



BALTIMORE METROPOLITAN COUNCIL

BMC Activity Based Model – InSITE

Model Overview and application

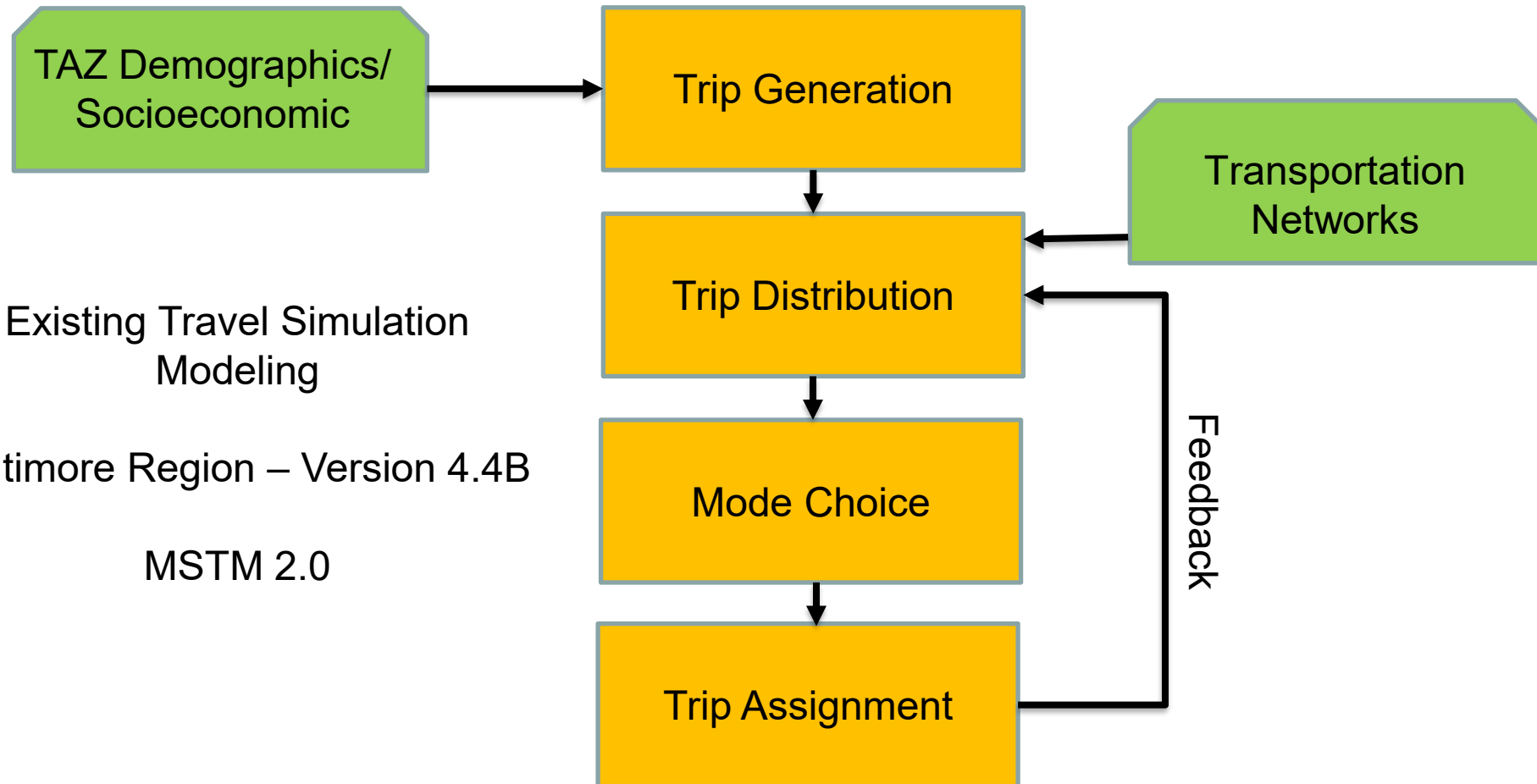
July 17, 2026



Background – Demographics and Travel

- **1980/90's**
 - FHWA's Highway Performance Monitoring System (HPMS) estimated ~4% VMT Annual Growth Rate
 - Zone based aggregated Trip Based Model (four-step model) 20-year forecast ~1.5% VMT Annual Growth Rate
 - Demographic Trends during high VMT Annual Growth Rate
 - Suburbanization
 - Average number of licensed drivers = number of household vehicles
 - Female Labor Force Participation ~ 38% in 1960 / 50% in 1980 / 60% in 2000
 - 2023 ~55.2% female and 65.6% male.
- **2000 Trip Based Model (aggregate) Enhancements**
 - Household Vehicle Availability Model
 - Household market segmentation for Home-Based Work trips
 - Households by income group (4) and workers (4)

