 27th Avenue to the west
  - Van Buren Street to the south
  - McDowell Road to the north
- An additional camera was configured to capture the Grand Avenue corridor to the northwest
- Supplementary ground cameras were added to re-confirm vehicles passing through the tunnel between 3rd Street and 3rd Avenue.

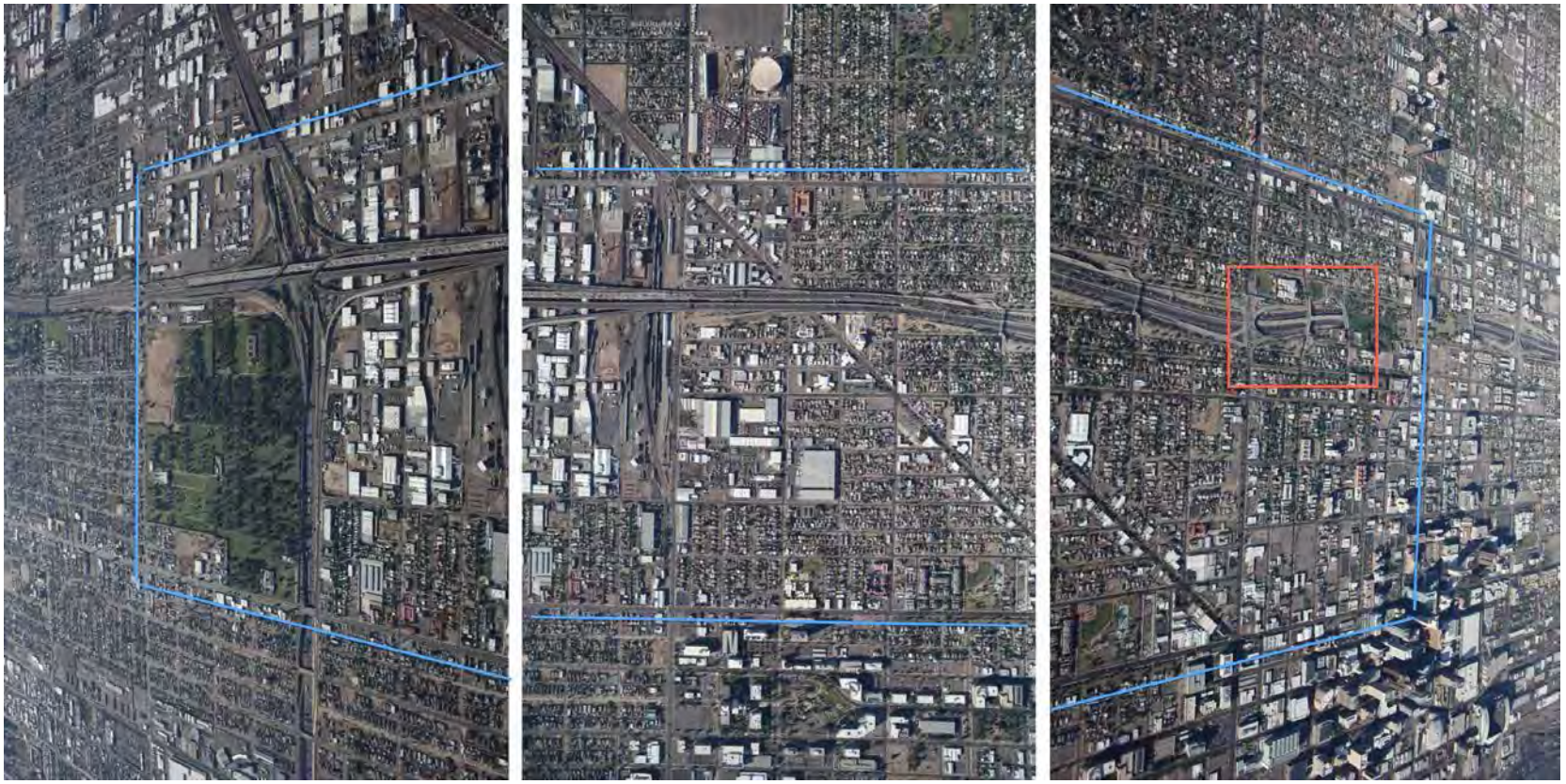
# Aircraft and Camera Configuration




Analysis: MAG Experience

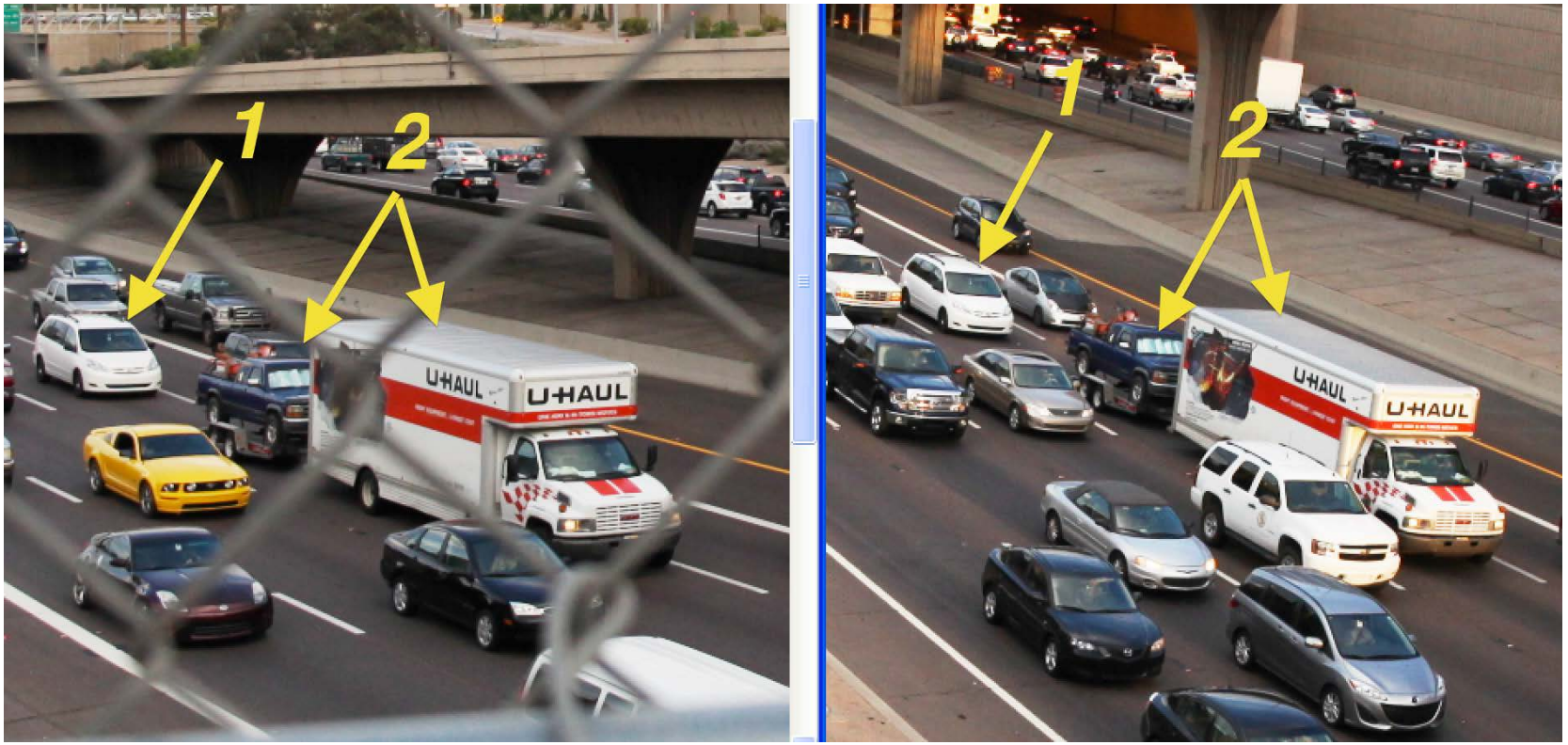
