MARYLAND DEPARTMENT OF TRANSPORTATION

STATE HIGHWAY ADMINISTRATION

TRAVEL DEMAND MODELING ACTIVITIES AT MDOT-SHA

National Capital Region Transportation Planning Board

Metropolitan Washington Council of Governments

Travel Forecasting Subcommittee

PRESENTATION OUTLINE

- MDOT-SHAs Travel Forecasting Evolving Needs *Lisa*
- Background/History of Analytical Tools (MSTM-TBM) *Lisa/Mark*
- Major Components/Research of MSTM-ABM
  - Multi-Resolution Inputs *Jonathan*
  - Statewide Freight Models (C20) *Sabya*
  - Long-Distance Passenger Model *Lei/Sepehr*
  - Statewide Short-Distance ABM Passenger Model (InSITE) *Lei/Sepehr*
- Next Steps/Future Plans *Lisa/Mark*
  - Improved Data Sharing with MPO models
  - MSTM-TBM2.0

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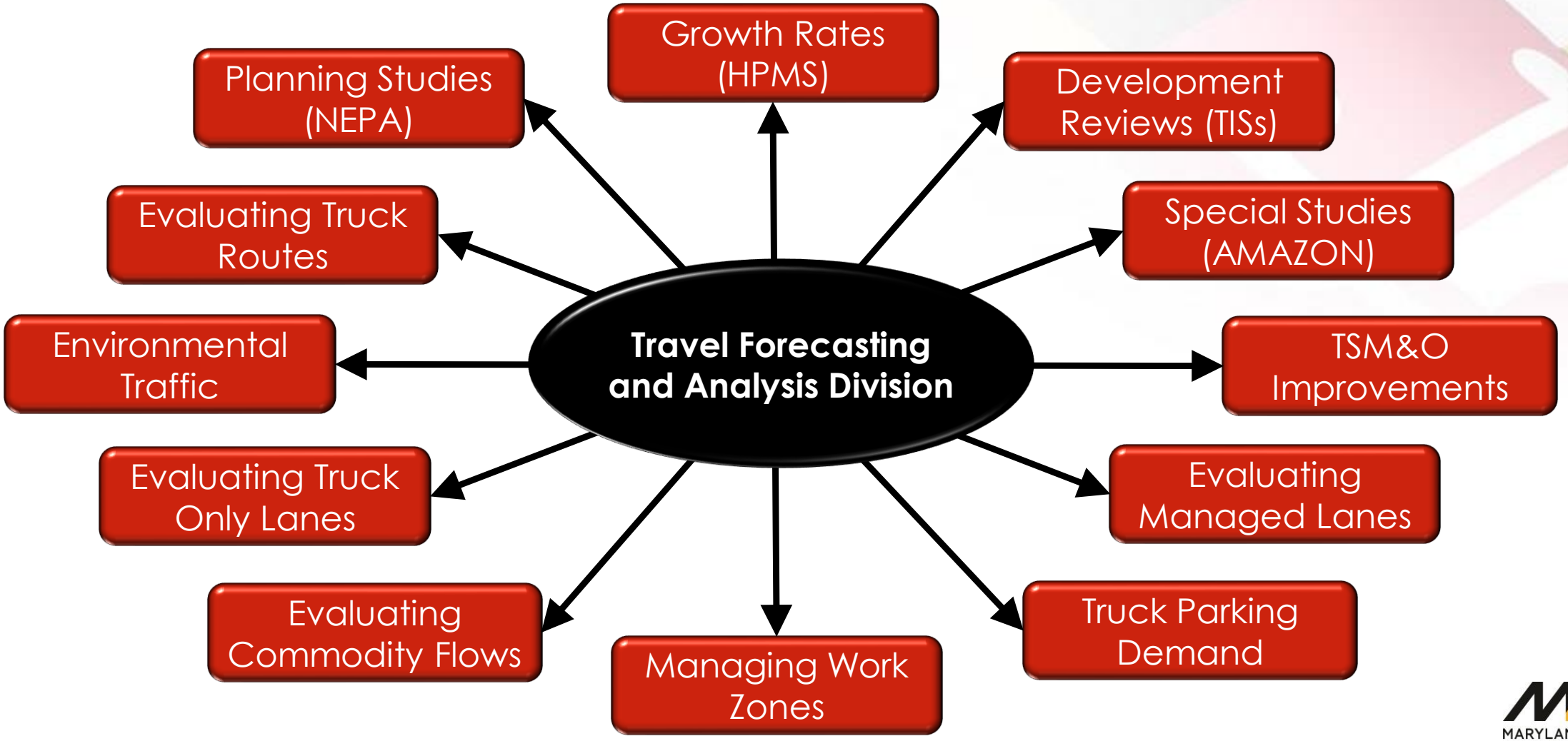
TFADs EVOLVING AND DIVERSE TECHNICAL NEEDS



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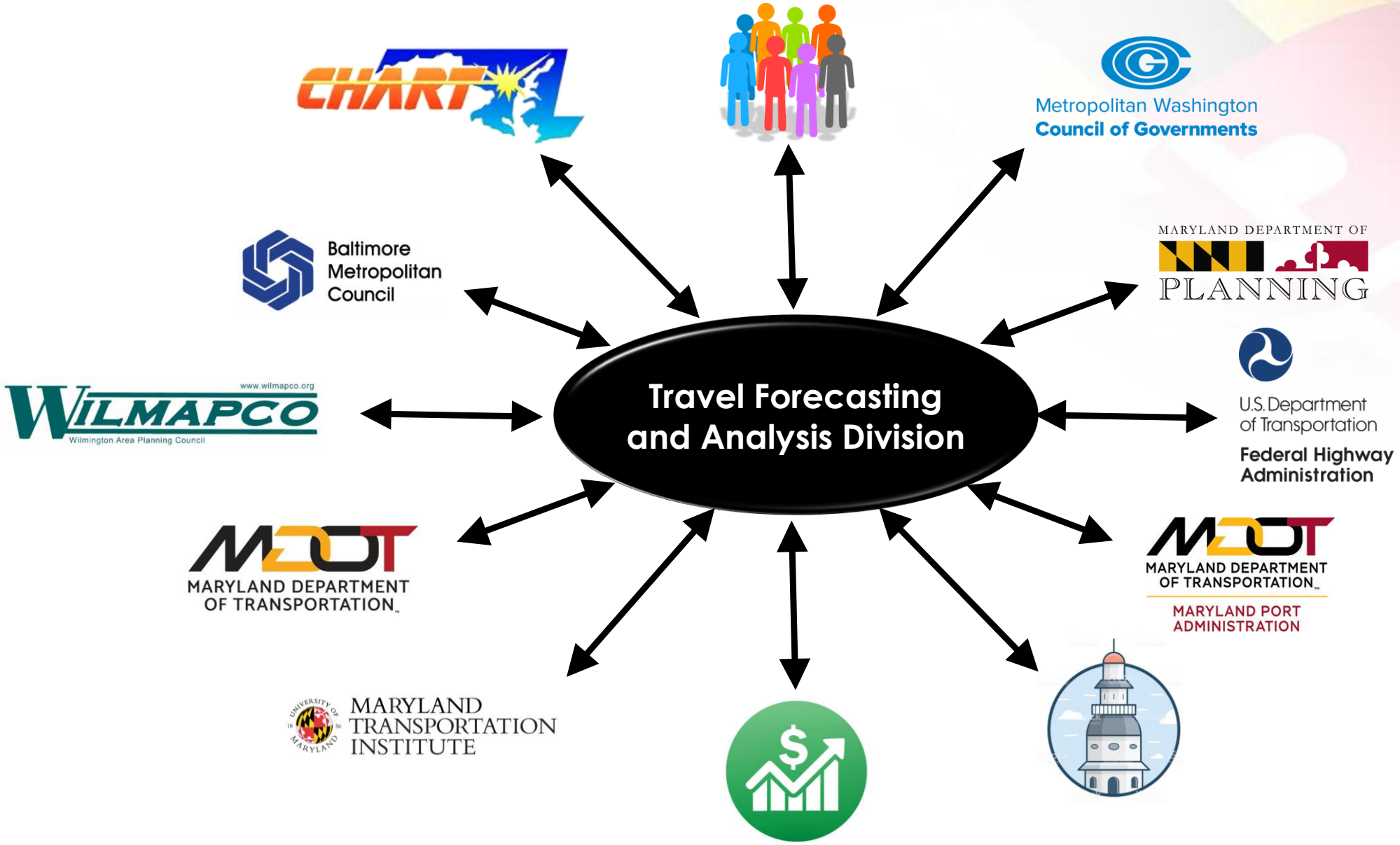
TFADs DIVERSE STAKEHOLDERS AND BUSINESS PARTNERS



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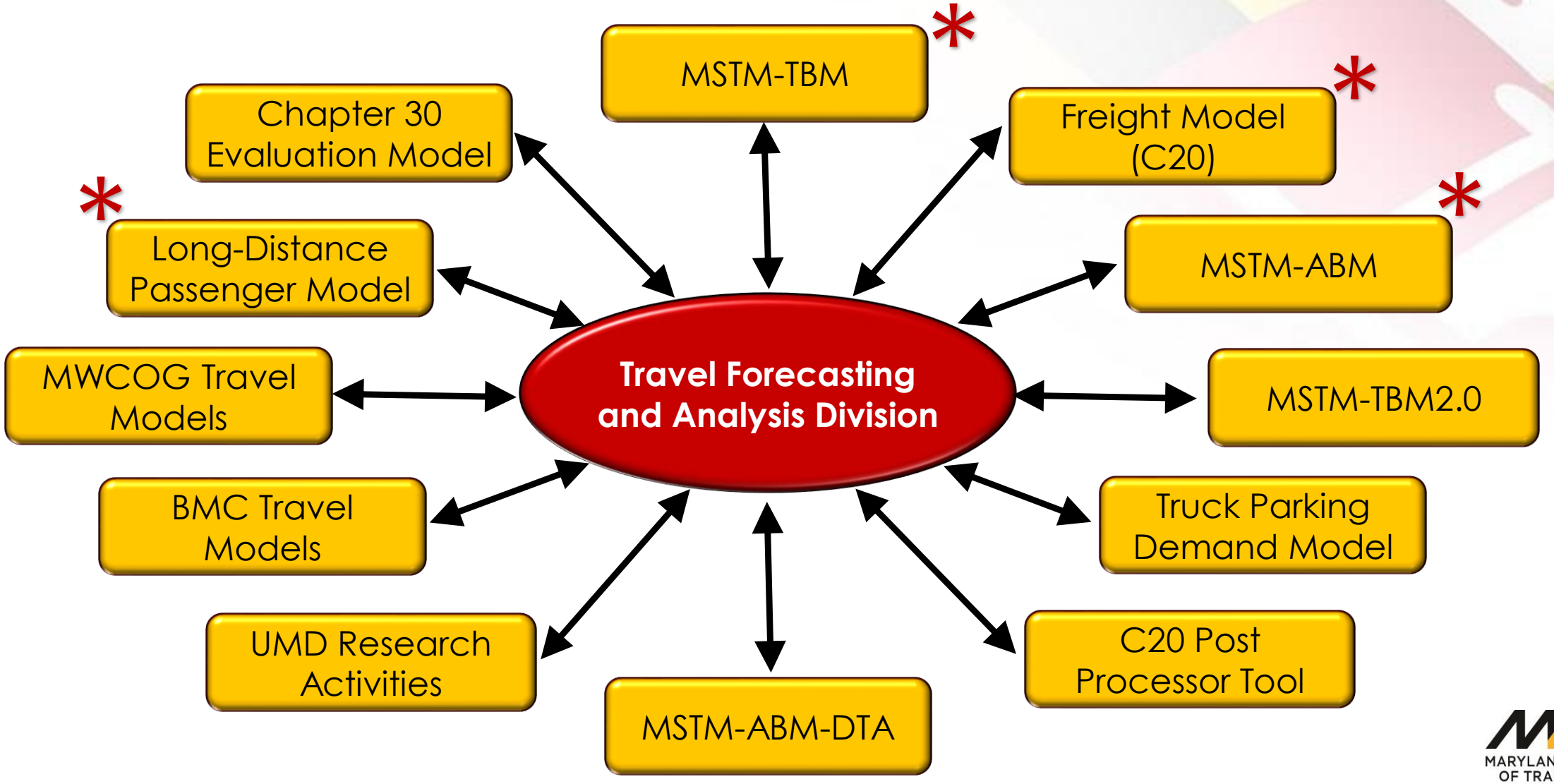
TFADs EVOLVING AND DIVERSE TECHNICAL TOOLS