Aggregate 4-Step Trip Based Model



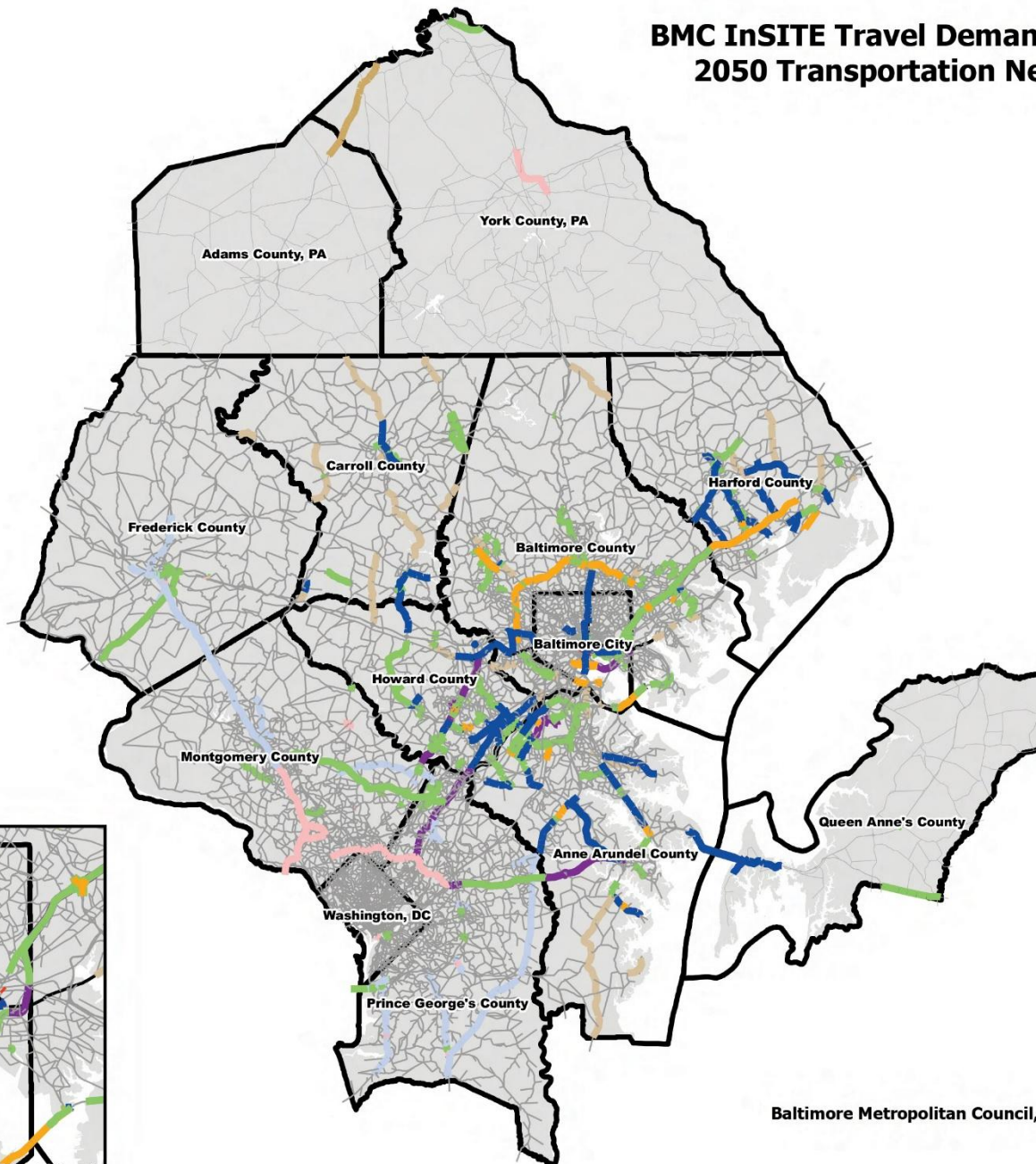
Background – Demographics and Travel

- **Need for a new approach**
 - Zone based aggregated model provided zonal averages and zone-to-zone trip movements.
 - A new approach referred to as microsimulation uses a very disaggregate approach to representing individual travel pattern.
 - Travel choices (e.g., destination, mode, departure time) are calculated as probabilities and Monte Carlo simulation techniques are applied to determine whether a trip was made, to what zone, by what mode, and at what time of day.
 - This new approach represents the future of travel forecasting.
 - The model must now consider roadway pricing, induced and latent travel demand, non-motorized trips, tourist trips, changing demographics, and new commuting patterns.