# Test Flight Photographs Camera A

# Test Flight Photographs Cameras B, C and D



# Test Flight Photographs Full Resolution

# Supplemental Ground Cameras



# Survey Images – Full Size Camera A

# Survey Images – Full Size Cameras B, C and D

# Survey Images – Full Size Cameras E, F and G

# Image Processing

- Precise alignment of 260,000 high resolution images
- Creation of combined image “photoboards” for each survey (two per survey) for data extraction

Western Photoboard

Eastern Photoboard

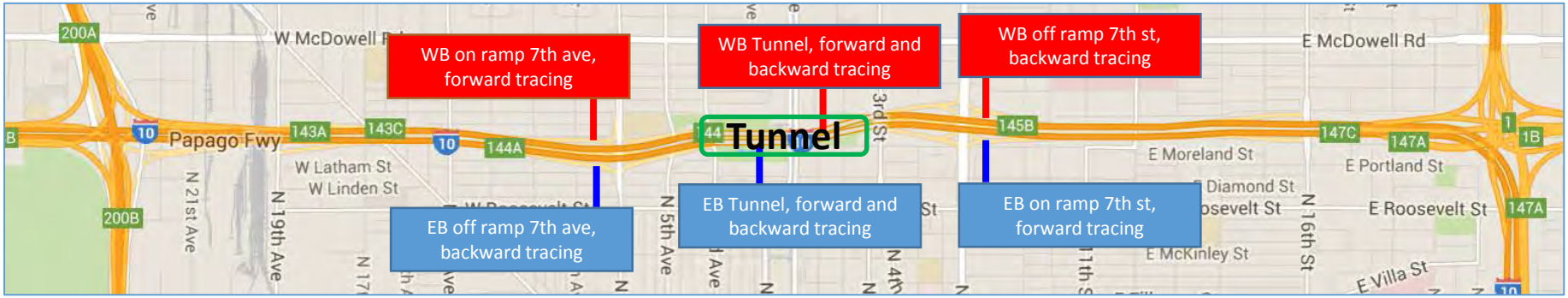
# Survey Images – Full Resolution SR51 / I-10 Interchange Video