* Discussing today

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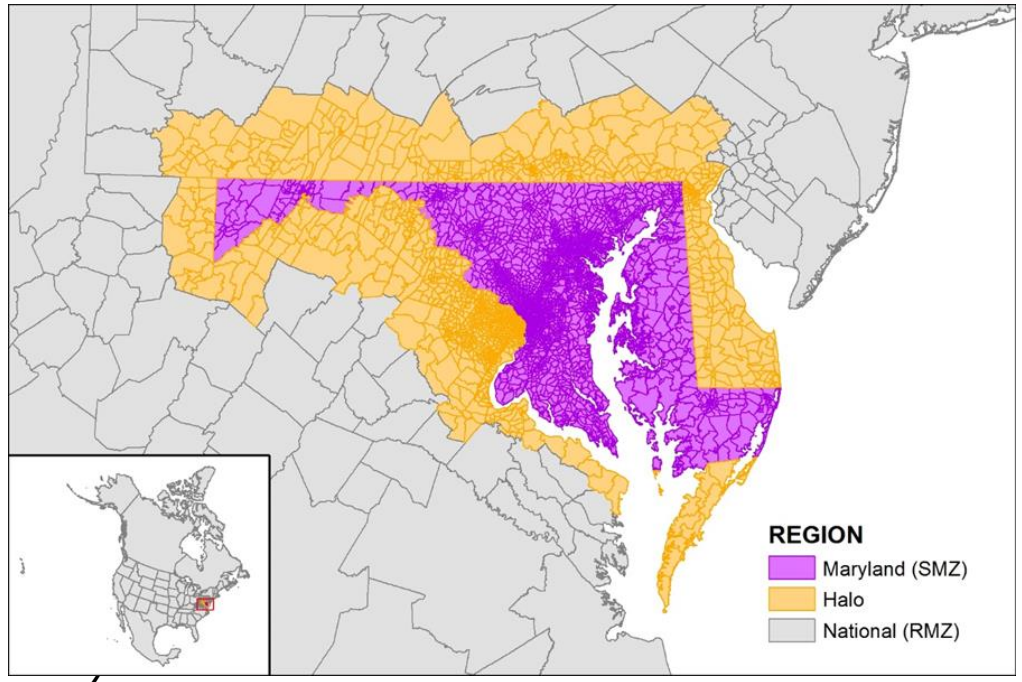
MARYLAND STATEWIDE TRANSPORTATION MODEL (MSTM-TBM)

- Developed with UMD and consultant team nearly 15 years ago
- Built off the Baltimore Metropolitan Council (BMC) regional model
- Trip-based model with ≈1,500 zones *within* Maryland
- Includes a 'halo' region around the state for a total of ≈1,800 zones
- Traditional 4-step model
- 4 time periods
- FHWA per review



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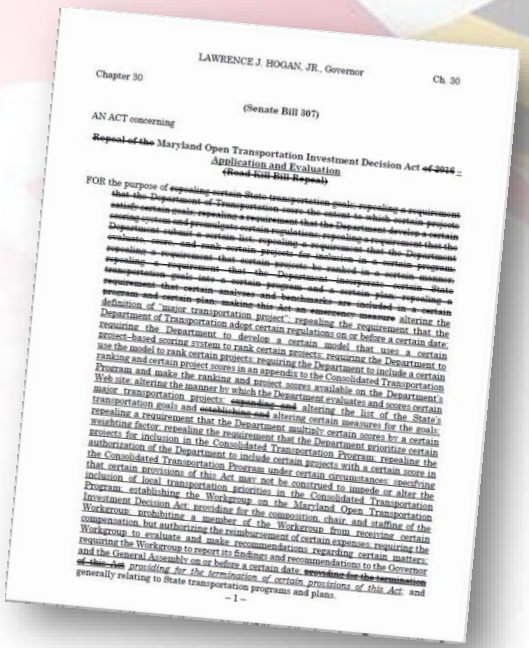
MSTM-TBM: MODEL OVERVIEW

- Provides a standardized platform for project evaluation, project prioritization (S.B. 307, e.g. Chapter 30), and statewide performance reporting.
- Socioeconomic inputs consistent with MPOs and MDP forecasts
- MPO zonal data nests within larger SMZs
- CUBE Voyager scripts executed within a MS-DOS batch file
- Approximately one-day runtime (i7 Intel 24-core processor, 64 Gb RAM)



LAWRENCE J. HOGAN, JR., Governor

Chapter 30 Ch. 30

(Senate Bill 307)

AN ACT concerning

~~Repeal of the~~ Maryland Open Transportation Investment Decision Act ~~of 2016~~ – Application and Evaluation

~~(Road Kill Bill Repeal)~~

FOR the purpose of ~~repealing certain State transportation goals; repealing a requirement that the Department of Transportation assess the extent to which certain projects would, certain transportation issues; repealing a requirement that the Department develop a certain scoring system and project selection process; repealing a requirement that the Department conduct, and submit to certain entities, a certain biennial report; repealing a requirement that the Department conduct, and rank certain projects in accordance with, a certain process; repealing a requirement that the Department develop a certain process for evaluating certain projects; repealing a requirement that certain projects be included in a certain transportation plan; repealing a requirement that the Department incorporate certain transportation goals into a certain program and a certain State program and certain plans; making this Act an emergency measure~~ altering the definition of "major transportation project"; repealing the requirement that the Department of Transportation adopt certain regulations on or before a certain date; requiring the Department to develop a certain model that uses a certain project–based scoring system to rank certain projects; requiring the Department to use the model to rank certain projects; requiring the Department to include a certain ranking and certain project scores in an appendix to the Consolidated Transportation Program and make the ranking and project scores available on the Department's Web site; altering the manner by which the Department evaluates and scores certain major transportation projects; ~~expanding~~ and altering the list of the State's transportation goals and ~~establishing~~ and altering certain measures for the goals; establishing factor; repealing the requirement multiply certain scores by a certain repealing a requirement that the Department prioritize certain projects for inclusion in the Consolidated Transportation Program; repealing the authorization of the Department to include certain projects with a certain score in the Consolidated Transportation Program under certain circumstances; specifying that certain provisions of this Act may not be construed to impede or alter the inclusion of local transportation priorities in the Consolidated Transportation Program; establishing the Workgroup on the Maryland Open Transportation Investment Decision Act; providing for the composition, chair, and staffing of the Workgroup; prohibiting a member of the Workgroup from receiving certain compensation, but authorizing the reimbursement of certain expenses; requiring the Workgroup to evaluate and make recommendations regarding certain matters; requiring the Workgroup to report its findings and recommendations to the Governor and the General Assembly on or before a certain date; ~~providing for the termination of certain provisions of this Act~~ ~~of the Act~~ providing for the termination of certain provisions of this Act; and generally relating to State transportation programs and plans.

– 1 –

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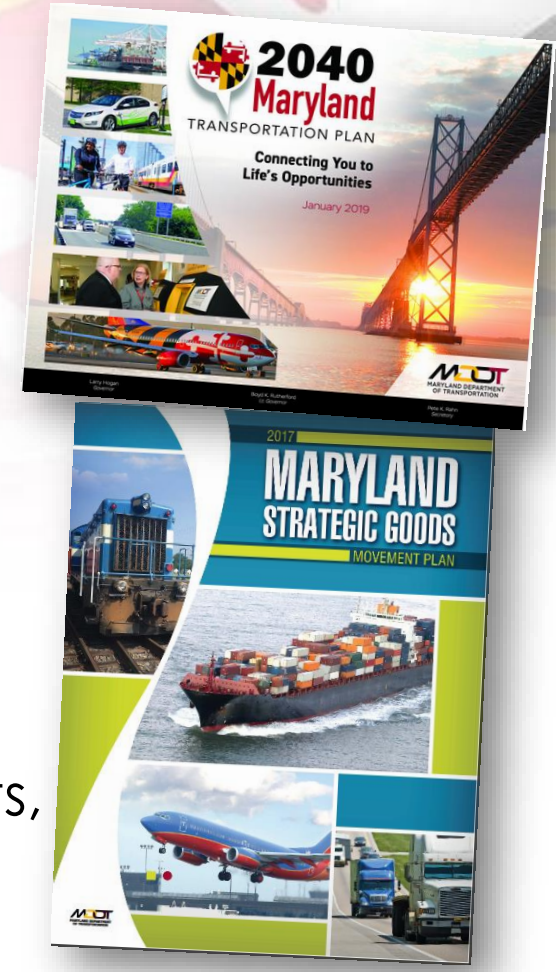
MSTM-TBM: TYPICAL IMPLEMENTATIONS

- Complimentary tool with other MPO models (MWCOG, BMC, Wilmapco)
- Project-level analyses still rely on regional MPO models when appropriate.
- Address model needs where evaluation tools are unavailable.
- Universal tool for project evaluation/project prioritization.
- Can better address projects that are along the fringes, traverse multiple MPO modeled regions, or lie outside modeled regions.
- Provides system-wide growth rates for mandatory FHWA-HPMS reporting.
- Informing MDOT-SHA initiatives (Maryland Transportation Plan, Maryland Strategic Goods Movement Plan, Annual Mobility Reports, etc.
- Policy sensitivity analyses (truck lanes, CAVs, etc.).
- *Current challenges with evaluating operational issues such as managed lanes, peak spreading, TSMO efforts, etc.*



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NCHRP/SHRP2 AWARDS AND OTHER RESEARCH

- Technical challenges led to exploration of several FHWA/SHRP2 grants
  - Behavior based Freight Models (C20): SHA/ BMC developed supply chain based statewide freight models and tour based commercial vehicle models ($350K)
  - Advanced Travel Analysis Tools (C10): SHA/UMD developed a multi-resolution and time-dependent travel demand model for integrated planning and operations ($700K)

- UMD was also involved in the development of a national long-distance passenger model as part of an FHWA Exploratory Advanced Research (EAR) grant.

SHRP2 STRATEGIC HIGHWAY RESEARCH PROGRAM

RSG

CAMBRIDGE SYSTEMATICS

UNIVERSITY OF MARYLAND 1856 MARYLAND TRANSPORTATION INSTITUTE

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DEVELOPMENT OF SELECTED NEW TOOLS

- Multiresolution zones and networks
- The importance of freight in Maryland
- Long distance trips to and from Maryland

MSTM: HIGHWAY NETWORK EVOLUTION

Background

- Original MSTM Network: Developed by stitching together MPO networks at the time and augmented with national data sources.

Challenges

- Quickly becomes outdated as MPO networks evolve and are updated
- Unable to leverage data from MDOT including centerline geography, geometric attributes and count data
- No connection between MSTM and covered models (MWCOG, BMC, Peninsula Model)
- Challenges in application
  - Time required to develop refined networks for model applications

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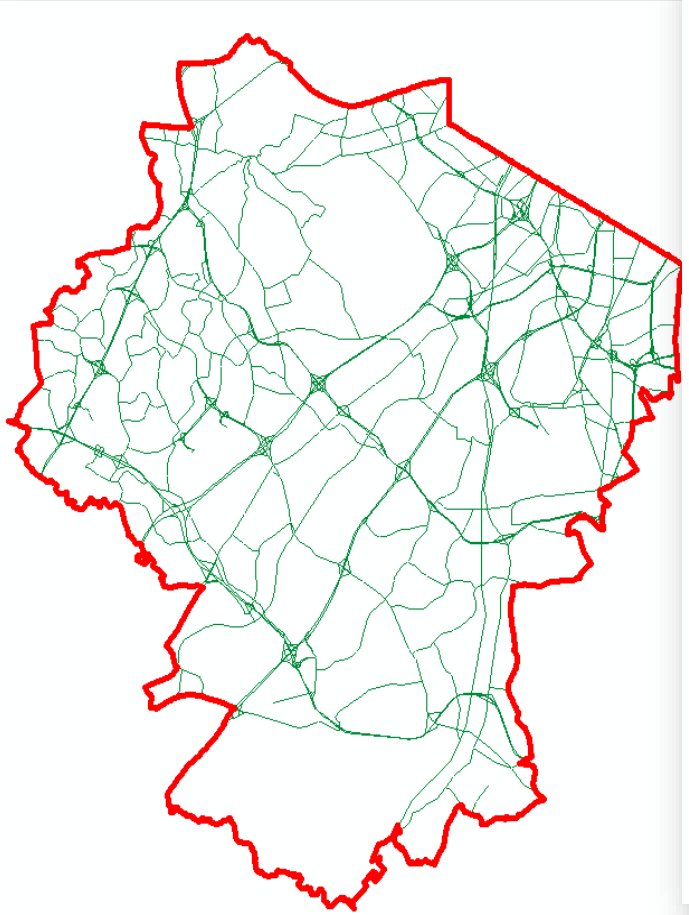
NEW DATA MODEL

