MARICOPA ASSOCIATION of GOVERNMENTS

Development Status and Overview of the MAG Activity Based Model for Transportation Planning

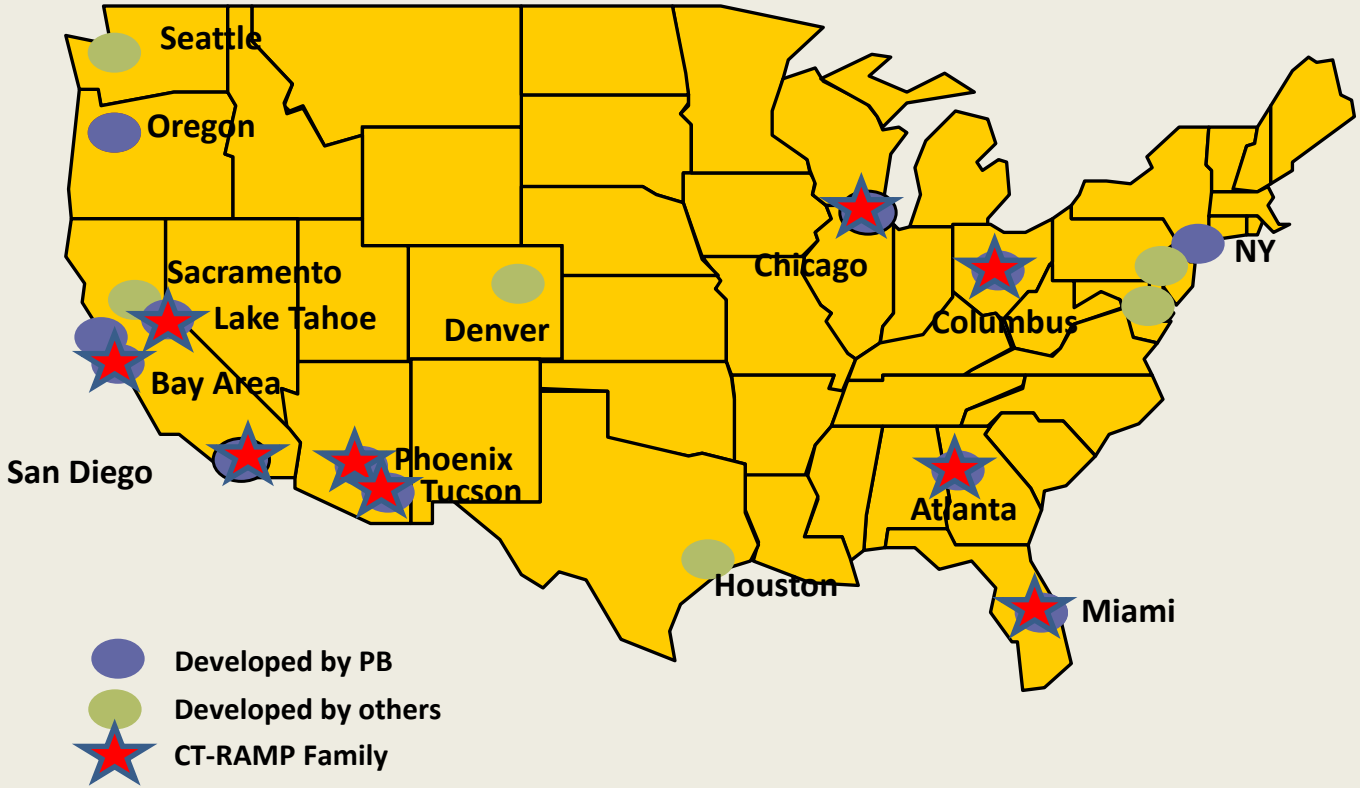
MAG Transportation Review Committee

July 28, 2016

Agenda Item 8

MAG ABM

- Developed in three phases with interruptions for contractual processes, funding allocations and amendments in order to incorporate critical latest research results.
- Phase I work started in mid 2009, Phase III completed in 2015 with operational model deployed on MAG servers in early 2016.
- Joint funding and in-kind support from MAG, PAG, PB
- Arguably the most advanced travel demand forecasting model in world at the moment. Many other agencies are building on it. MAG built on the experience of previous ABMs.