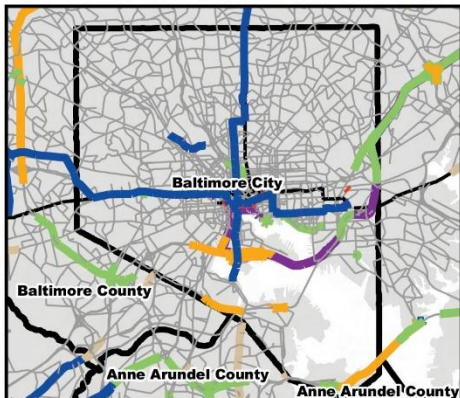
BMC InSITE Travel Demand Model: 2050 Transportation Network

Legend

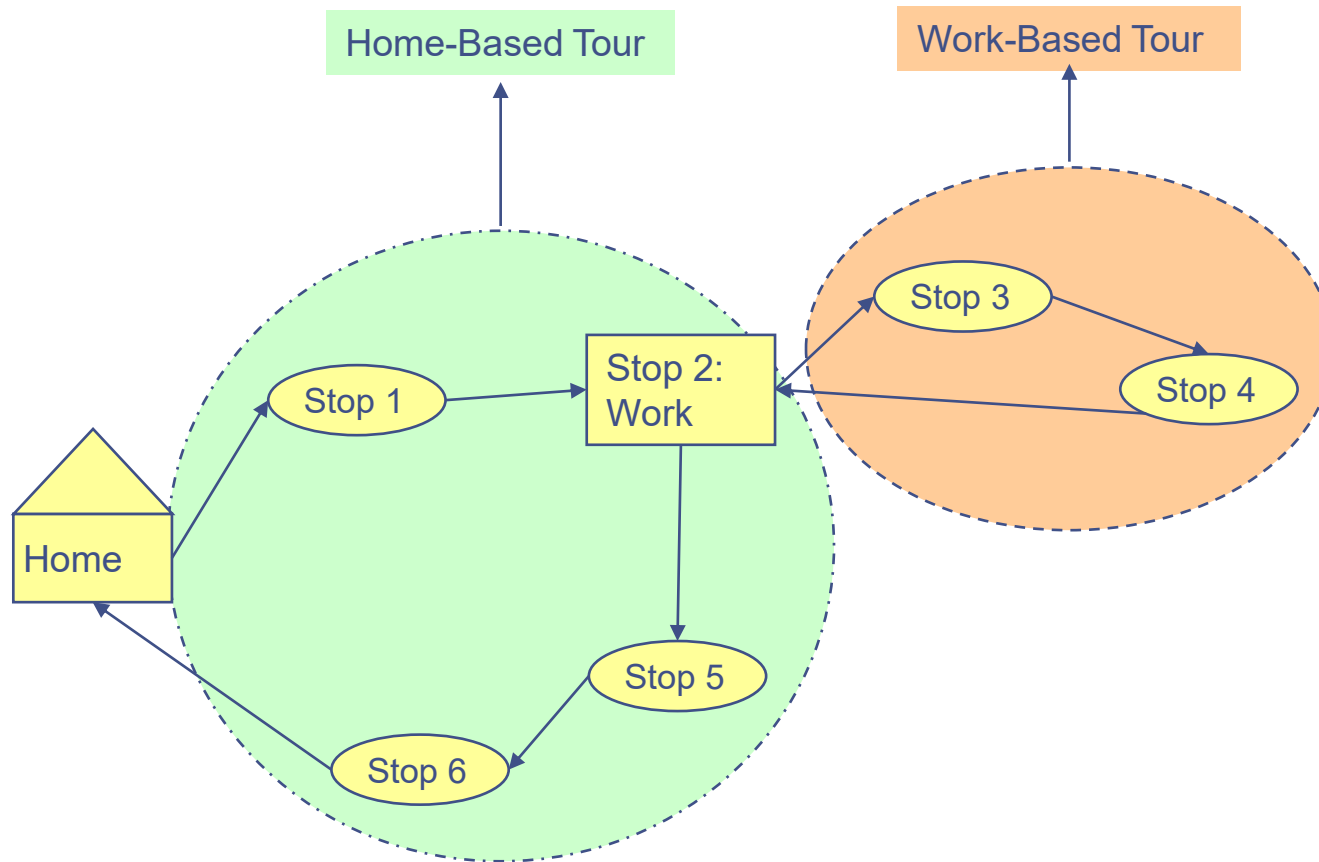
- Base Year Roads
- PROJECT SOURCE**
- Base Year Roads
- Completed Projects
- ETL Network
- Deferred Projects - Road
- ETL Network (B/W Pkwy)
- ETL Network (I-270)
- Kent Island Roads
- Queen Anne's County Roads
- PA Roads
- BMC TIP Projects
- East-West BRT road mods
- East-West Transit Alternatives
- North-South Transit Alternatives
- East-West BRT road mods
- BMC LRP Projects
- BRT Projects
- SHA HNI - Capacity
- Deferred Projects - Transit
- COG TIP
- COG LRP
- SHA HNI - Non-Capacity
- <all other values>