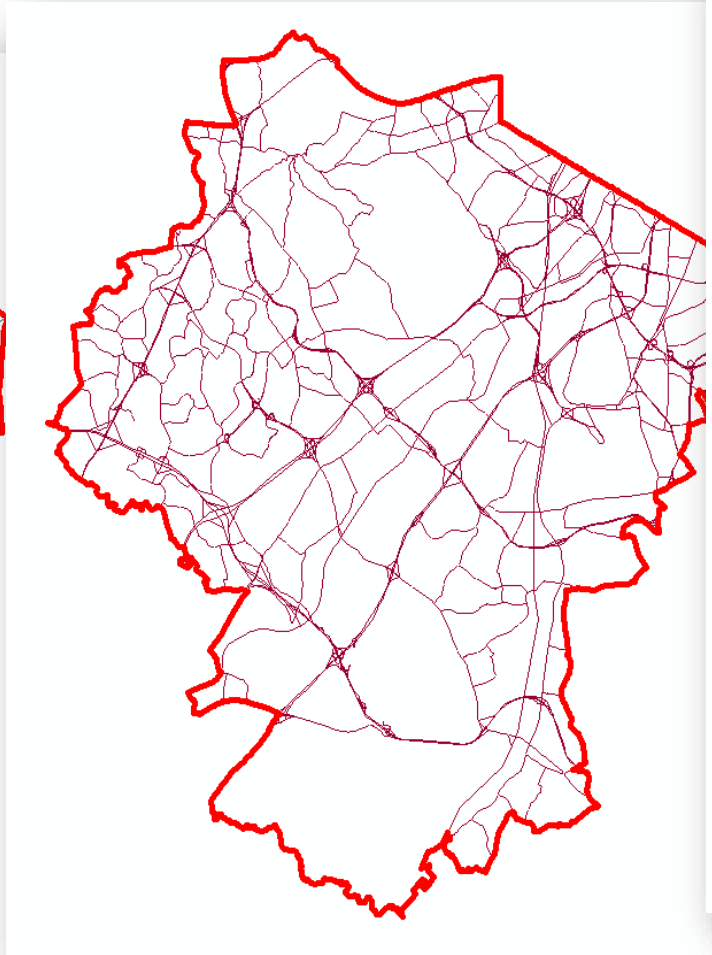
- Develop a network database that:
  - Leverage data from MDOT and partner models including attributes, counts, projects, etc.
  - Consistency in underlying data between overlapping models including trip based, activity based and mesoscopic tools
  - Development of a multi-resolution system of geography at both the zone and network scale with:
    - Consistency in design and implementation
    - Nesting of network and zone structures
  - Quickly build very high resolution networks for project level analysis, including meso and microscopic tools

SAMPLE SCALABLE PLATFORM: NETWORK

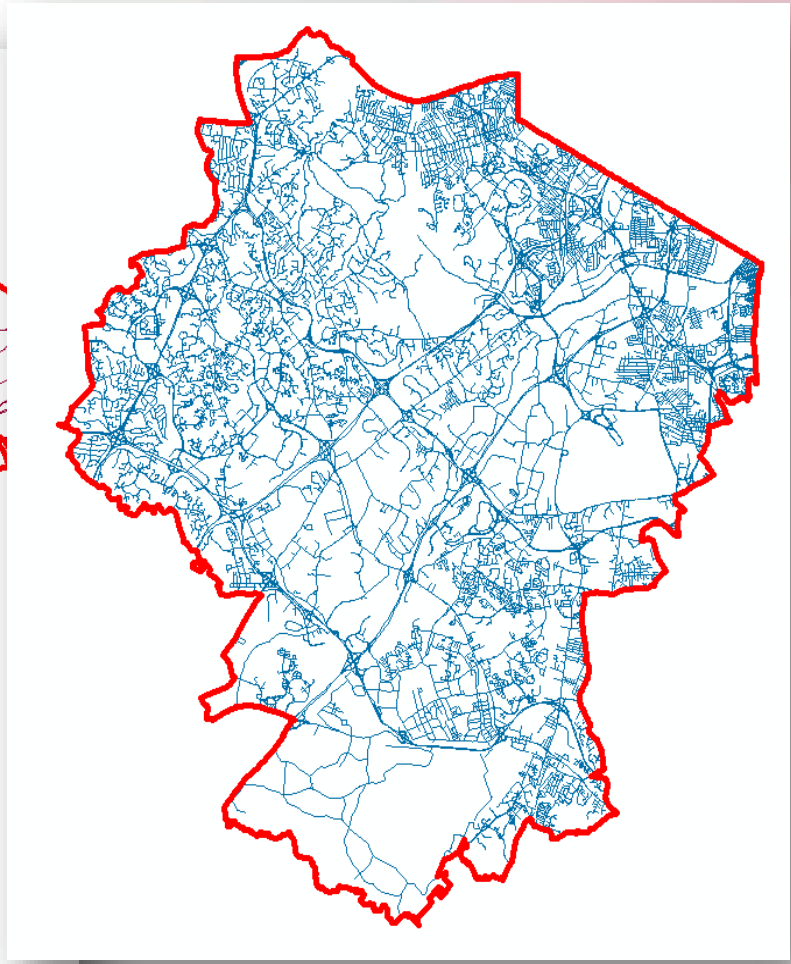
Level 1
MSTM Network



Level 2
MPO Network



Level 3
SHA Centerline Network



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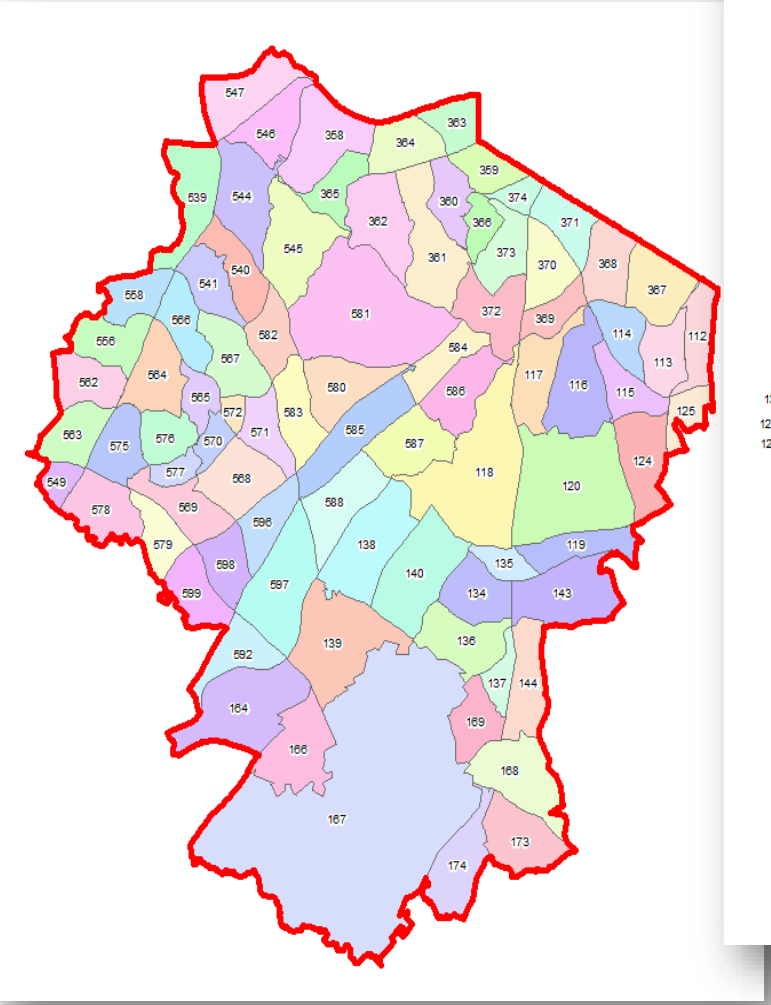
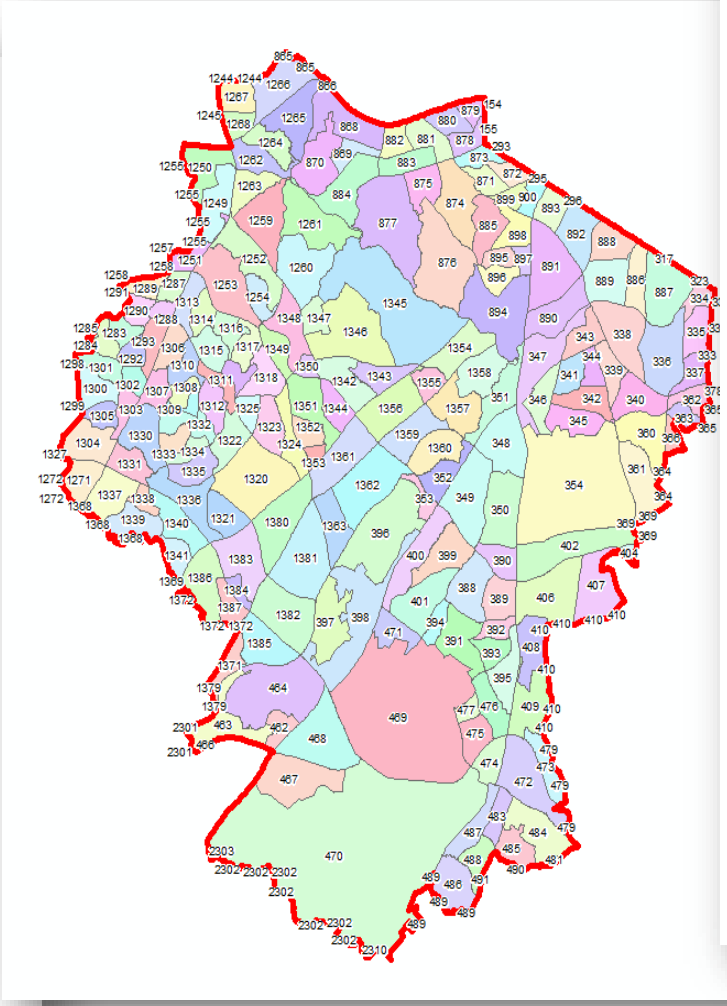
SAMPLE SCALABLE PLATFORM: ZONE STRUCTURE