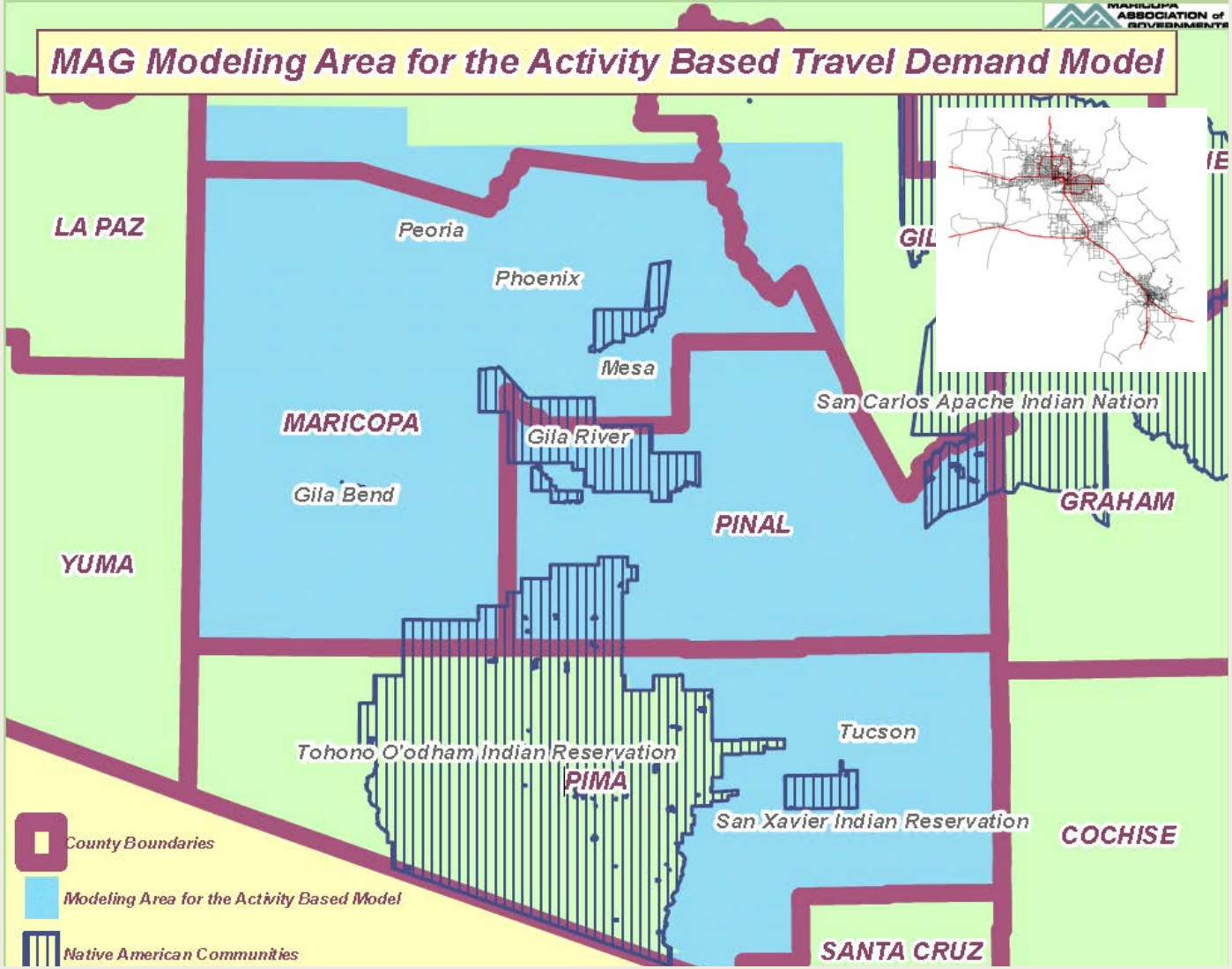

Seattle
Oregon
Sacramento
Lake Tahoe
Bay Area
San Diego
Phoenix
Tucson
Denver
Chicago
Columbus
NY
Atlanta
Houston
Miami
Developed by PB
Developed by others
CT-RAMP Family