Baltimore



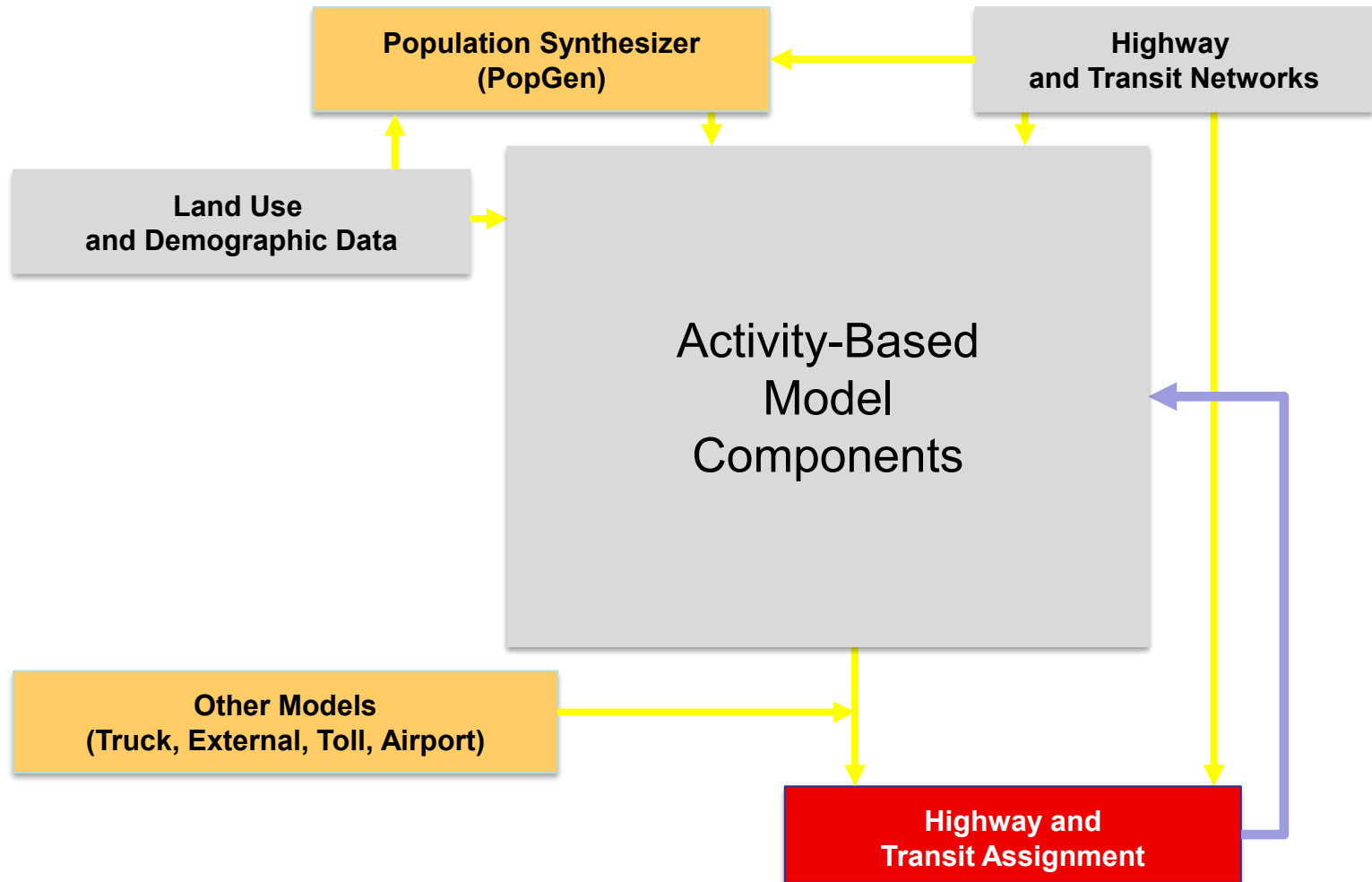
Activity Based Modeling



Activity-Based Models: Analytical Advantages

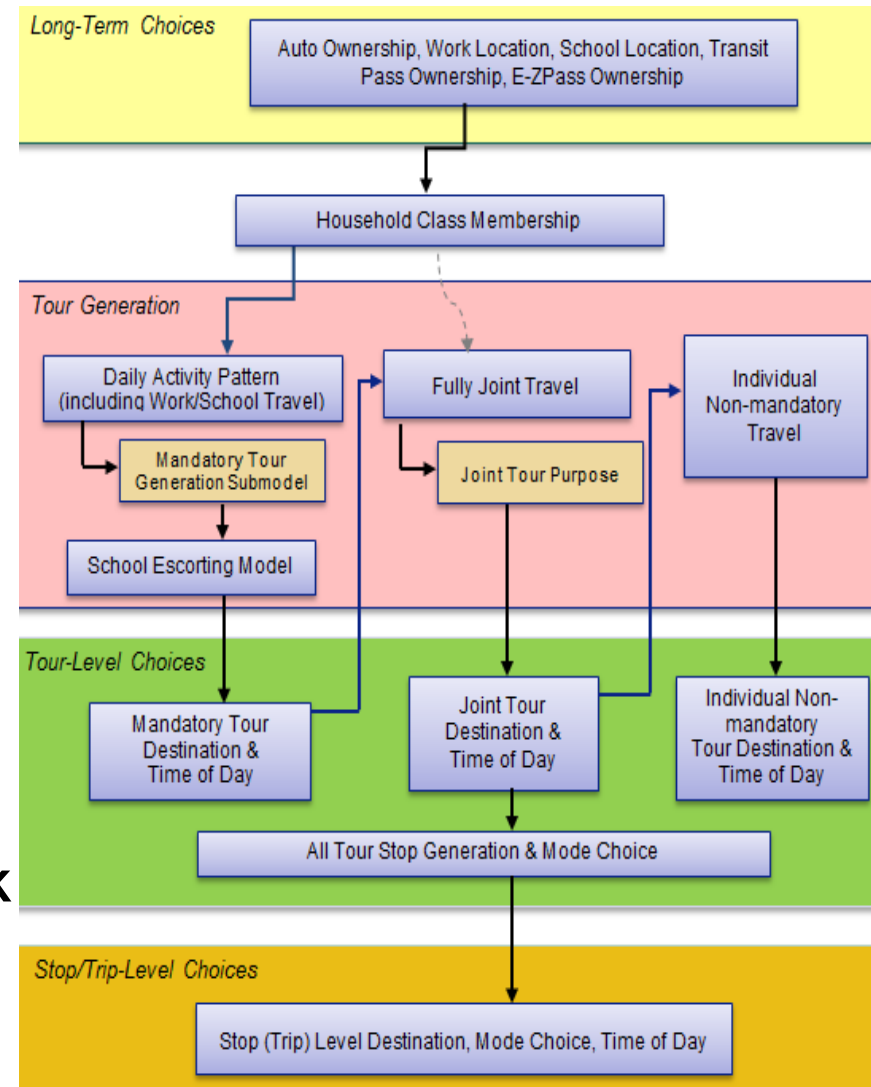
- More accurate representation of travel behavior, therefore expected to produce more accurate results for policy/project testing
- Disaggregate application – reduces aggregation error
- Can be easier to understand for decision makers and public (who are not necessarily familiar with four-step models)