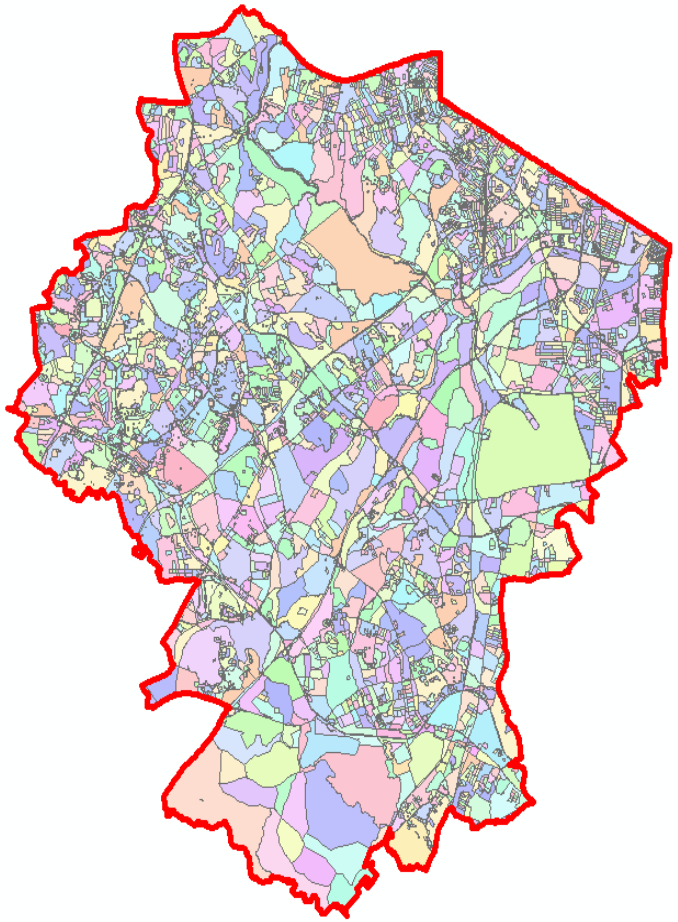
Level 1
MSTM Zones



Level 2
MPO Zones



Level 3
Census Block Zones



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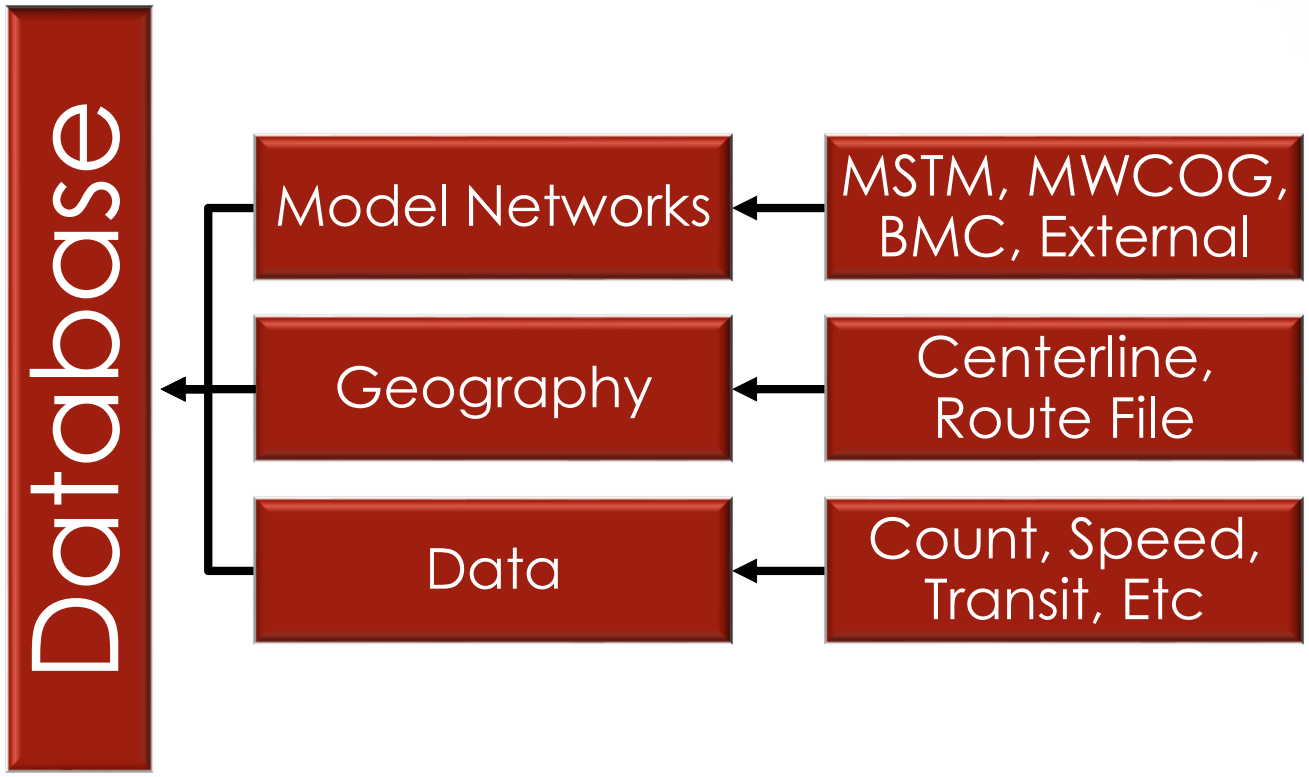
MDOT-SHA MULTI-RESOLUTION DATABASE



- Built from Centerline file
  - Association of Route, MSTM (v1) and other source datasets to centerline segmentation.
  - Linkage with SHA asset data
  - Creation of segmentation to support model network requirements
  - Single-Point intersection coding for future junction modeling

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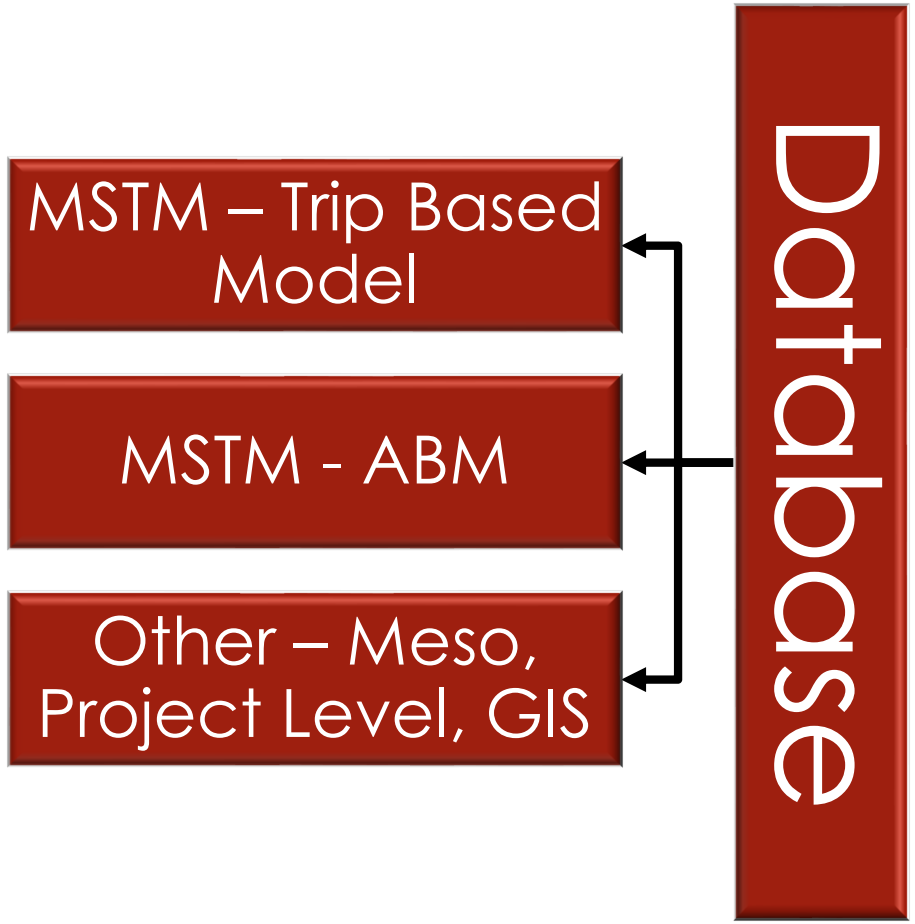
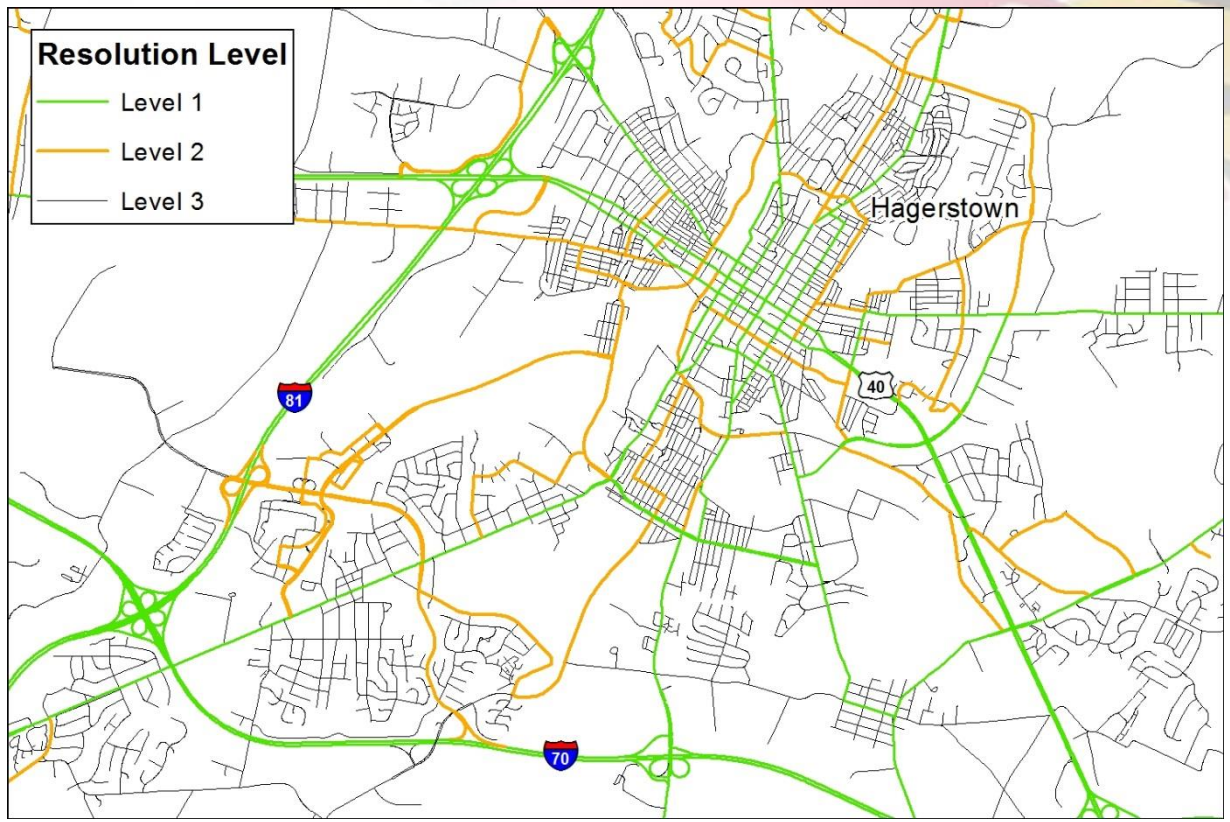
MDOT-SHA MULTI-RESOLUTION DATABASE





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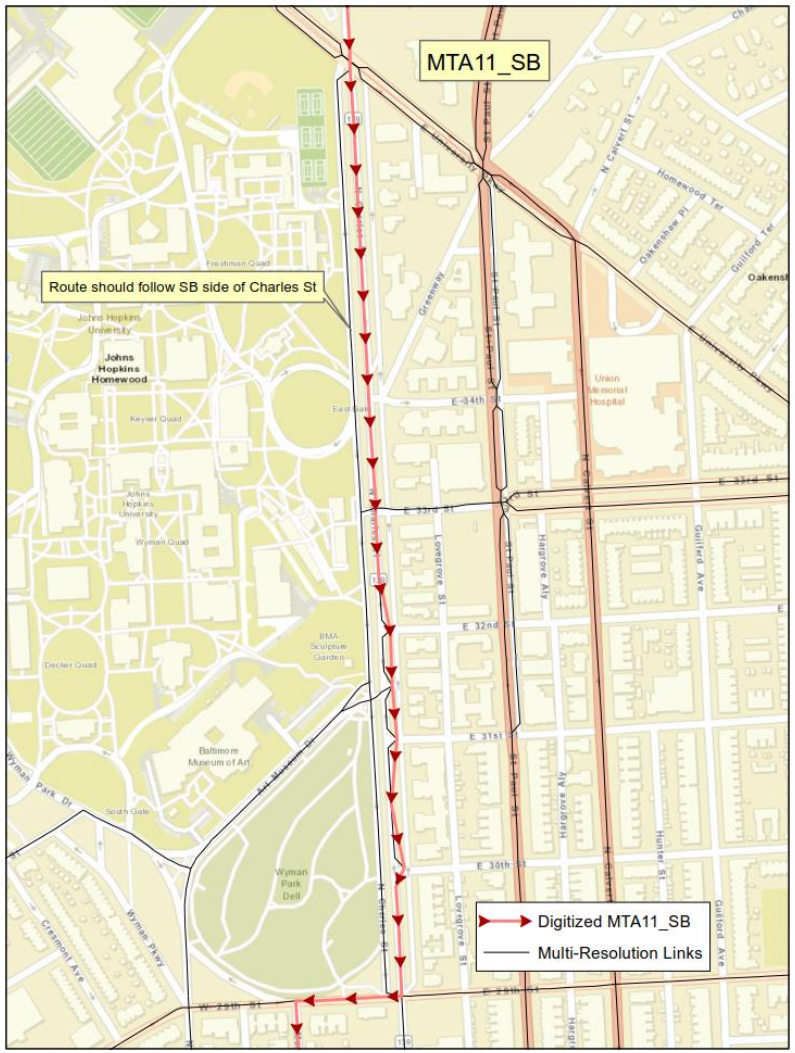
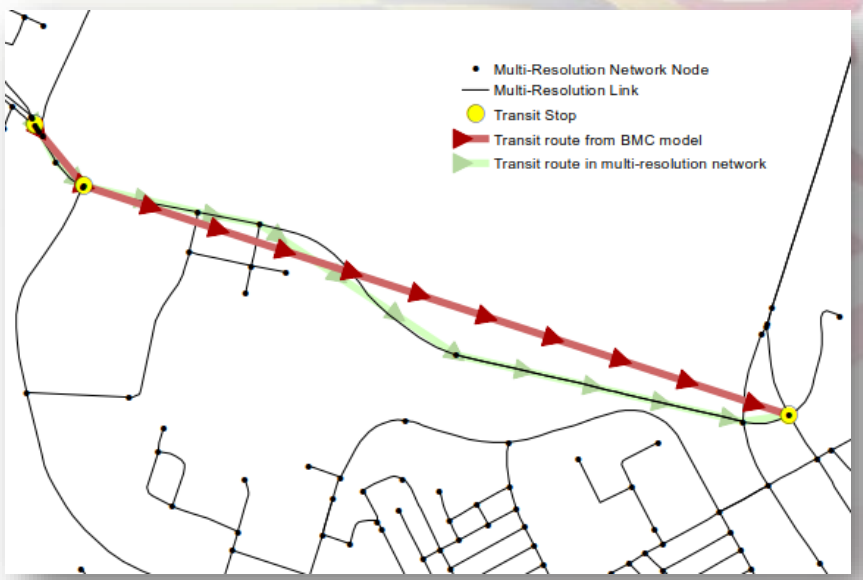
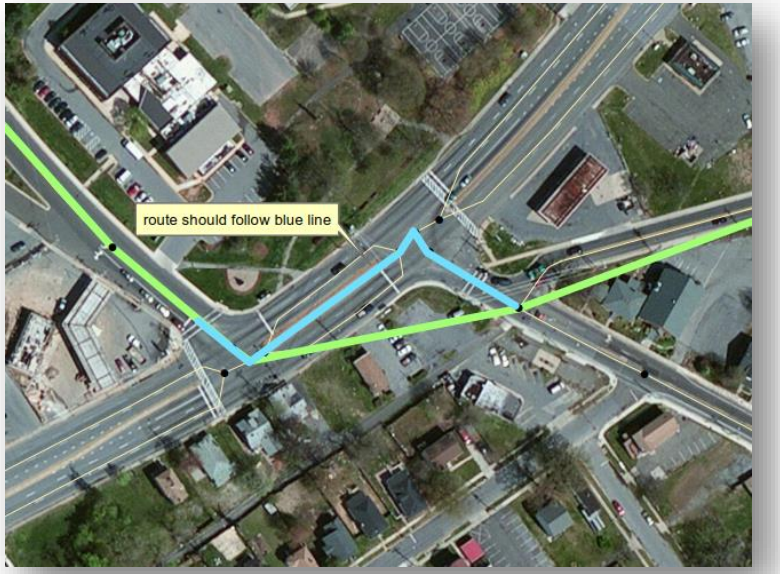
INCORPORATING TRANSIT