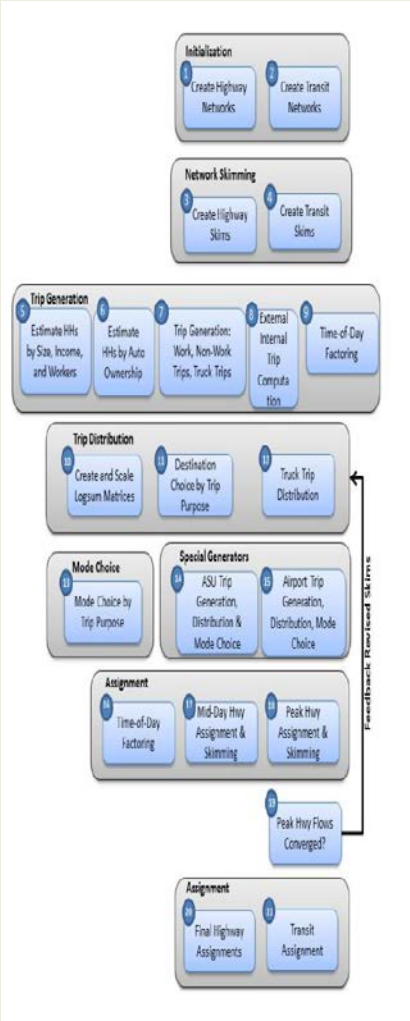
A Cutting Edge State-of-the-Art Model

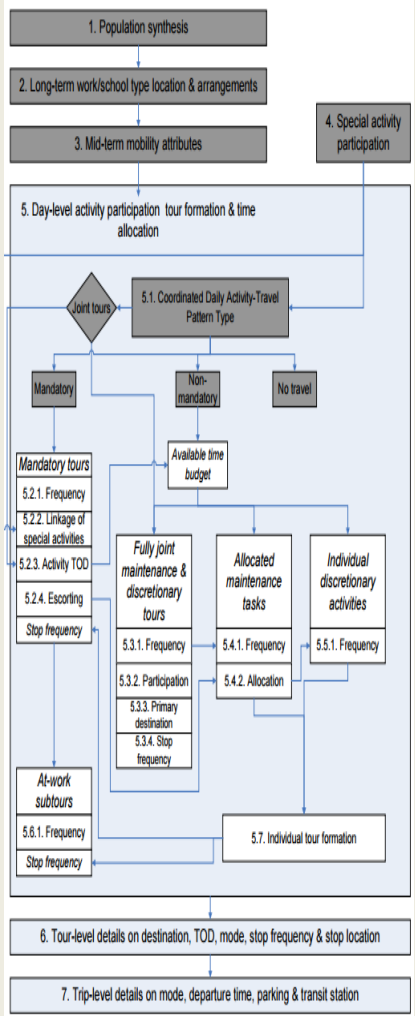
- **A mega-regional model**
- **A next-generation ABM, a third generation CT-RAMP model**
- **A MAZ-based model**

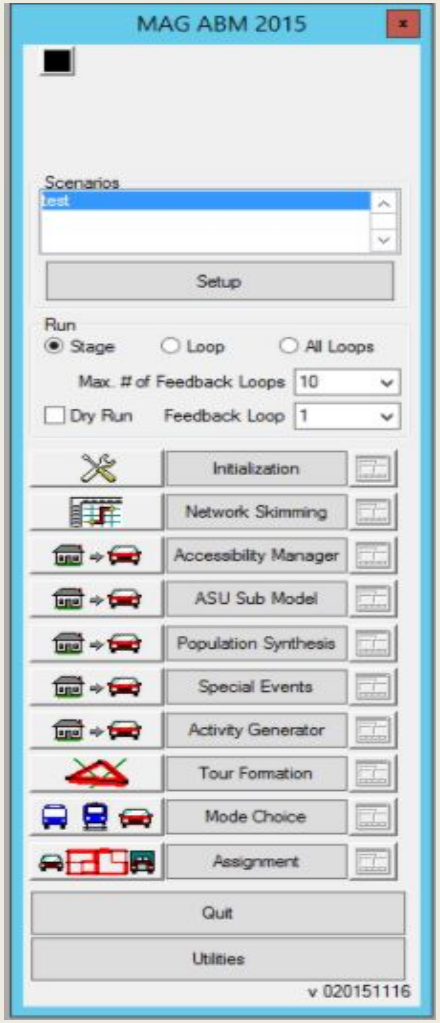
(3000+ TAZs, 26000+ MAG MAZs, 7000+ PAG MAZs)