# Links to Sample Videos

- Sample videos will be available in the next few days at

  www.skycomp.com/tmip

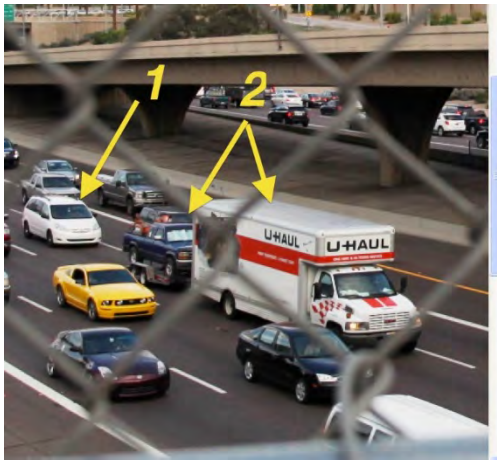
# Assignment Lines and Sample Rate




| Dir | AL | Start | End | 15-min vol | site | # lanes | max dist to trace | avg dist to trace | Speed | avg trav time | 15-min vol | % of 15-min vol. to trace | No. of peaks | freq. | samples | travel time (min) | trace time (min) | DL (hr) | Confidence Level | Margin of Error - MOE (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WB | 1 | 3:45 | 4:00 | 1691 | WB Tunnel | 4 | 3.7 | 2.6 | 22 | 7.0 | 1691 | 0% | 1 | 8% | 0 | 7.0 | 27.8 | 0 | 95% | |
| WB | 1 | 4:00 | 4:15 | 1705 | WB Tunnel | 4 | 3.7 | 2.6 | 21 | 7.5 | 1705 | 100% | 1 | 8% | 136 | 7.5 | 30.1 | 68 | 95% | 8.1 |
| WB | 1 | 4:15 | 4:30 | 1485 | WB Tunnel | 4 | 3.7 | 2.6 | 18 | 8.6 | 1485 | 100% | 1 | 8% | 119 | 8.6 | 34.3 | 68 | 95% | 8.6 |
| WB | 1 | 4:30 | 4:45 | 1273 | WB Tunnel | 4 | 3.7 | 2.6 | 12 | 13.1 | 1273 | 100% | 1 | 8% | 102 | 13.1 | 52.3 | 89 | 95% | 9.3 |
| WB | 1 | 4:45 | 5:00 | 1009 | WB Tunnel | 4 | 3.7 | 2.6 | 8 | 19.4 | 1009 | 100% | 1 | 8% | 81 | 19.4 | 77.7 | 105 | 95% | 10.5 |
| WB | 1 | 5:00 | 5:15 | 1206 | WB Tunnel | 4 | 3.7 | 2.6 | 10 | 15.4 | 1206 | 100% | 1 | 8% | 96 | 15.4 | 61.5 | 99 | 95% | 9.6 |
| WB | 1 | 5:15 | 5:30 | 1229 | WB Tunnel | 4 | 3.7 | 2.6 | 14 | 11.0 | 1229 | 100% | 1 | 8% | 98 | 11.0 | 44.1 | 72 | 95% | 9.5 |
| WB | 1 | 5:30 | 5:45 | 1147 | WB Tunnel | 4 | 3.7 | 2.6 | 10 | 15.0 | 1147 | 0% | 1 | 8% | 0 | 15.0 | 60.2 | 0 | 95% | |
| WB | 2 | 3:45 | 4:00 | 340 | WB off ramp 7th st, backward tracing | 2 | 1.2 | 0.8 | 22 | 2.3 | 340 | 0% | 1 | 14% | 0 | 2.3 | 9.0 | 0 | 95% | |
| WB | 2 | 4:00 | 4:15 | 341 | WB off ramp 7th st, backward tracing | 2 | 1.2 | 0.8 | 21 | 2.4 | 341 | 100% | 1 | 14% | 48 | 2.4 | 9.8 | 8 | 95% | 13.1 |
| WB | 2 | 4:15 | 4:30 | 362 | WB off ramp 7th st, backward tracing | 2 | 1.2 | 0.8 | 18 | 2.8 | 362 | 100% | 1 | 14% | 51 | 2.8 | 11.1 | 9 | 95% | 12.7 |
| WB | 2 | 4:30 | 4:45 | 359 | WB off ramp 7th st, backward tracing | 2 | 1.2 | 0.8 | 12 | 4.2 | 359 | 100% | 1 | 14% | 50 | 4.2 | 17.0 | 14 | 95% | 12.7 |
| WB | 2 | 4:45 | 5:00 | 388 | WB off ramp 7th st, backward tracing | 2 | 1.2 | 0.8 | 8 | 6.3 | 388 | 100% | 1 | 14% | 54 | 6.3 | 25.2 | 23 | 95% | 12.5 |
| WB | 2 | 5:00 | 5:15 | 378 | WB off ramp 7th st, backward tracing | 2 | 1.2 | 0.8 | 10 | 5.0 | 378 | 100% | 1 | 14% | 53 | 5.0 | 19.9 | 18 | 95% | 12.5 |
| WB | 2 | 5:15 | 5:30 | 369 | WB off ramp 7th st, backward tracing | 2 | 1.2 | 0.8 | 14 | 3.6 | 369 | 100% | 1 | 14% | 52 | 3.6 | 14.3 | 12 | 95% | 12.5 |
| WB | 2 | 5:30 | 5:45 | 398 | WB off ramp 7th st, backward tracing | 2 | 1.2 | 0.8 | 10 | 4.9 | 398 | 0% | 1 | 14% | 0 | 4.9 | 19.5 | 0 | 95% | |
| WB | 3 | 3:45 | 4:00 | 305 | WB on ramp 7th ave, forward tracing | 1 | 0.9 | 0.6 | 22 | 1.7 | 305 | 0% | 1 | 14% | 0 | 1.7 | 6.8 | 0 | 95% | |
| WB | 3 | 4:00 | 4:15 | 322 | WB on ramp 7th ave, forward tracing | 1 | 0.9 | 0.6 | 21 | 1.8 | 322 | 100% | 1 | 14% | 45 | 1.8 | 7.3 | 5 | 95% | 13.6 |
| WB | 3 | 4:15 | 4:30 | 352 | WB on ramp 7th ave, forward tracing | 1 | 0.9 | 0.6 | 18 | 2.1 | 352 | 100% | 1 | 14% | 49 | 2.1 | 8.3 | 7 | 95% | 13.0 |
| WB | 3 | 4:30 | 4:45 | 337 | WB on ramp 7th ave, forward tracing | 1 | 0.9 | 0.6 | 12 | 3.2 | 337 | 100% | 1 | 14% | 47 | 3.2 | 12.7 | 10 | 95% | 13.3 |
| WB | 3 | 4:45 | 5:00 | 325 | WB on ramp 7th ave, forward tracing | 1 | 0.9 | 0.6 | 8 | 4.7 | 325 | 100% | 1 | 14% | 46 | 4.7 | 18.9 | 14 | 95% | 13.3 |
| WB | 3 | 5:00 | 5:15 | 335 | WB on ramp 7th ave, forward tracing | 1 | 0.9 | 0.6 | 10 | 3.7 | 335 | 100% | 1 | 14% | 47 | 3.7 | 15.0 | 12 | 95% | 13.3 |
| WB | 3 | 5:15 | 5:30 | 334 | WB on ramp 7th ave, forward tracing | 1 | 0.9 | 0.6 | 14 | 2.7 | 334 | 100% | 1 | 14% | 47 | 2.7 | 10.7 | 8 | 95% | 13.3 |
| WB | 3 | 5:30 | 5:45 | 321 | WB on ramp 7th ave, forward tracing | 1 | 0.9 | 0.6 | 10 | 3.7 | 321 | 0% | 1 | 14% | 0 | 3.7 | 14.6 | 0 | 95% | |