Overall Model Design



BMC's Initiative to Simulate Individual Travel Events (InSITE) Model

- Completed in 2017
- Covers 10 Jurisdictions
 - Baltimore City
 - 8 MD counties: Baltimore County, Anne Arundel, Carroll, Harford, and Howard including 3 in MWCOG region (Frederick, Montgomery, and Prince George's)
 - Washington D.C.
- 2012 base year
- Simulates activities and travel through activity-based process
- 23 components of ABM Framework are implemented using TourCast platform and Cube software



Activity Based Model Components

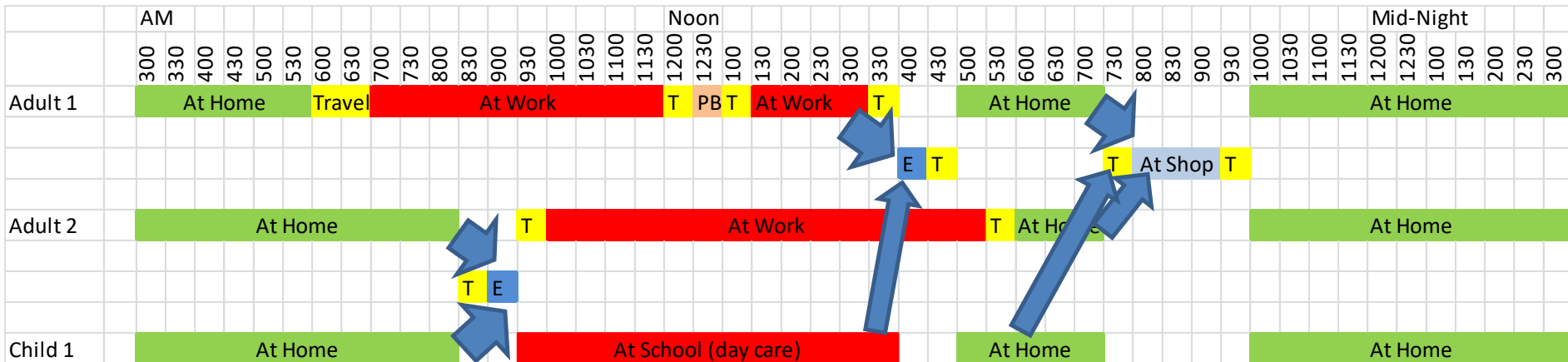
- **Synthetic population generator**
- **Long term choice models**
 - Workplace location, school location, auto ownership, transit pass ownership
- **Daily activity pattern models**
 - Daily activity pattern (work, school travel), joint travel, school escorting
- **Tour level models**
 - Tour destination choice, tour mode choice, time of day choice (the time period arriving at destination), work sub tour generation
- **Trip level models**
 - Trip mode choice, trip departure time, intermediate stop location,
- **Trip assignment**
 - Highway assignment (link volumes, travel time/speed), transit assignment (trips/boarding by route/stop)