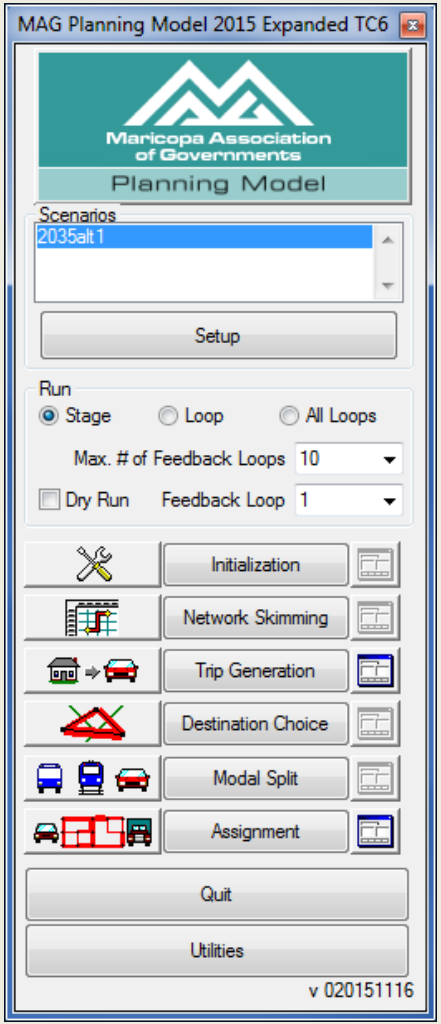
- **Agent-based behavioral fidelity with detailed person-types, personal mobility attributes, socio-economic activities and travel purposes**
- **A continuous time model**
- **A model with full intra-household member interactions**
- **The first model with tour formation and not tour generation**
- **The first model with detailed escorting sub-models**
- **The first model with elements of establishment-driven activity scheduling and fully incorporated special events sub-model**
- **Innovative visualization interface through CityPhi**

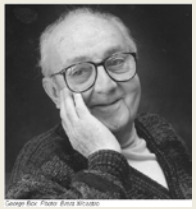

MAG Modeling Area for the Activity Based Travel Demand Model
LA PAZ
Peoria
Phoenix
Mesa
MARICOPA
Gila River
Gila Bend
San Carlos Apache Indian Nation
GRAHAM
PINAL
YUMA
Tucson
Tohono O'odham Indian Reservation
PIMA
San Xavier Indian Reservation
COCHISE
SANTA CRUZ
County Boundaries
Modeling Area for the Activity Based Model
Native American Communities


Initialization
1 Create Highway Networks
2 Create Transit Networks
Network Skimming
3 Create Highway Skims
4 Create Transit Skims
Trip Generation
5 Estimate HHs by Size, Income, and Workers
6 Estimate HHs by Auto Ownership
7 Trip Generation: Work, Non-Work Trips, Truck Trips
8 External Internal Trip Computation
9 Time-of-Day Factoring
Trip Distribution
10 Create and Scale Logsum Matrices
11 Destination Choice by Trip Purpose
12 Truck Trip Distribution
Mode Choice
13 Mode Choice by Trip Purpose
Special Generators
14 ASU Trip Generation, Distribution & Mode Choice
15 Airport Trip Generation, Distribution, Mode Choice
Assignment
16 Time-of-Day Factoring
17 Mid-Day Hwy Assignment & Skimming
18 Peak Hwy Assignment & Skimming
19 Peak Hwy Flows Converged?
Feedback Revised Skims
Assignment
20 Final Highway Assignments
21 Transit Assignment