# Tunnel matching before tracing

- Vehicle matching at two sides of tunnel;
- Samples evenly pulled from each lane
- Sample selected according to vehicle type percentage: largely PC and SUV, also pickup, medium truck and heavy truck
- Prefer vehicle in light color for the ease of tracing
- Avoiding bus, RV and motorcycle

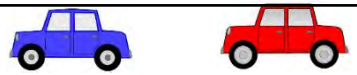



Tunnel Entrance

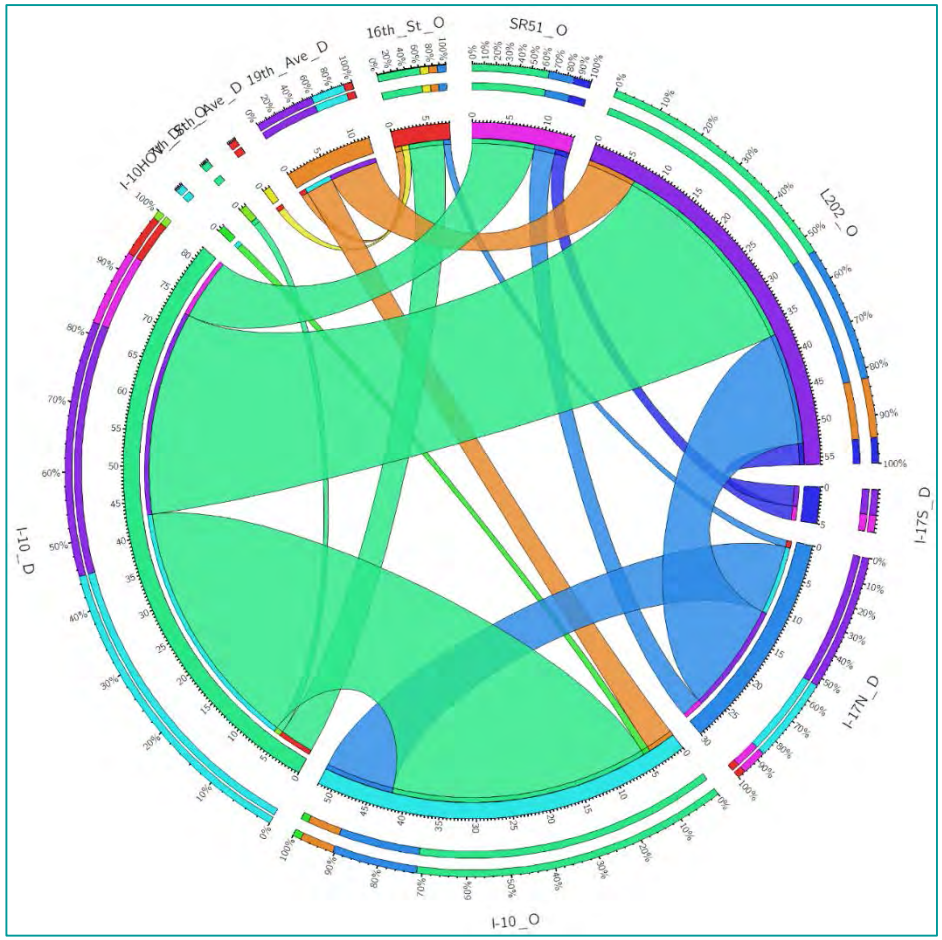

Tunnel Exit

# Vehicle Tracing

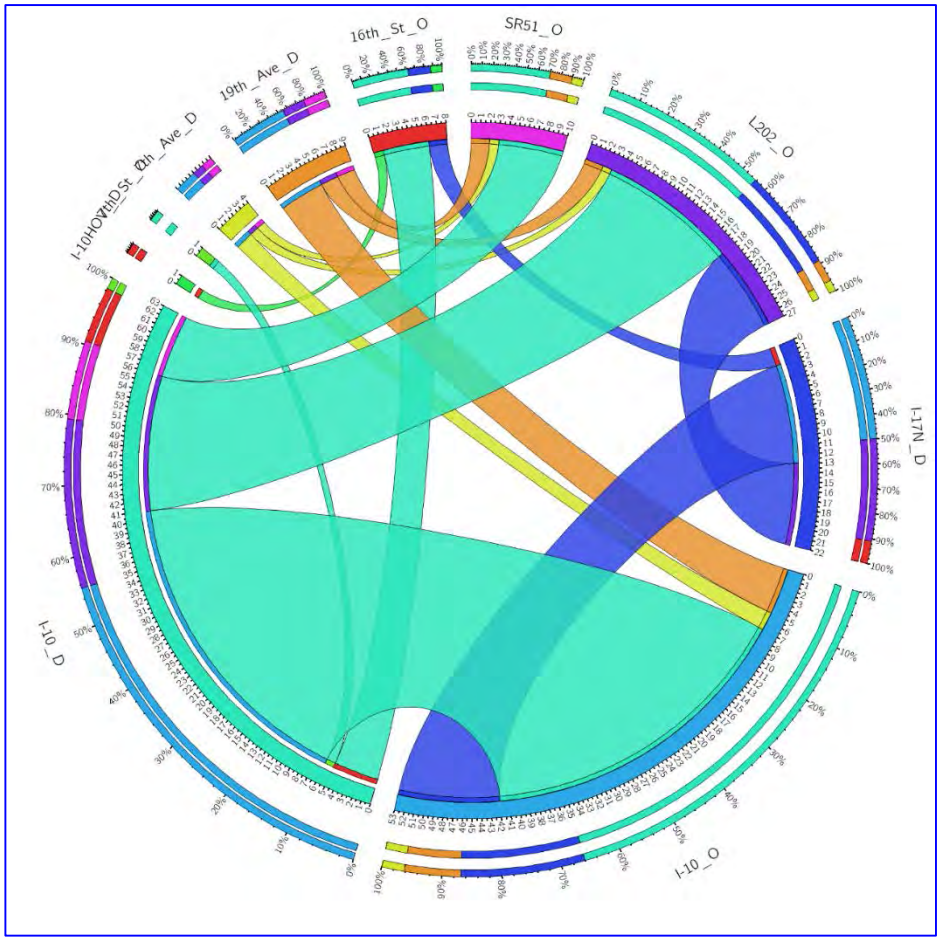
- Backward /forward tracing combined
- 95% success rate
- White cars frequently seen, but not always easy to trace (due to platooning)
- Difficult to trace a car when it goes underneath an overpass in queue
- Data such as O-D, travel time, and lane change frequency are obtained

| | | |
|---|---|---|
| Easy | Truck |  |
| ↓ | Yellow, Green, White Car |  |
| | Blue and Red Car |  |
| Hard | Black and Gray Car |  |

# "O-D 4:00PM"




# "O-D 5:00PM"



# Preliminary Results

On going

Vehicle tracing work stratified by assignment line and time interval:

- Surprising O-D patterns recognized
- Unbalanced lane utilizations observed
- Frequent lane change activities documented

| O-D | 6:45-7:00am | 7:00-7:15am | 7:15-7:30am | 7:30-7:45am | 7:45-8:00am | 8:00-8:15am | 4:00-4:15pm | 4:15-4:30pm | 4:30-4:45pm | 4:45-5:00pm | 5:00-5:15pm | 5:15-5:30pm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Study Area |  |  |  |  |  |  |  |  |  |  |  |  |

# What's Next

On going

Vehicle tracing work stratified by assignment line and time interval:

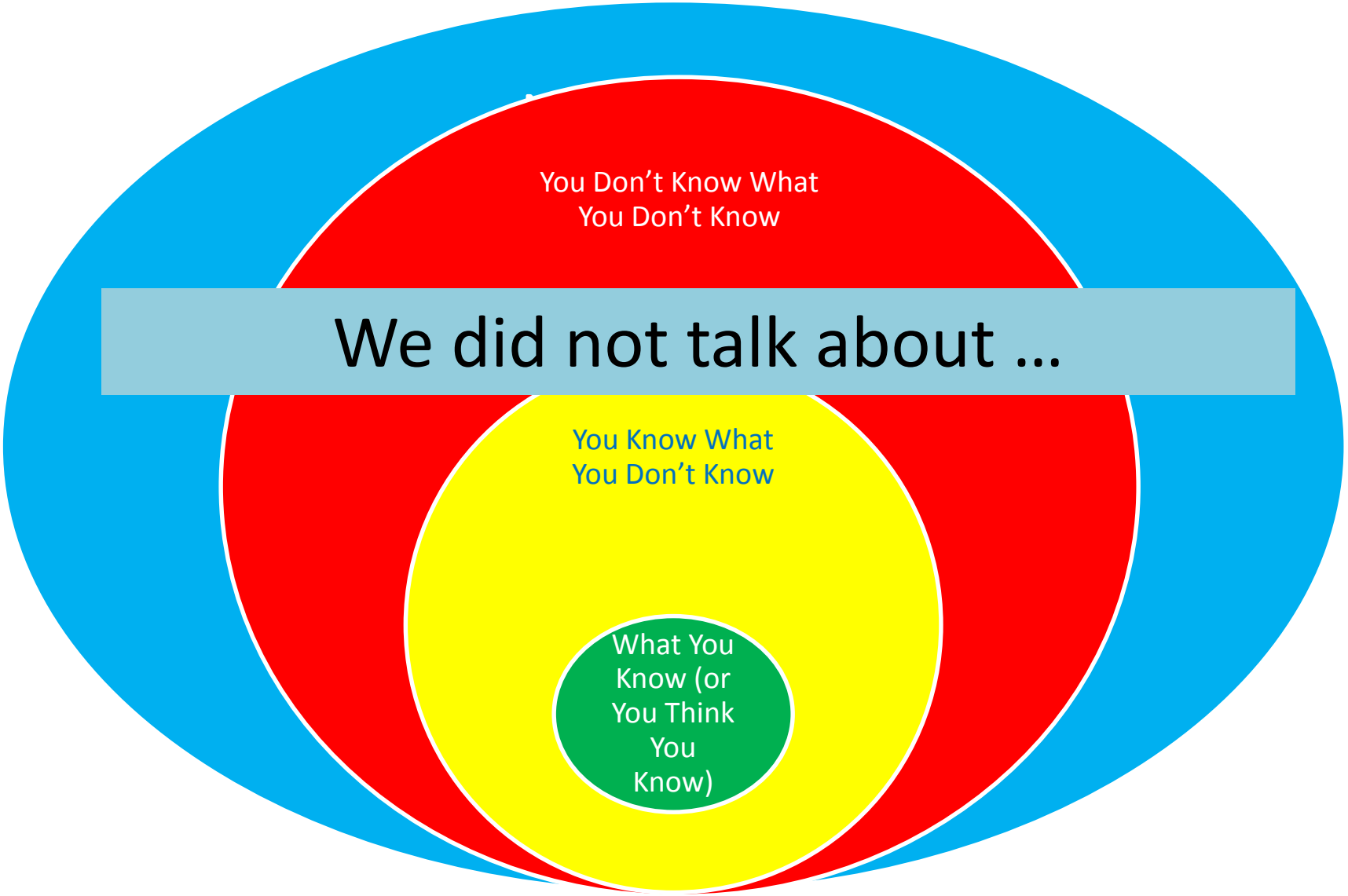
- Surprising O-D patterns recognized
- Unbalanced lane utilizations observed
- Frequent lane change activities documented