Activity Based Model Components

Intra-Household Interaction

School Escorting on the Half Tour

Fully Joint Non-Mandatory Travel

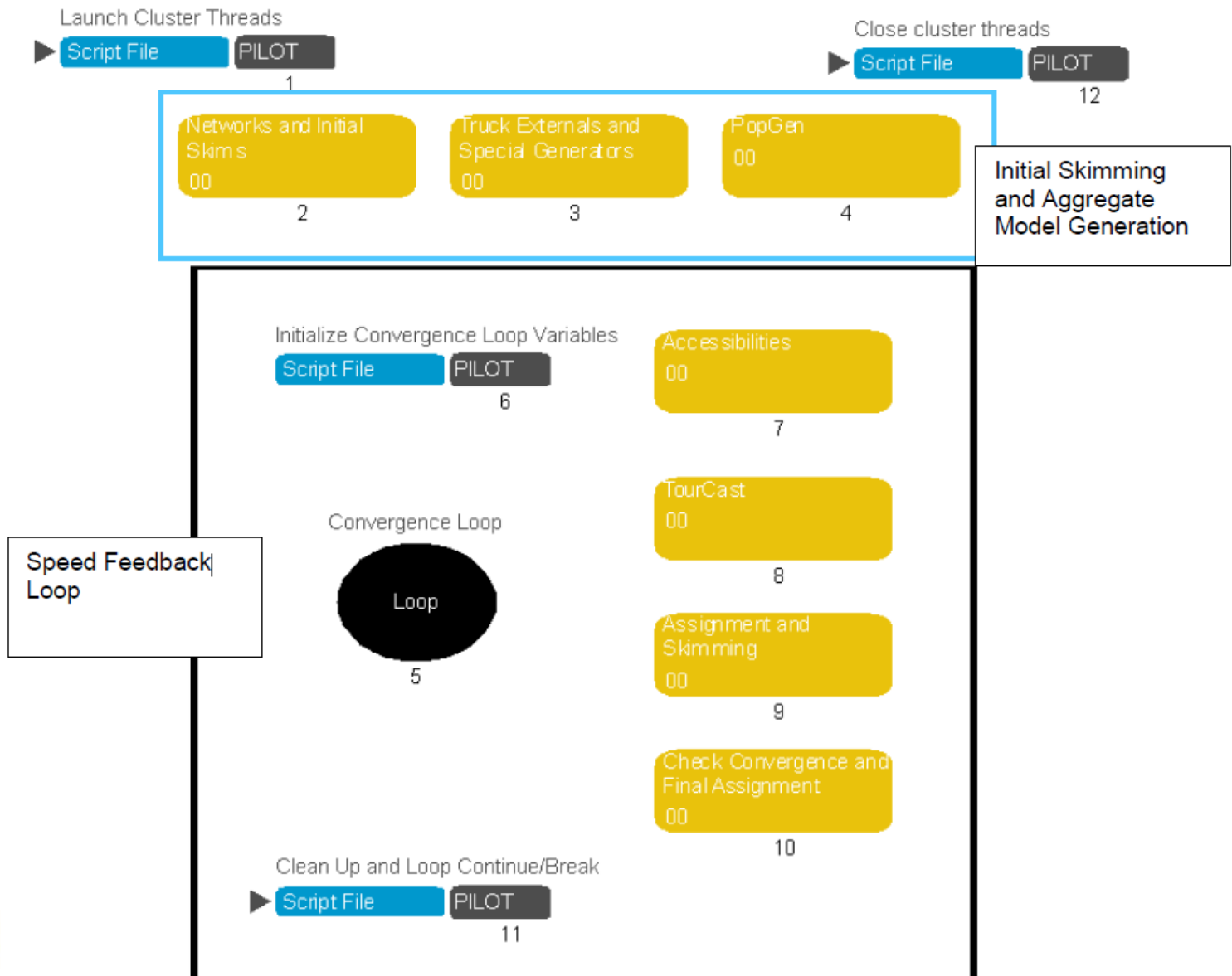


Intra-Household Interaction Could Effect Time of Day, Mode, Location Choice, and Route (Toll)

InSITE – Time of Day/Skims

Highway Network	Off Lanes												AM Lane				Off Lanes												PM Lanes				Off Lanes																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
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Steps of InSITE Model



Steps of InSITE Model

- **Network and Initial skimming:** Takes highway network and transit line files as inputs. Free-flow skims are generated for non-motorized modes, highways, and transit.
- **Truck and special generator:** This step models the part of external model components.
- **PopGen:** It creates sample households and persons tables using controls at jurisdiction and TAZ levels.
- **Accessibilities:** Calculates the aggregate logsums for activity-based choice model components.
- **Tourcast:** TourCast is the modeling framework consisting of different model components. Tourcast set the input and output files and select model components through scenario manager.