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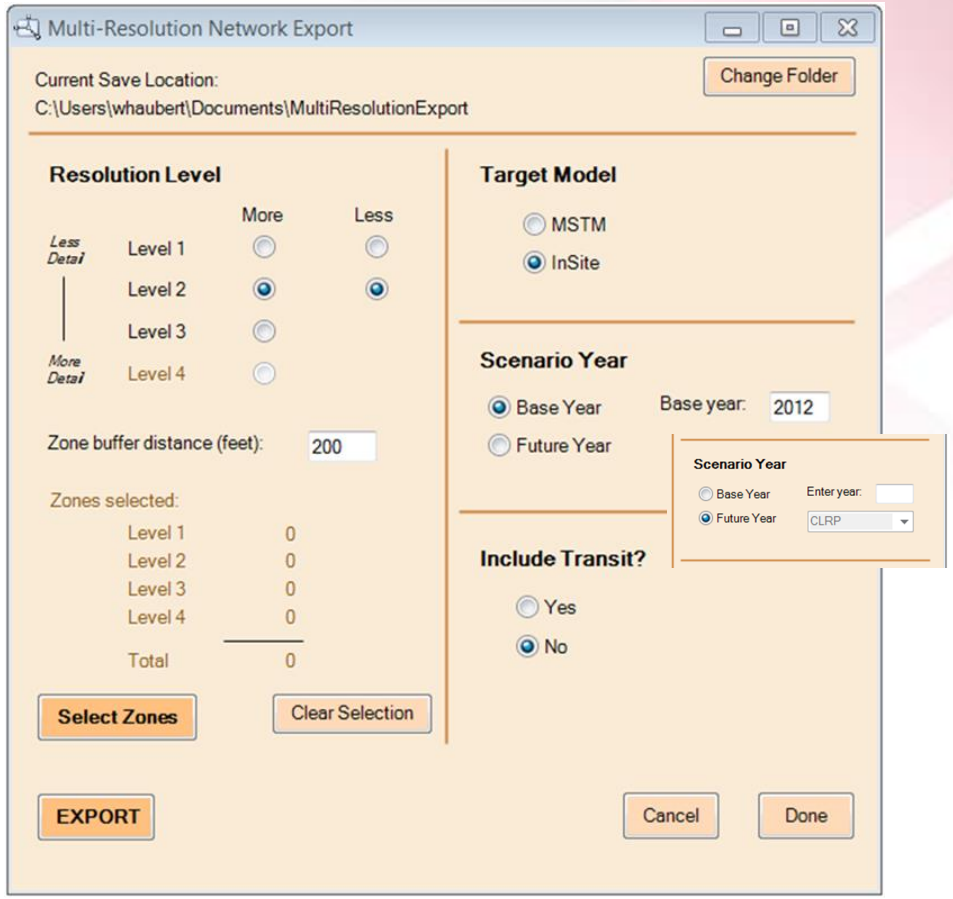
MANAGEMENT VIA A GRAPHICAL USER INTERFACE

Graphical User Interface

- Selection of resolution
- Definition of buffer area for resolution transition
- Management of selection process
- Selection of attribute scheme
- Model year, and scenario
- Includes transit data



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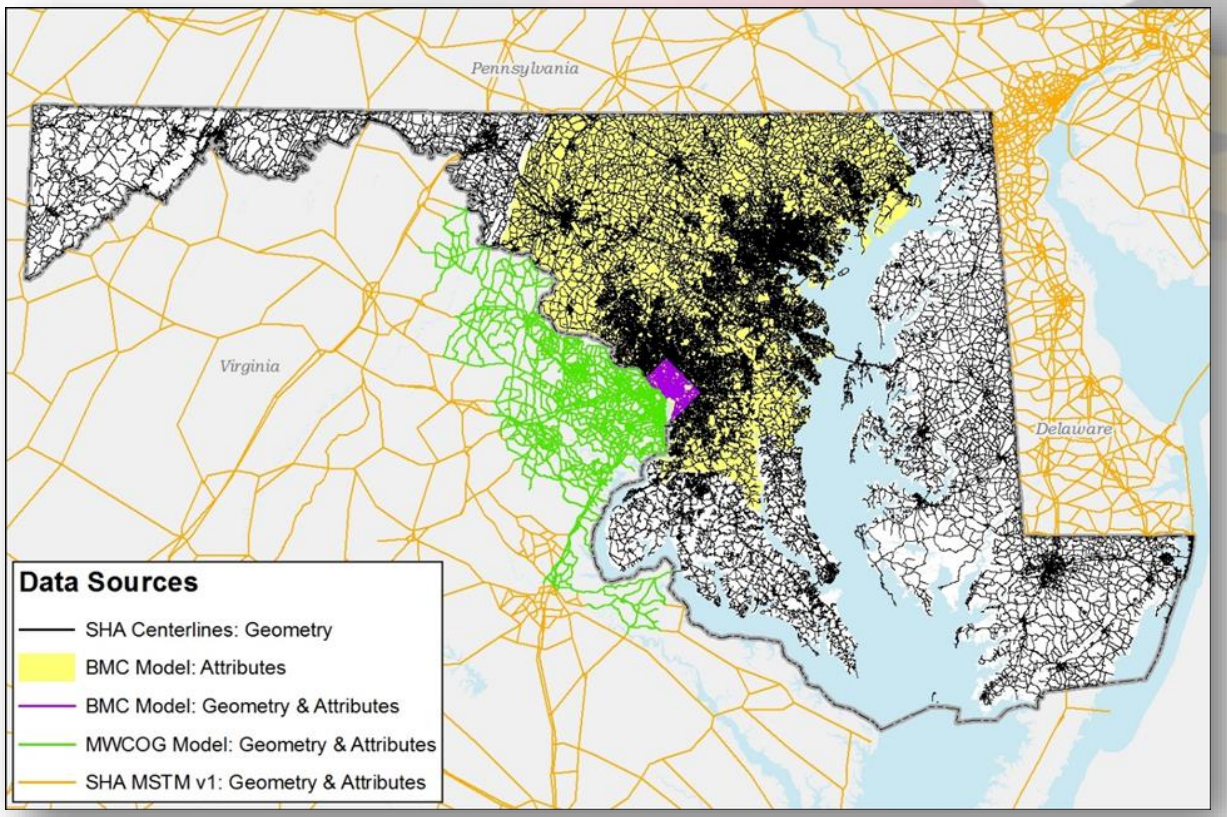
THE MSTM MULTI-RESOLUTION DATABASE – NEXT STEPS

- Implementation of update and maintenance
  - Integration of new projects from SHA, MWCOG, BMC, DelDOT, and halo regions
  - Moving base year forward
  - Consistency with demographic projections
  - Consistent network scheme across TFAD Tools
- Use of networks to support…



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DEVELOPMENT OF BEHAVIOR-BASED FREIGHT MODEL

- Based on SHRP2/C20 research grant
- Includes national supply-chain model, regional truck model, and commercial vehicle truck touring model
- Freight tours available
- O-D's can be based on any time slice (e.g., every 15 minutes)
- Truly multimodal model (not just truck based)
- Freight mode choice can easily be done
- Truck touring model for the entire modeling region
- Open source model structure in R (no installations needed)
- New enhanced dashboard for visualization

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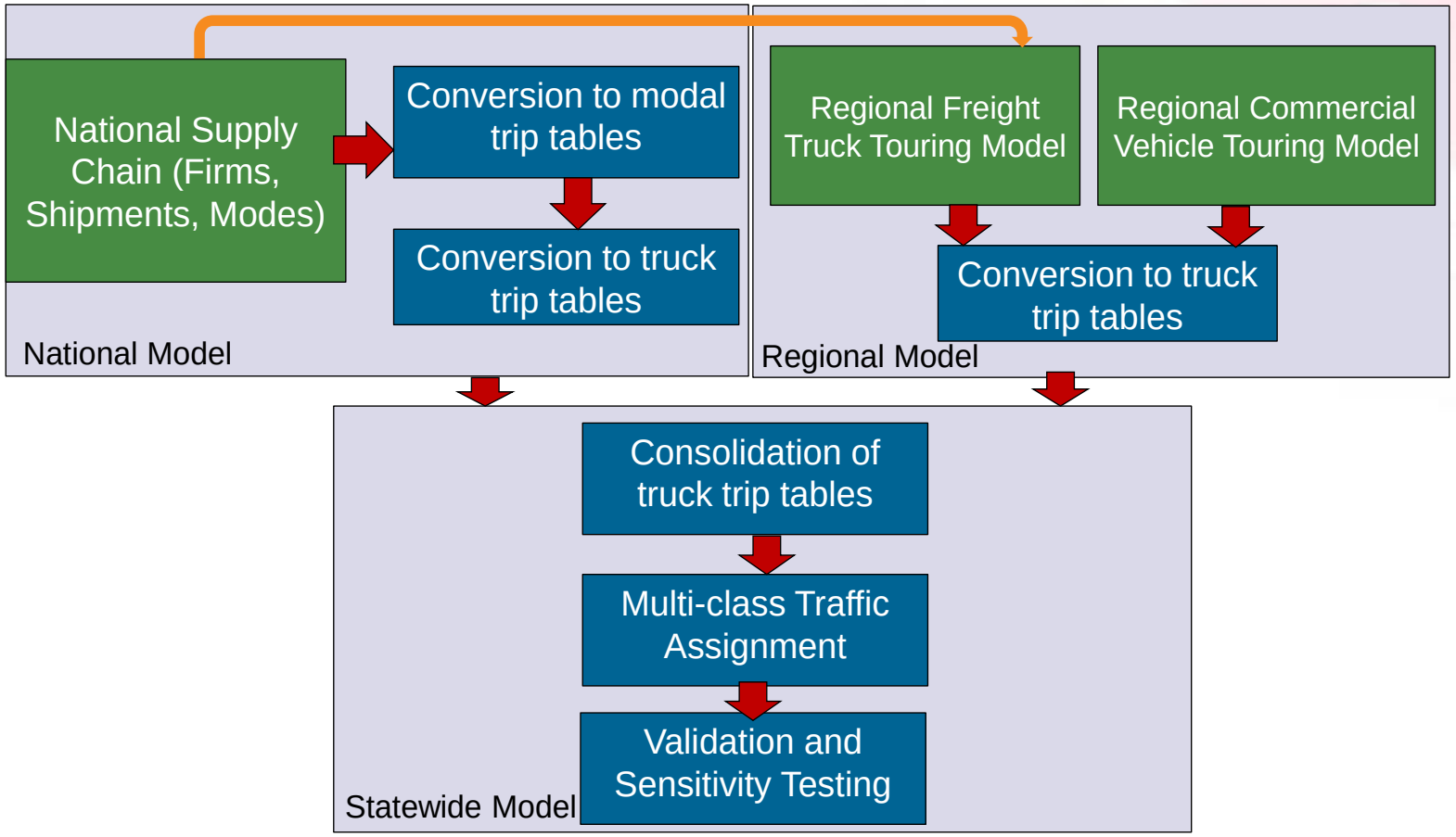
C20 FREIGHT MODEL: APPROACH