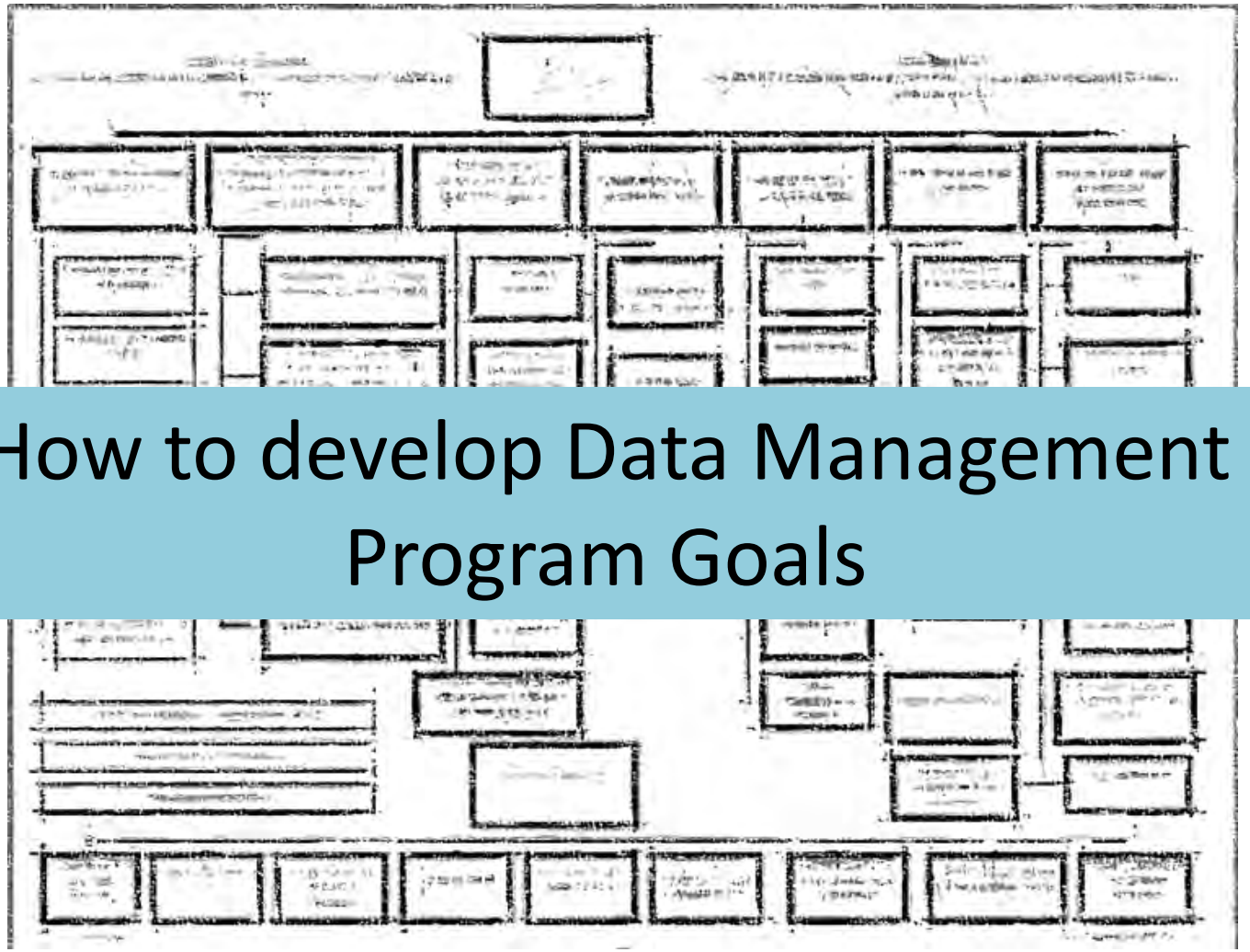
Coming up…

Calibration of micro-simulation models based on vehicle tracing results

Final Report (all phases)