Steps of InSITE Model

- **Highway assignment:** Complete assignment for four time periods and aggregate trips of different time periods and converts person trips to vehicle trip.
- **Transit skim:** uses the loaded highway network to update the transit speeds and generate a new set of transit skims.
- **Convergence:** If convergence is achieved, results from highway assignment and transit assignment are combined into a single network.
- **Transit Assignment:** Assigns the walk-transit and drive-transit trip tables for peak and off-peak periods.

InSITE Model

- **InSITE – disaggregate micro simulation - Simulation for Each Person**
 - Synthetic Household/Population Generator – Household and Person Roster Record
 - Person Tour/Trip Roster – Simulated number of Tours/Trips for an Average Weekday
- **InSITE adopts the Daily Activity-Schedule Approach**
 - Daily Activity Schedule is Defined through the Concepts of Activity Pattern, and Activity Schedule
- **Two Activity Patterns**
 - “Mandatory” Activities – Work, School (day care), University
 - “Non-Mandatory” Activities – Meal, Shop, Personal Business, Social/Recreation, and Non-School Escorting

InSITE Model

- **What Demographic Trends to Simulate?**
 - **Baby Boomers**
 - Census estimates that seniors will surpass the number of children in 2034
 - **Households with Children**
 - ~ 2000 Household **with** Children were <50%
 - Adults living without children ~ 52.5 % 1967 / 71.3 % 2016
 - **Declining Total Fertility Rate (TFR) (more recent)**
 - US TFR ~ 1.66 (2.10 is considered replacement level)
 - **Region's Population Growth Will Require Domestic/International Migration (more recent)**
 - International Migration ~ 1.05 Million 2015-2016 / 477,000 2019-2020

Synthetic Household/Population Generation

- **Tools**

- Cooperative Forecast – TAZ estimates of Population, Households, and Total Employment
- PopGen version 2.0 – Marginal Control Variables at Two (Jurisdiction/TAZ) Geographic Levels
 - Jurisdiction Marginal Totals
 - Households - 1) Household by Size(5), 2) Household by Income(5)/Workers(4)
 - Group Quarter 1)Total Non-Institutional
 - Persons - Cohort(18)/Gender(2)/Race\Ethnicity (Non-Hispanic White Alone/Other)(2) (pOPTICS)
 - TAZ Marginal Totals
 - Households 1)Households by Size(5), 2) Households by Income, 3) Households by Workers (4)
 - Group Quarter – 1)Total Non-Institutional
 - Person – 1)Worker/Non-Work(2)/Race(Non-Hispanic White Alone/Other)(2)
- pOPulation Trends Interpreting Cohort Shifts (pOPTICS) – Components (Births/Deaths/Net Migration) of change Spreadsheet Model

InSITE Updates in 2022

- 2019 base year
- Expansion of model region
 - Queen Anne's County (MD)
 - York and Adams Counties (PA)
- Data/network updates
 - 2019 updates
 - Maryland Travel Survey
 - LOCUS (LBS)
- Updates to model structure
 - E.g., eliminated E-ZPass transponder ownership model





InSITE Run Time Enhancements

- **Population sampling**
 - Determined that 25% sample produced accurate results
 - Implemented within TourCast
 - Decreased run time by 45%
- **TourCast multi-processing**
 - Split households and persons according to TAZ's
 - Run a number of independent TourCast processes, each tied to a unique subdirectory of input files and a matching database
 - Run a set of scripts that coalesce results back into a single common trip matrix and common database
 - Decreased run time by 32%

What Analyses Will the Model Be Used For?

- Long range transportation planning
- Air quality analysis
- Land use planning
- Transportation infrastructure investments and improvements: Highway, Transit, and Non-motorized
- Travel Demand Management
- Equity/environmental justice analysis
- Effects of demographic changes
- Analysis of road pricing and managed lanes actions
- Planning for multimodal freight movements and alternatives to facilitate them



InSITE input data requirement

- **accessibilities:** accessibility logsum parameters for different zones used for choice models
- **network:** preprocessed highway networks with nodes and links
- **skims:** loaded highway and transit skims for first iteration (optional)
- **transit:** transit factor by time and region, line, fare, and system files describing parameter for transit modes
- **popgen:** preprocessed PopGen outputs
- **inputsFromPrevModel:** external, truck, and special generator files from trip based model
- **sedata:** zonal and parcel data

For More Information

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