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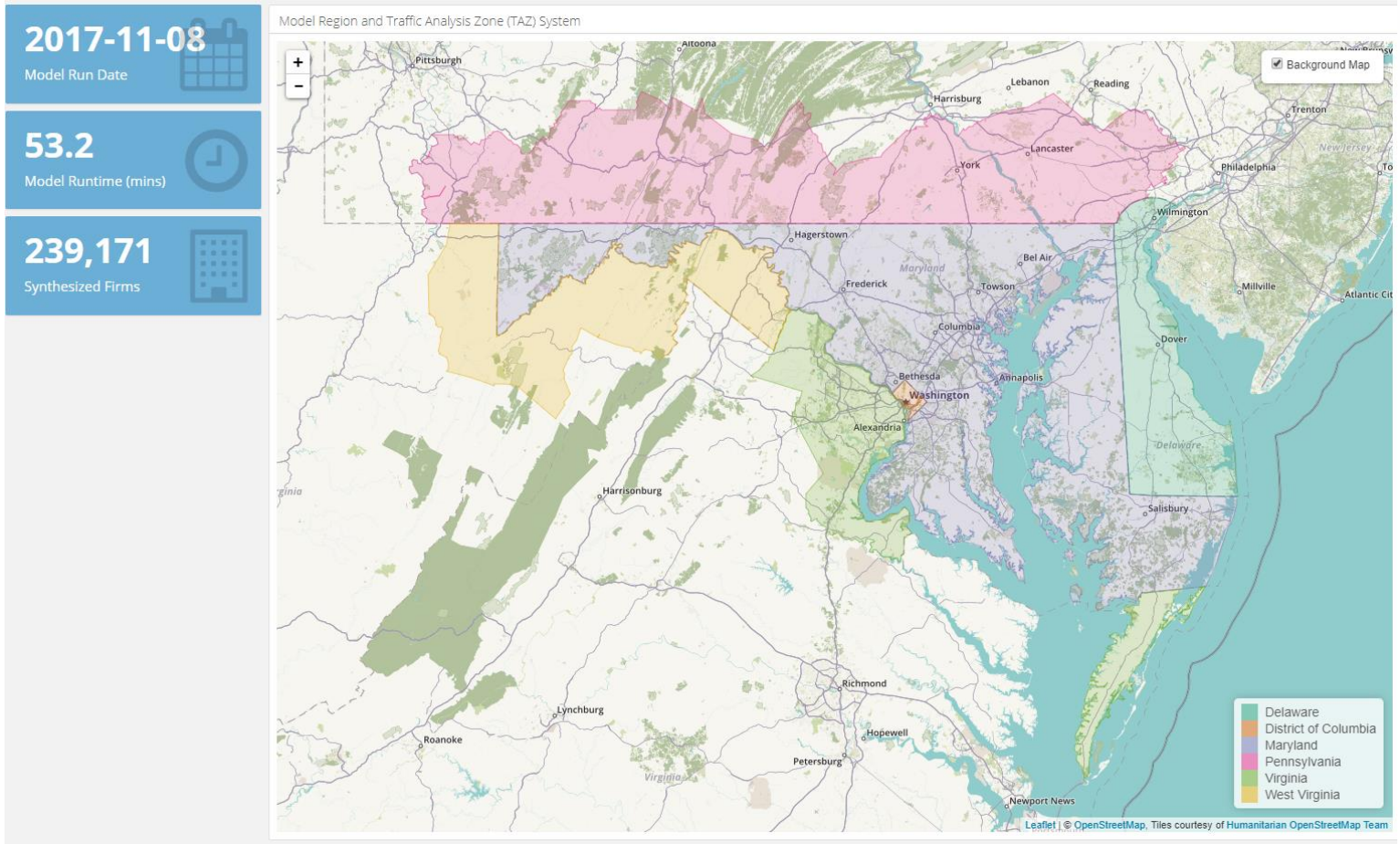
C20 FREIGHT MODEL: DASHBOARD

- Truck touring model includes MD, DE, DC and portions of VA, PA and WV
- 5,281 SMZs and 132 RMZs



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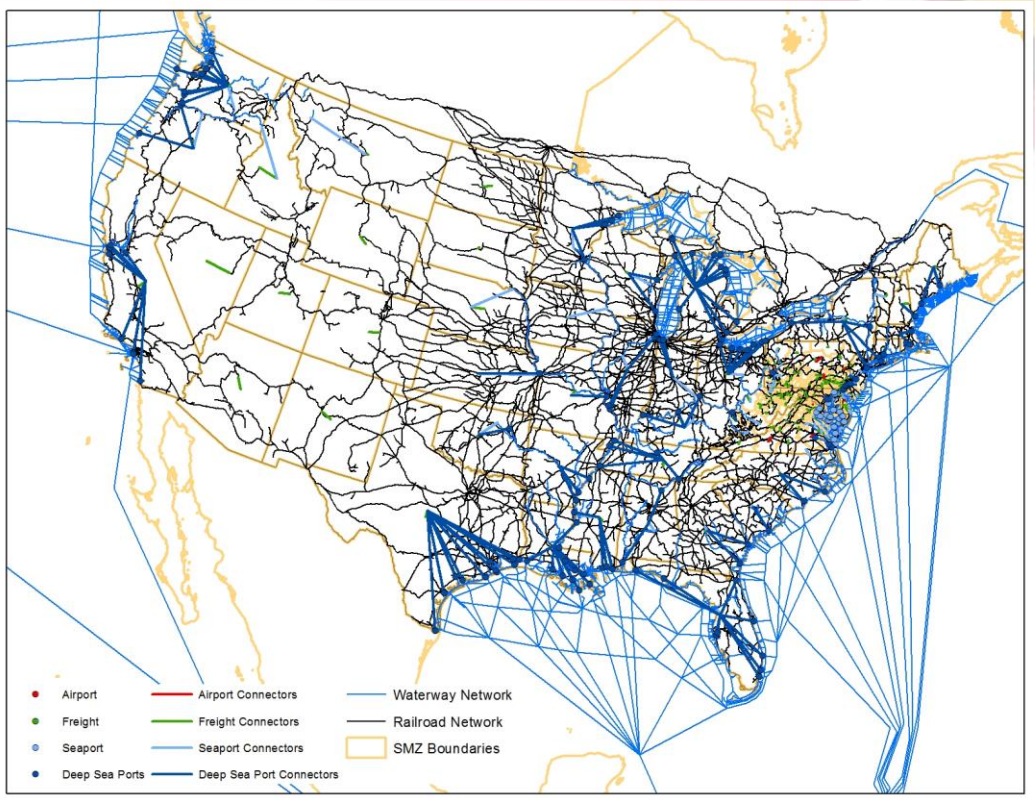
C20 INPUT DATA

- National multimodal network and properties
  - Road/Rail/Waterway/Pipeline
  - Higher resolution in study area
- Zone system
  - Internal and external
- Network skims
- Desired time of days
  - Eight times of day
    - 3-AM Peak (early, peak, late)
    - 1-Midday
    - 3-PM Peak (early, peak, late)
    - 1-Nightime



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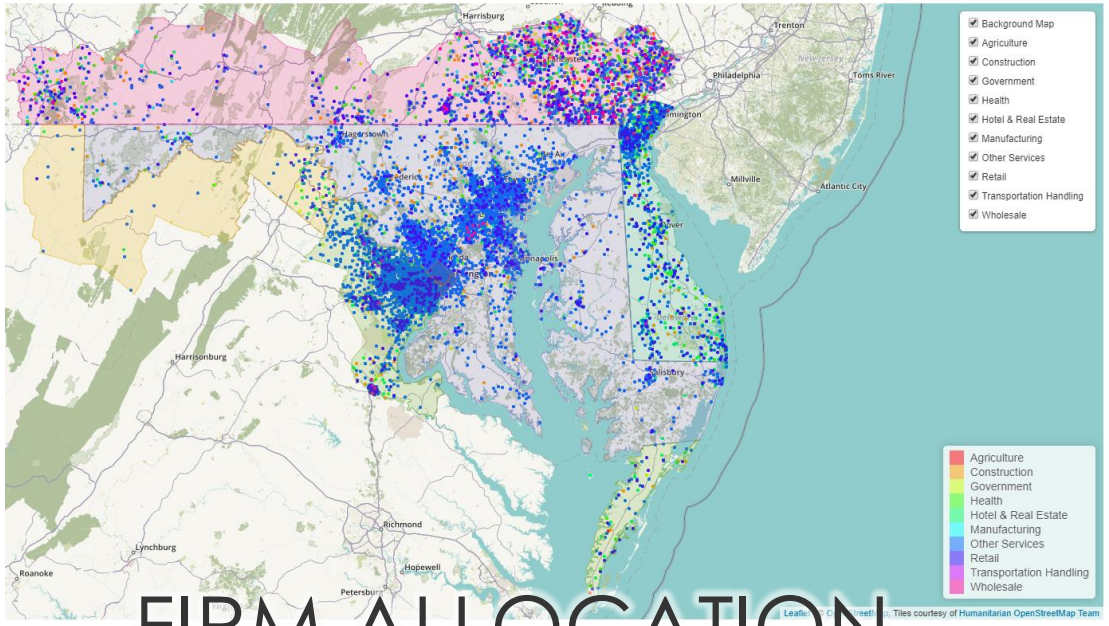
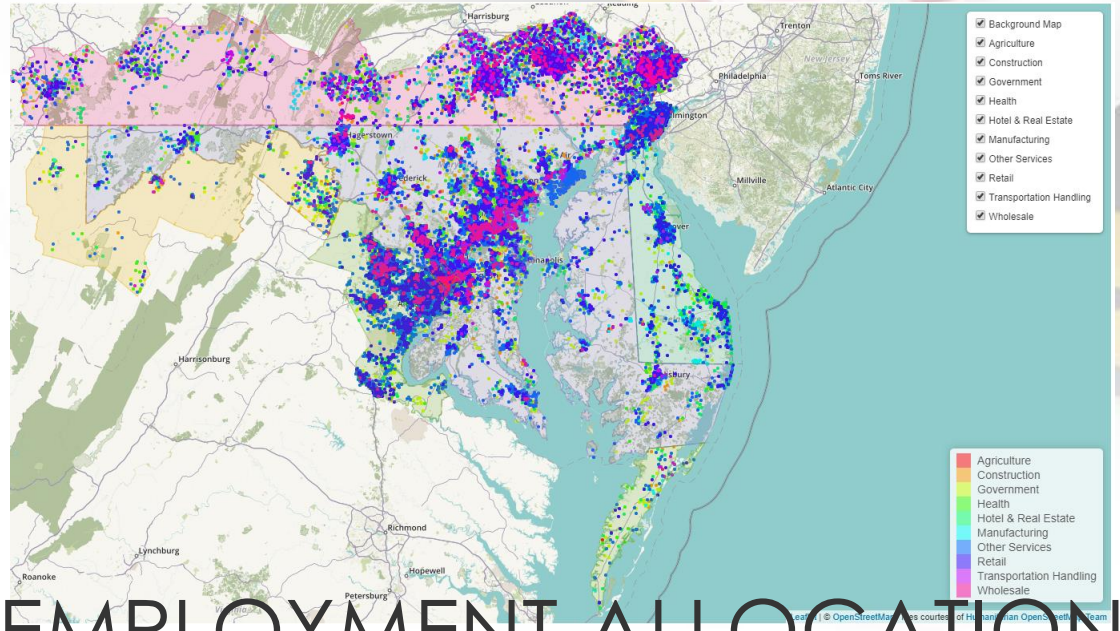
C20 FREIGHT MODEL: FIRM SYNTHESIS