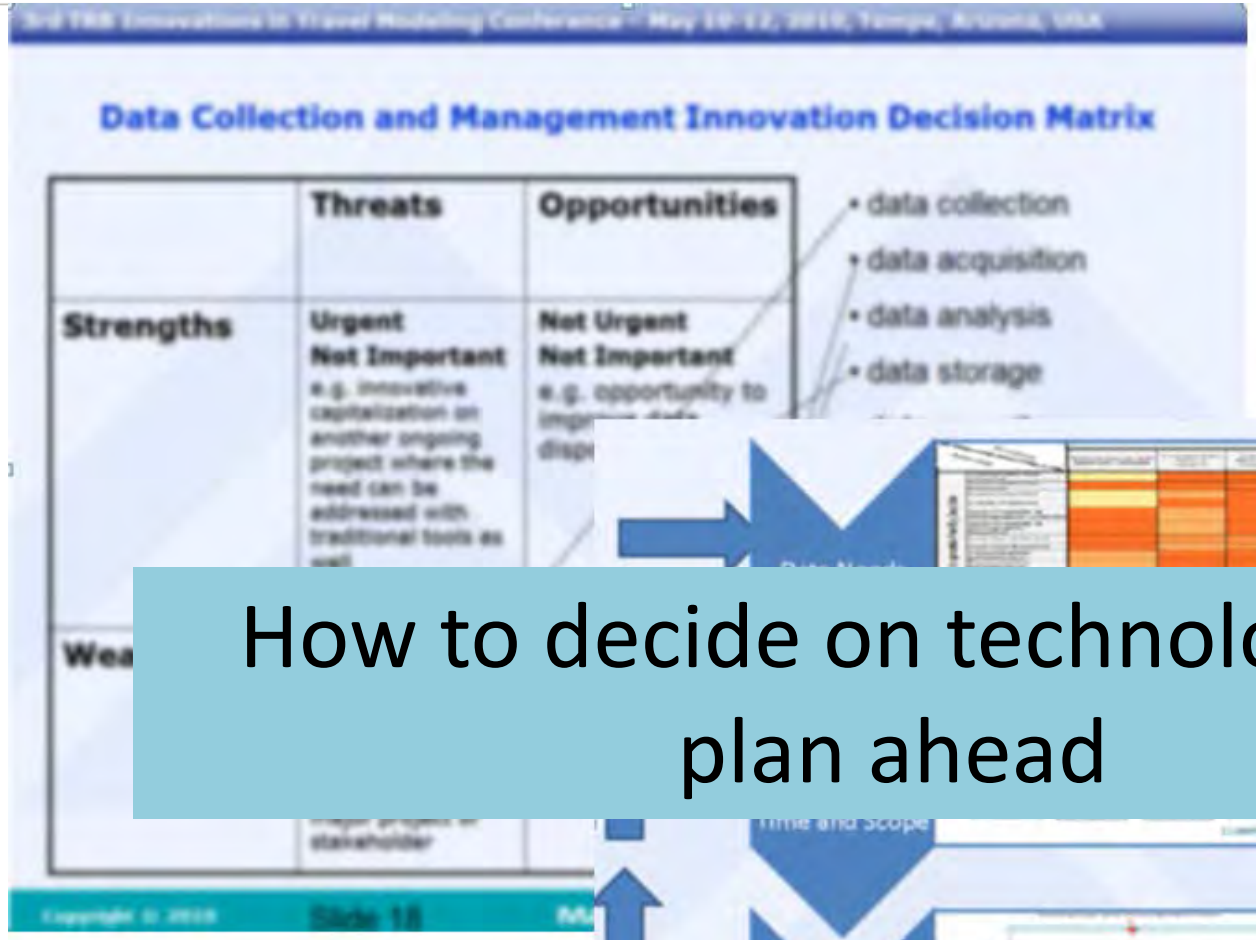
# Development of Transportation Data Collection and Management Program in the Context of a Large MPO Business Processes – some concluding remarks