1. Population synthesis
2. Long-term work/school type location & arrangements
3. Mid-term mobility attributes
4. Special activity participation
5. Day-level activity participation tour formation & time allocation
Joint tours
5.1. Coordinated Daily Activity-Travel Pattern Type
Mandatory
Non-mandatory
No travel
Mandatory tours
5.2.1. Frequency
5.2.2. Linkage of special activities
5.2.3. Activity TOD
5.2.4. Escorting
Stop frequency
Available time budget
Fully joint maintenance & discretionary tours
5.3.1. Frequency
5.3.2. Participation
5.3.3. Primary destination
5.3.4. Stop frequency
Allocated maintenance tasks
5.4.1. Frequency
5.4.2. Allocation
Individual discretionary activities
5.5.1. Frequency
At-work subtours
5.6.1. Frequency
Stop frequency
5.7. Individual tour formation
6. Tour-level details on destination, TOD, mode, stop frequency & stop location
7. Trip-level details on mode, departure time, parking & transit station


MAG ABM 2015
Scenarios
test
Setup
Run
Stage
Loop
All Loops
Max. # of Feedback Loops 10
Dry Run
Feedback Loop 1
Initialization
Network Skimming
Accessibility Manager
ASU Sub Model
Population Synthesis
Special Events
Activity Generator
Tour Formation
Mode Choice
Assignment
Quit
Utilities
v 020151116


MAG Planning Model 2015 Expanded TC6
Maricopa Association of Governments
Planning Model
Scenarios
2035alt1
Setup
Run
Stage
Loop
All Loops
Max. # of Feedback Loops 10
Dry Run
Feedback Loop 1
Initialization
Network Skimming
Trip Generation
Destination Choice
Modal Split
Assignment
Quit
Utilities
v 020151116



George Edward Pelham Box
(1919 – 2013)

For such a model there is no need to ask the question "Is the model true?". If "truth" is to be the "whole truth" the answer must be "No". The only question of interest is "Is the model illuminating and useful?".

We need Activity-Based Models (ABM) because they are less wrong and more useful:

- **Micro-simulation** models (modeling of individual households, people, cars) as opposite of aggregate models (modeling some aggregated spatial and temporal averages). They micro-simulate transportation demand and sometimes traffic as well (if integrated with traffic micro-simulations). ABM can be **agent-based models** (completely driven by behaviors of individual agents).
- **Disaggregate** models with high degree of spatial and temporal disaggregation (MAZ, parcels, continuous timelines vs. TAZ, aggregate time periods).
- Treating **travel demand as demand derived** from of socio-economic activities.
- **Tour-based** as opposite of trip-based, with tour FORMATION based on the socio-economic activities.
- Can **replicate surveys** in their structure and are person type, household type and detailed trip purpose based as opposite of simplified purpose-based models.

There is a new reality out there – it requires new tools and approaches

PLANNING NEEDS

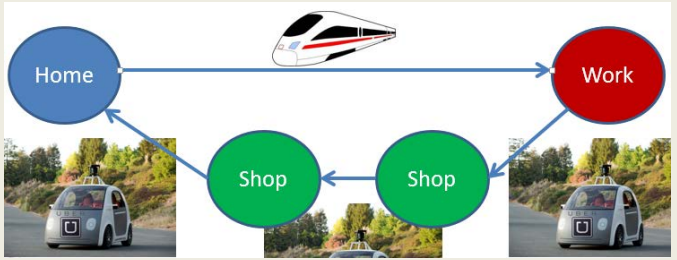
- **Need to plan in a transformative disruptive technological environment**
- Need to Evaluate New Policies and Regulations
- Need to Reflect New Travel Behavior
- **Need to Reflect changing demographic environment and changing generational travel preferences**
- Climate Change and Environmental Protection Needs
- Sustainability Needs
- Needs to account for Economic Volatility and for Plan Sensitivity
- Needs to Account for Uncertainty
- Needs to Evaluate New Travel Modes and Transportation Technologies