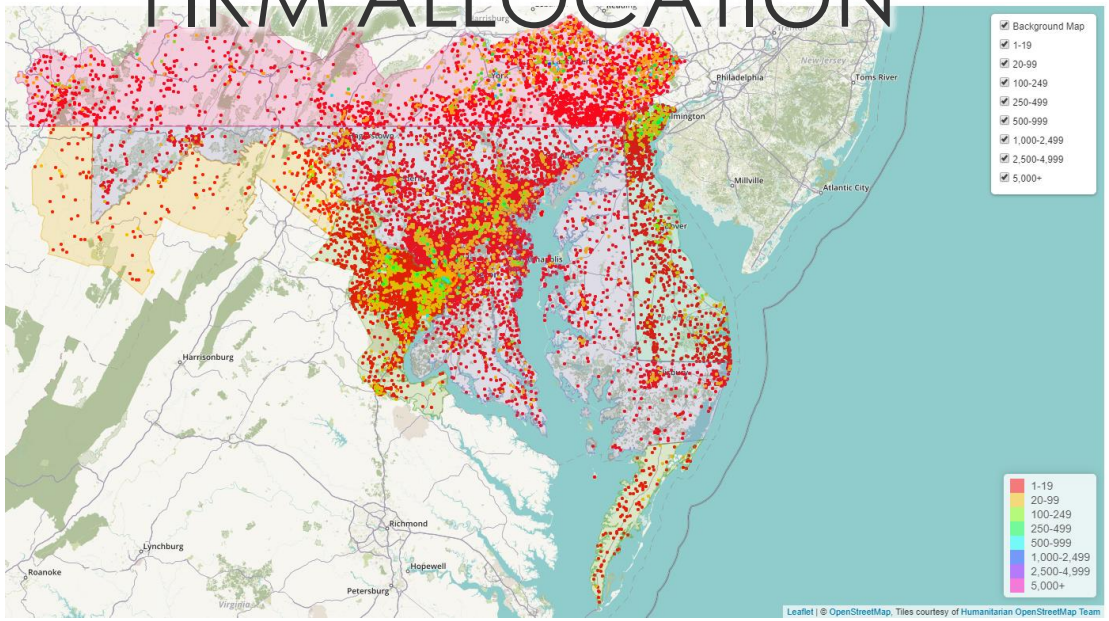


By Industry

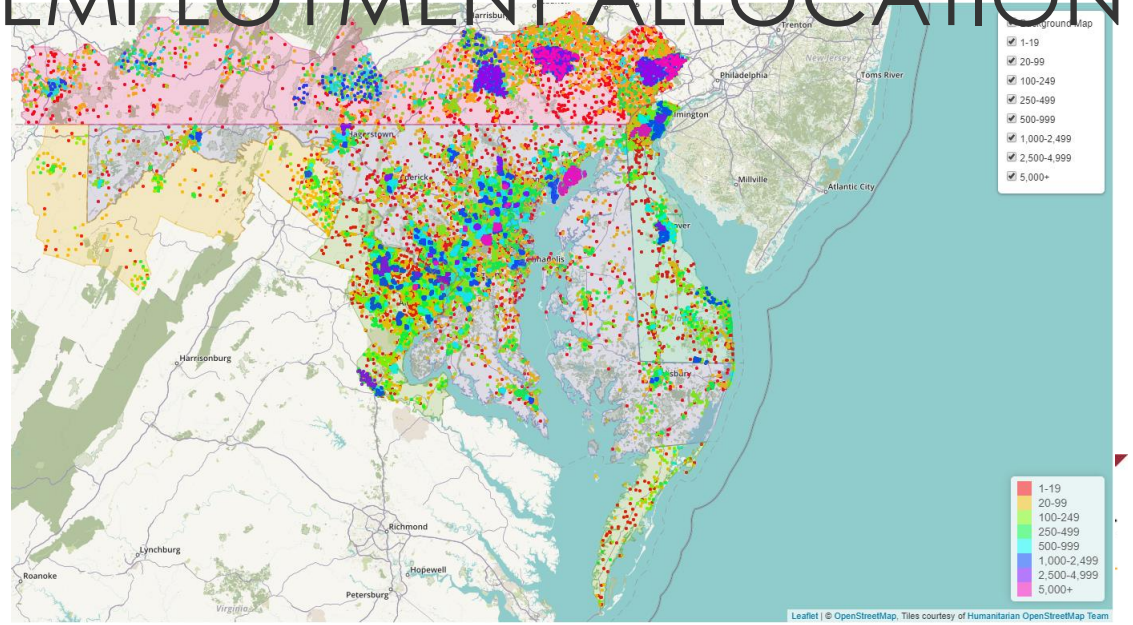


FIRM ALLOCATION

EMPLOYMENT ALLOCATION

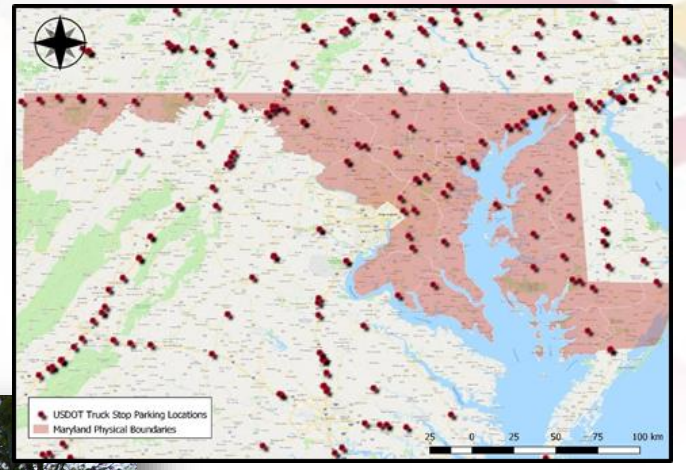


By Size



MSTM-ABM: FUTURE C20 IMPLEMENTATIONS

- Evaluation of port expansion
- Evaluation of truck-only lanes
- Evaluation of truck CAVs
- Commodity assignment post-processor
- Truck parking demand tool



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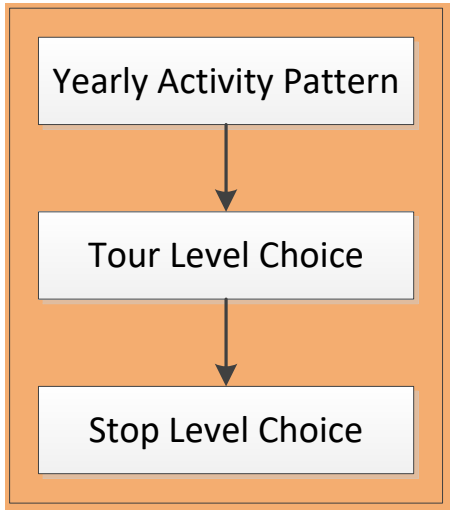
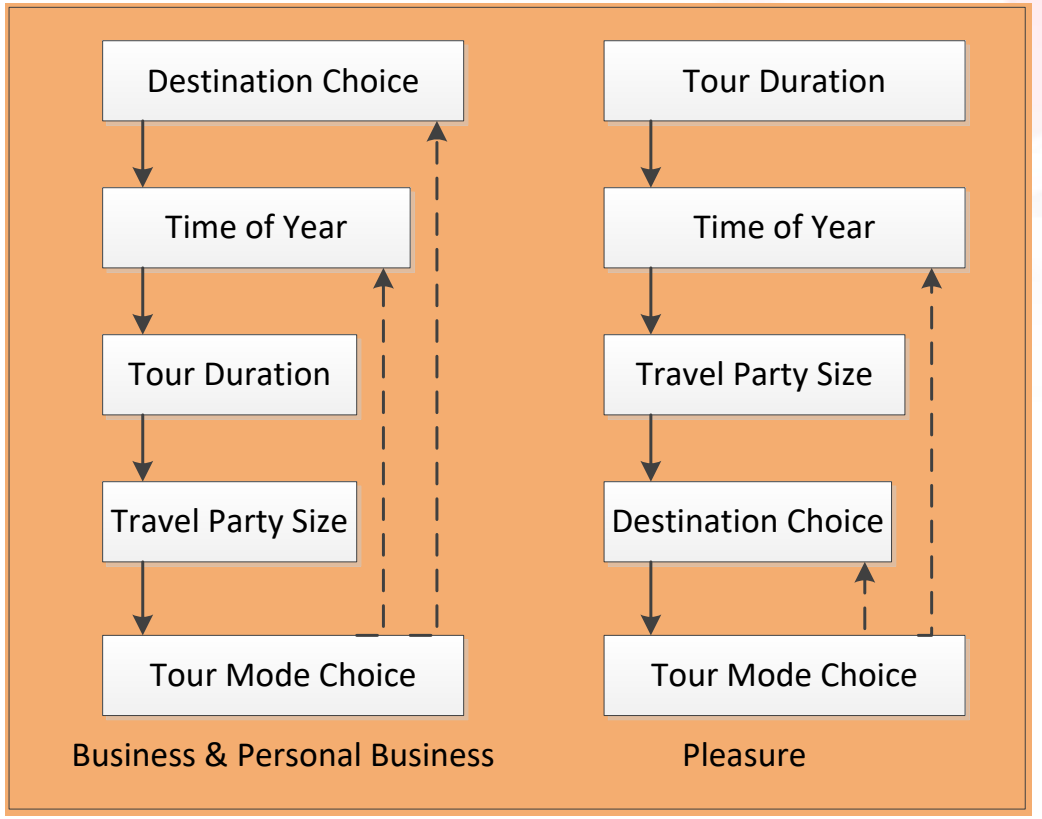
MSTM-ABM - LONG-DISTANCE PASSENGER MODEL

Long Distance Travel Demand Model System



Tour Level Procedure and Model Components



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LONG-DISTANCE PASSENGER MODEL COMPONENTS

Model Component	Level	Output	Model
Activity Pattern	Tour Level	Number of Business, Personal Business and Pleasure activities in on year	Multiple Classification Analysis (MCA)
Travel Mode Choice	Tour Level	The Chosen mode from Air, Car and Train alternatives	Multinomial Logit Model
Time of Year Choice	Tour Level	The Chosen time of year for the tour from the choice set{Q1,Q2,Q3,Q4}	Multinomial Logit Model
Tour Duration Choice	Tour Level	Number of Days for a complete tour	Hazard duration Model
Travel Party Size Choice	Tour Level	Determines how many persons participating in the tour	Multinomial Logit Model
Tour Destination Choice	Tour Level	Determines the location of the tour's primary destination at TAZ level	Multinomial Logit Model
Stop Frequency Choice	Stop Level	determines the number of intermediate stops people make on the way to tour destination	Multinomial Logit Model
Stop Purpose Choice	Stop Level	Determines the purpose of each stop	Multinomial Logit Model
Stop Location Choice	Stop Level	Determines the location of each stop	Multinomial Logit Model

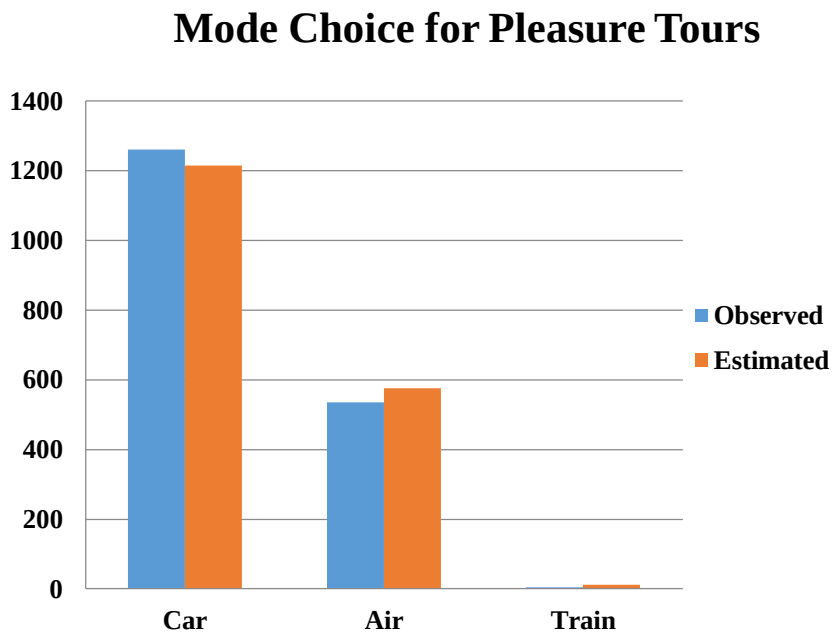
LONG-DISTANCE MODEL CALIBRATION

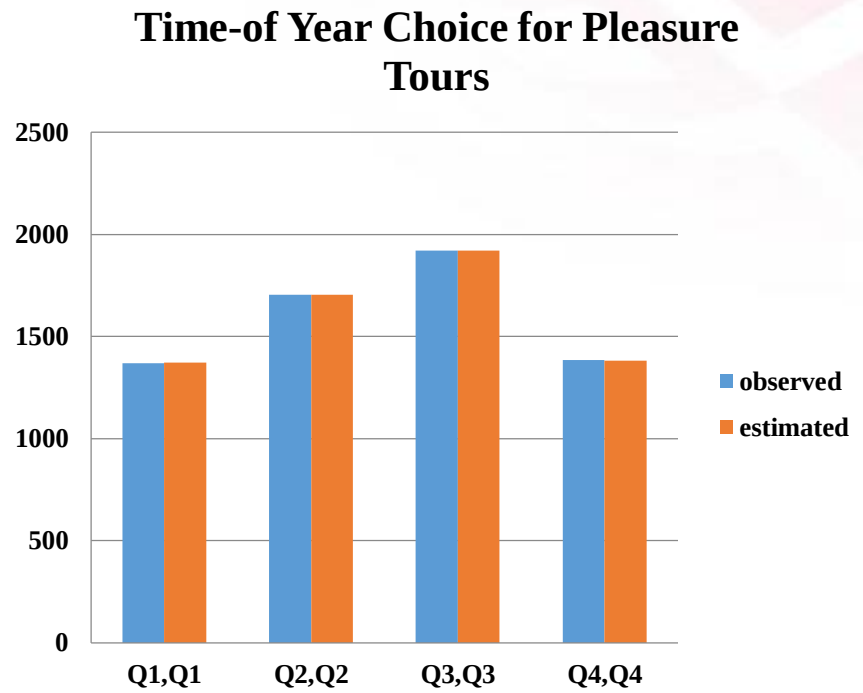
- System-wide calibration of parameters: find the value of the parameters that minimize the error between observed and modeled
- Airline Origin and Destination Survey (DB1B) data used for calibration
- Mode choice and time-of year choice models were selected to be calibrated against airline OD data
- Alternative specific constants for these models were selected as the variables to be calibrated
- Constrained minimization optimization problem :

$$[\![minimize]\!]_\theta \quad w\,|\,(\,|\,O\_m - O\_S\,(\theta)\,|\,)\,|\,\hat{}2 \quad \text{s.t} \;\; O\_S = F(Z;\theta)\;,\; l \le \theta \le u$$

LONG-DISTANCE MODEL VALIDATION

- The validation of the long-distance model components is done by cross-validation using 80 percent % for estimation and 20% for validation.