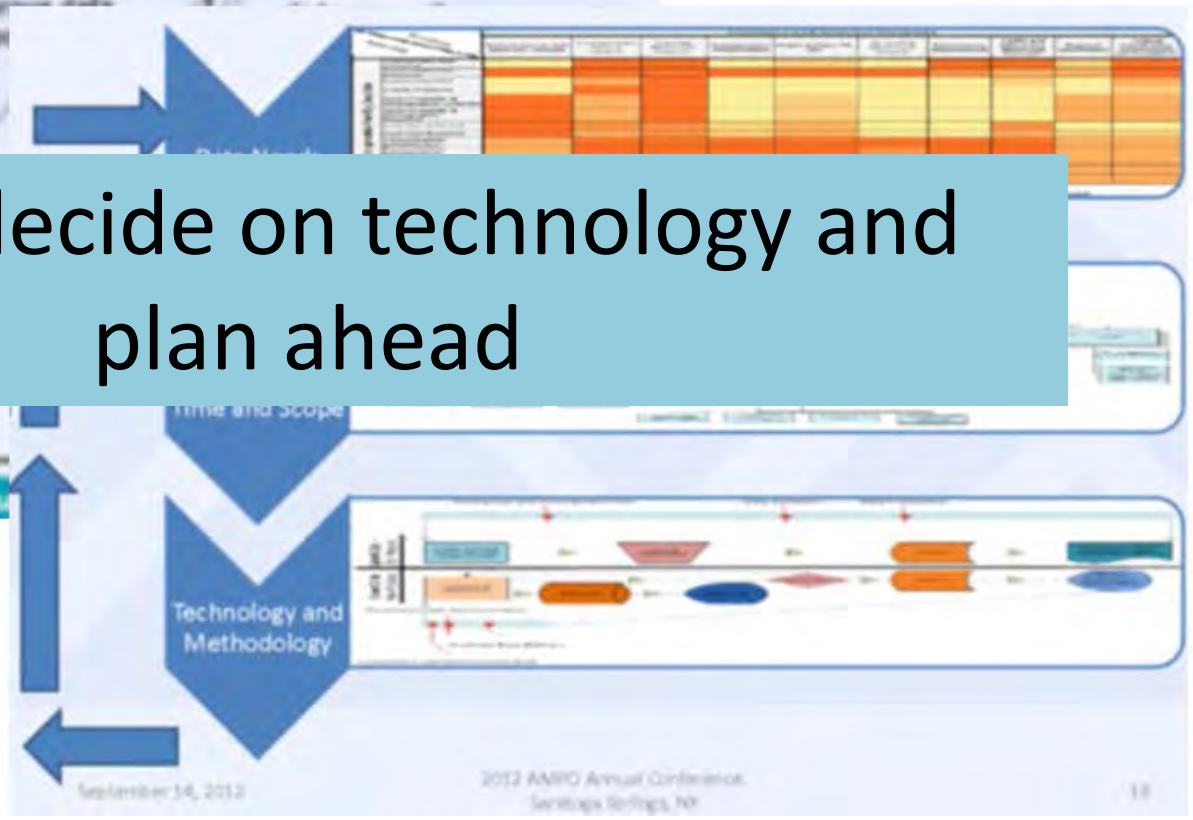

You Don't Know What
You Don't Know
We did not talk about …
You Know What
You Don't Know
What You Know (or You Think You Know)



# How to develop Data Management Program Goals


# How to develop Data Management Program Projects and Tasks Based on the Program Goals




# How to decide on technology and plan ahead

| Transportation Data/Data Management Function | Traffic Volumes | Traffic Speed | Travel Time | Trajectories | Traffic Flow Composition: Occupancy, Classification Counts | OD Travel Information | Infrastructure Information: Transit, Road | Predominantly |
|---|---|---|---|---|---|---|---|---|
| data collection | 1 | 3 | 1 | 0 | 1 | 1 | 3 | 1 |
| data acquisition | 1 | 2 | 0 | 0 | 0 | 3 | 3 | 3 |
| data ana | | | | | | | | 3 |
| data st | | | | | | | | 3 |
| data se | | | | | | | | 3 |
| data ret | | | | | | | | 3 |
| data acce | | | | | | | | |
| dissemi | | | | | | | | 3 |
| data arc | | | | | | | | 3 |
| data dis | | | | | | | | 1 |
| Predominantly | 3 | 3 | 3 | 0 | 3 | 3 | 1 | 3 |

# How to decide on outsourcing and balance in-house work with consultant projects

# Some of the MAG Main Transportation Data Projects in the Past 10 Years

- Socio-Economic data (Pop, Empl, Enrollment, …)
- Land-Use Data (Future developments, Industrial, Retail, …)
- **Traffic Data** (counts, speed, travel time, …) – **DTA, Microsimulation**
- **Travel Data** (trips, households, vehicles …) – **ABM, Special Generators, 4-step**
- **Transportation Infrastructure Data** (roads, parking, transit, …) – **Network Models, GIS-T**
- Environmental Data (air quality, water, …)

2006 Freeway LOS Study; 2007 FMS Data Quality Evaluation; 2007 Regional Travel Time and Speed Study; 2010-2015 Commercial Speed Data Purchases; Regional Volume and Classification Counts 2007, 2011, 2014-2015; Screenline and local counts annually; 2010 Regional Intersection Volume Counts; 2008-2015 Regional Web-based Traffic Data Portal Development; 2006, 2012 Vehicle Occupancy Studies; 2013 Bluetooth OD study; 2014 Cell Phone OD study; 2006, 2015 Regional Bottleneck Studies

Regional multimodal networks; multimodal freight networks; traffic signal timing information; GIS-T; commercial street network data acquisitions; regional aerial photography data acquisitions; field network data collections

2007 Regional Truck Survey; 2007, 2012 ASU Surveys; 2008 External Travel Survey; 2009-2010 Regional Special Events Survey; 2008 NHTS; 2012 Travel Data Web Portal; 2012 Regional Airport Survey; 2015 Regional HTS; 2015 Regional ES

# The End

## Thank You for Your Time

Vladimir Livshits, vlivshits@azmag.gov

Wang Zhang, wzhang@azmag.gov

Sreevatsa Nippani, snipanni@azmag.gov

Krishnan Viswanathan, viswanathank@cdmsmith.com

William Kasper, Kasper@skycomp.com