PLANNING SCENARIOS

- **Autonomous/Connected Vehicles, Driverless Reality**
- **Peer-to-peer ridesharing**
- **Commuter rail, High-Speed Rail, LRT, Innovative Transit Modes**
- **HOT/Toll Roads/Congestion Pricing/Dynamic Pricing**
- **Parking and Land use policies and regulations**
- **Non-motorized modes**
- **Travel Demand Services**
- **Environmental Justice**
- **Emerging Mega-regional Areas**

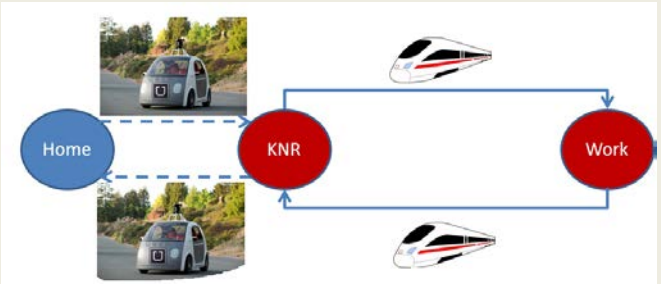
Impact of Connected and Autonomous Vehicles (2035)

- Elderly, youth, disable, and other people w/o driver license will have access to cars => ABM: SOV, HOV/driver modes not constrained by age
- Cars available at any location any time, not necessarily from home for entire tour => ABM: Trip mode combinations on the tour less restrictive with any sequence of auto and transit



Impact of Connected and Autonomous Vehicles (2035)

- Empty repositioning trips made by CAVs => ABM: Certain travel tours with 1 destination and long duration (4h+) may have car repositioning trips to and from home
- General convenience of CAV-KNR versus PNR and transit with walk access/egress => ABM: KNR convenience parameters equalized to auto



Impact of Connected and Autonomous Vehicles (2035)

- In-Vehicle Time Productivity => ABM: productivity “Bonus” for premium transit (-25% of IVT) applied to CAV
- Optimized use of highway capacity, more efficient driving, increased intersection capacity => ABM: Assumed modest link capacity growth 5-10% (other scenarios assume 50 to 100% capacity increases)

CAV Scenario Run Analysis

- Substantial growth in auto “driver” trips
- Elimination of many passenger, walk, taxi, and school bus trips
- Shift of transit users to Kiss and Ride
- CAVs generate more trips proportionately for simple and complex tour chains
- CAV is convenient for simple 1-destination tours due to possible repositioning (parking avoidance)
- CAVs largely eliminate auto passenger trips for simple tours
- CAVs reduce conventional transit especially for complex tours
- CAVs reduce Premium transit w/walk access especially for complex tours
- CAVs make KNR to Premium transit very strong and somewhat reduce PNR
- CAVs primarily reduce all other modes especially school bus
- Adds almost 500,000 empty trips (modeling assumptions can be revised)

What's Next?

- Application of the ABM for challenging planning projects, including autonomous vehicles, transit lanes, road pricing scenarios, planning policy examinations and main regional planning tasks
- Implementation of additional special generators, travel time reliability measures, additional behavioral agent-based features
- Integration with regional dynamic traffic simulations
- Detailed modeling of non-motorized modes
- Implementation of fleet composition models with behavioral modeling of fleet evolution
- Integration with the agent-based freight model
- Further development of visualization tools
- Additional training

We need Transportation Models because they are

- the only source of **quantifiable** information about the future.
- the only source of **consistent** system-wide information that seamlessly integrates disparate attributes of transportation system (volume, speed, OD demand, path, time-of-day, personal attributes, household attributes, etc.)
- **indispensable** for project selection, scenario testing, design, system analysis, forecasting and planning due to expensiveness or infeasibility of a real life testing.
- **evolving** and complimenting each other, providing a tool box rather than a single tool for all tasks.

Questions?

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