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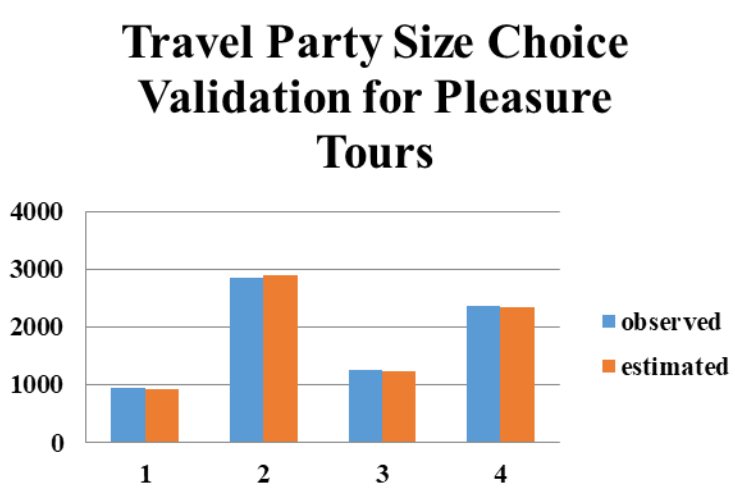
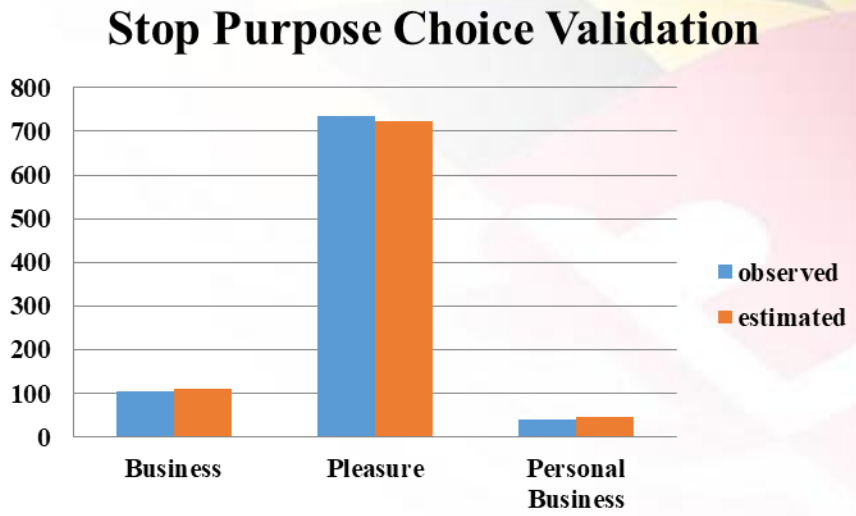
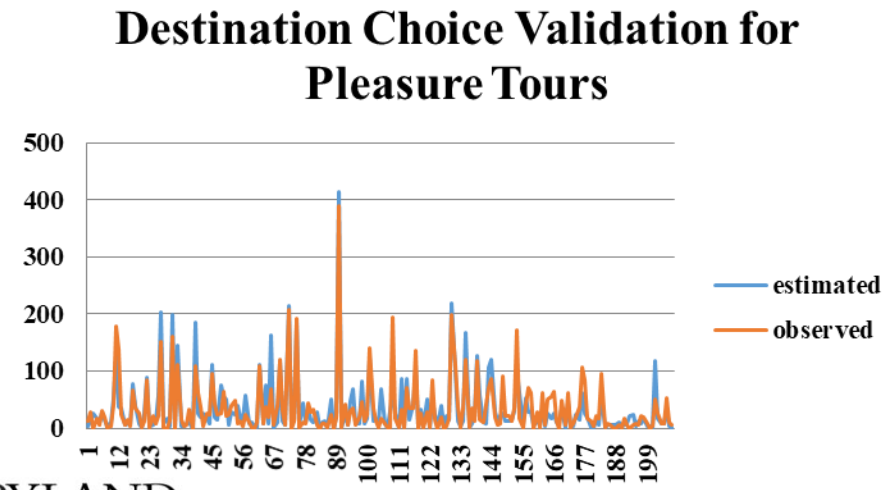
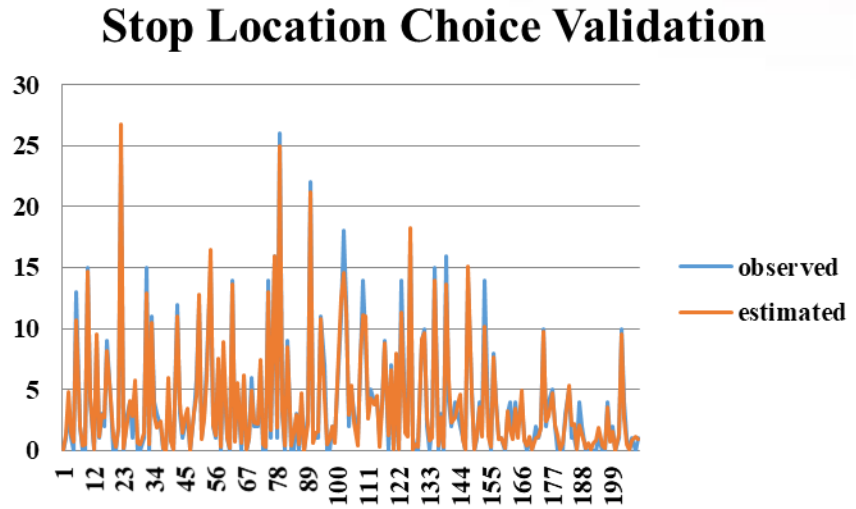
LONG-DISTANCE MODEL VALIDATION









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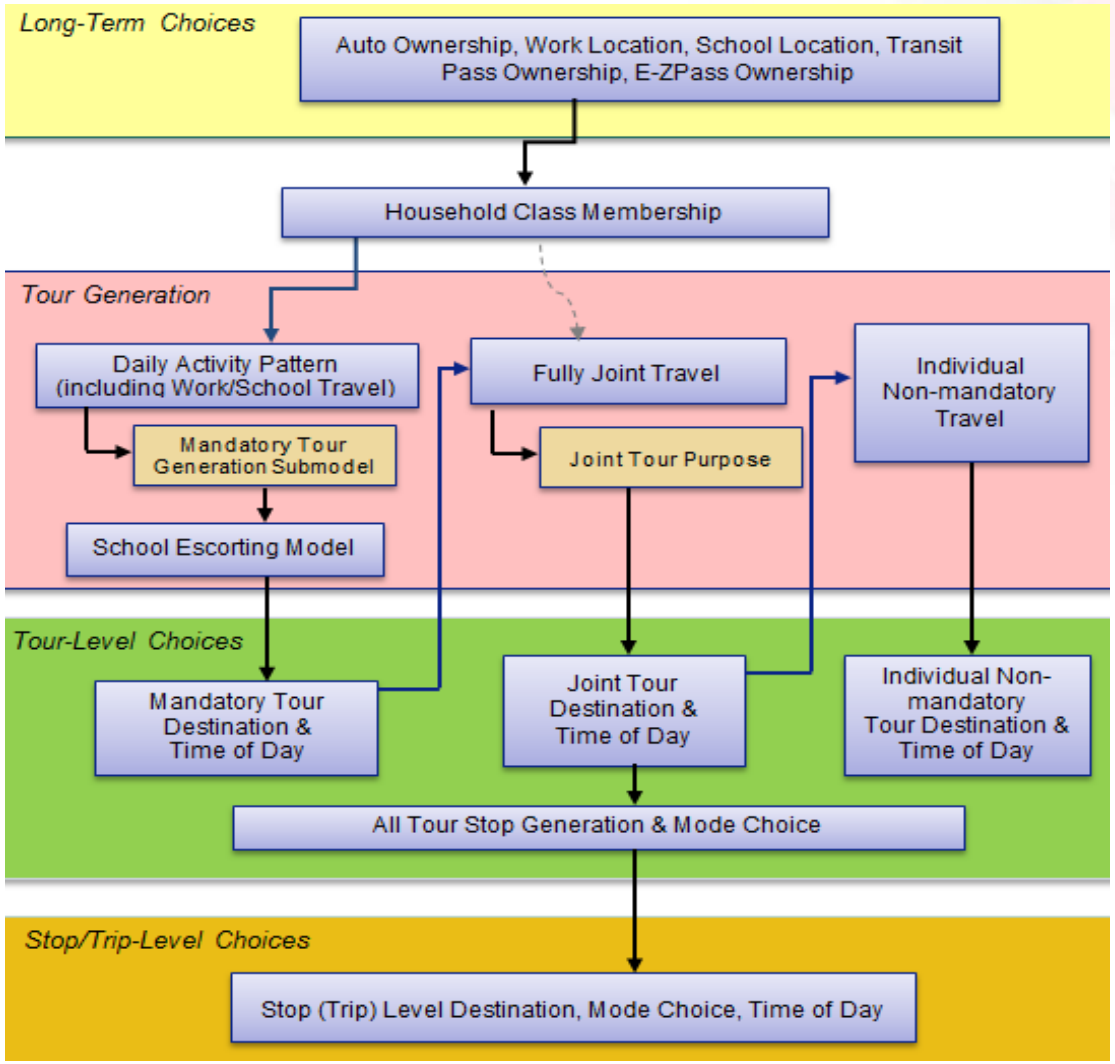
MSTM-ABM: MODEL CAPABILITIES

- Disaggregate demand at all levels
- Participation decisions for activities
- Chaining of trips according to temporal and spatial constraints
- Decisions based on lifestyle choices
- Fine time resolution of the demand for the 24 hours
- Value of Travel Time Savings for each traveler, and activity type
- Activity-based Accessibility measures

MSTM-ABM: SHORT-DISTANCE PASSENGER MODEL

- Based on BMCs InSITE Activity-Based Travel Demand Model
  - Originally developed by Cambridge Systematics for BMC and extended to cover the state of Maryland and halo area in this project.
  - Composed of interconnected discrete choice models.

MSTM-ABM: SHORT-DISTANCE PASSENGER MODEL (INSITE ABM MODEL STRUCTURE)



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MSTM-ABM: MODEL COMPONENTS

Application Sequence	Model Component	Model Applied
0	Population synthesis	Once for entire region
1	Usual Work Location Choice Model (Long-term)	For every worker
2	School Location Choice Model (Long-term)	For every child & (university student)?
3	Vehicle Availability Model (Long-term)	For every household
4	Daily Activity Pattern Model	For every individual
5	Tour destination choice model – mandatory	For every work tour
6	Transit Pass Ownership	For every household
7	E-ZPass Ownership	For every household
8	Tour time-of-day choice model – mandatory	For every mandatory tour
9	School escorting model	For every child making school tour
10	Joint tour model	For every household (with at least 2 traveling members)
11	Tour destination choice model - joint tours	For every joint tour
12	Tour time-of-day choice model - joint tours	For every joint tour
13	Joint tour participation	For every traveler in household
14	Tour generation - individual non-mandatory travel	For every individual (not stay-at-home)
15	Tour destination choice model - non-mandatory tours	For every non-mandatory tour
16	Tour time-of-day choice model - non-mandatory tours	For every non-mandatory tour
17	Stop generation model	For every individual half-tour and all joint half-tours
18	Tour mode choice model – mandatory	For every mandatory tour
19	Tour mode choice model - joint tour	For every joint tour
20	Tour mode choice model - non-mandatory	For every non-mandatory tour
21	Stop destination	For every stop
22	Trip mode choice	For every trip
23	Stop time-of-day	For every stop

ONGOING IMPROVEMENTS FOR MSTM-ABM

Reducing the model run time

- Currently, there are 5 iterations of MSTM-ABM with the first iteration taking approximately 1.5 days.

Comprehensive calibration and validation

- After reducing the runtime of the MSTM-ABM, comprehensive calibration and validation can then be done in a more effective way, which should lead to a even higher accuracy levels.

Integrating MSTM-ABM with Dynamic Traffic Assignment (DTA)

- DTA integration can take full advantage of time-dependent travel demand outputs from the activity-based travel demand model.
- Innovative methods developed with the UMD team to enable the development and integration of a statewide DTA model for MSTM

UPCOMING MDOT-SHA INITIATIVES:

Integration of new tools into practice

- MSTM-ABM, C20, DTA, Long-distance passenger model, etc.

Development of MSTM-TBM2.0

- How can MSTM-ABM be used to inform current MSTM-TBM.
- Higher zonal resolution (6,600) from existing MSTM-TBM (1,800)
- Higher temporal resolution (8 time periods)
- Significantly reduced runtimes compared to MSTM-ABM

Development of a summer seasonal model to better address transportation needs on Maryland's eastern shore

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ONGOING/UPCOMING MDOT-SHA/UMD RESEARCH

- Truck Parking Study
- Using RITIS trajectory data to validate long-distance auto flows
- Identification of Best Practice Metrics for Varying Levels of Traffic Operations Analysis
- Evaluating the Effect of Complete Streets on Mode Choice
- Pedestrian Safety Data Analytics Platform (Proof of Concept)

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