

Multiresolution Network Databases

Experience in Maryland and
Delaware

Ohio Travel Demand Model Users
Group Meeting

March 19, 2021



Agenda

- WRA's approach to Network Database Management – Multiresolution Databases
 - Multi Geographic scale of resolution
 - Examples of applications
- How was it implemented
- Network Management / Network Building quandary at ODOT

Why does it matter?

- Simplify the network building process to support multiple geographic scales of modeling and tools
 - Statewide
 - MPO
 - Project Applications of TDM
- Create vertical integration with data sources
 - Project databases
 - MPO <-> Statewide Models
 - Centerline / Route Data
- Saves Time
- Reduces Error

Why does it matter?

- Common data platform to create networks to support: statewide model, regional model networks, project models and meso and micro tools
- Manage transportation related data in one place to support several tools
 - Create efficiency in the development of specific networks
 - Make models more sensitive to the built environment
 - Bring together multiple users
 - Modeling / forecasting
 - Operations
 - Planning
 - Policy Makers

What?

- Three elements:
 1. A network and TAZ data structure that can scale the level of detail for the area being modeled up or down as needed.
 2. Create consistency in data on shared geography.
 3. Accuracy of data at all resolutions.

Resolution

Peninsula Zones



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroX, IGN, IGP, swisstopo, and the © 1996-2014 United States Government

Resolution

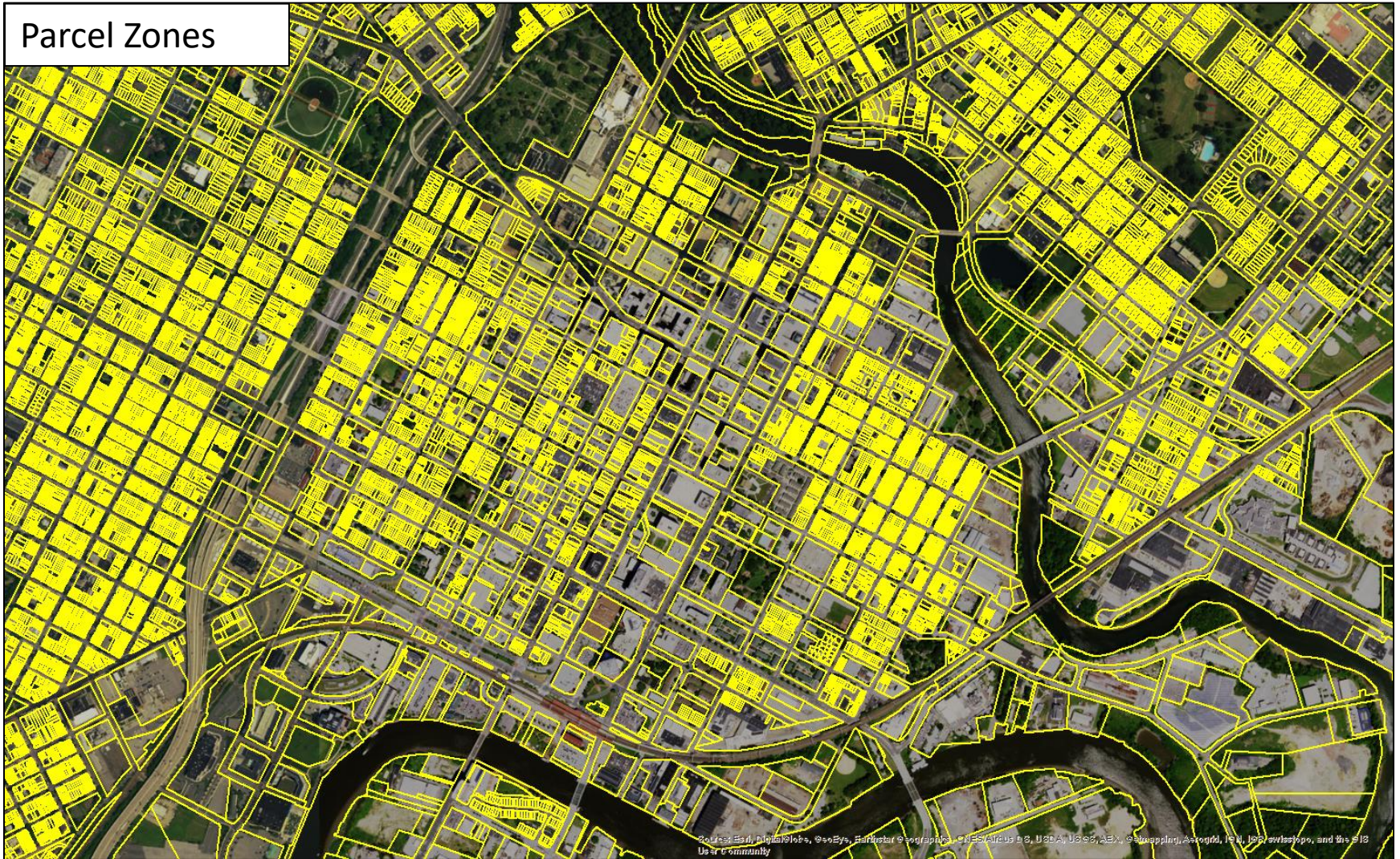
Census Block Zones



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, Aero, GeoMapping, IGN, IGN, IGP, swisstopo, and the GIS User Community

Resolution

Parcel Zones





Multi-Resolution Modeling

APPLICATIONS

Project Needs

DeIDOT

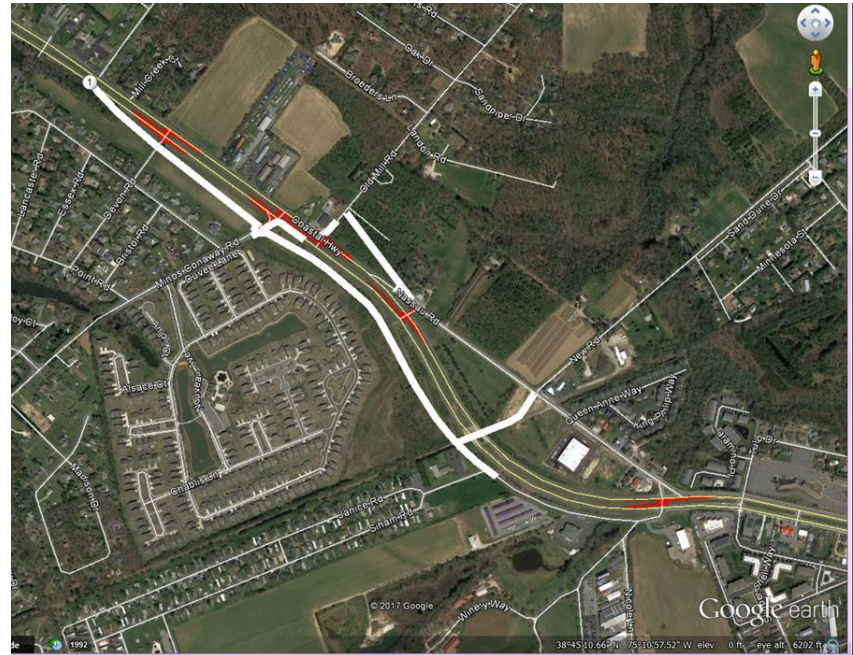
- Multi-Resolution
- Accessibility changes
- Urban form
- Scenario Planning
- ITHIM Data
- Link Level Walking Trips
- Link Level Biking Trips
- TID Evaluations
- Evacuation Models
- POD Models

MDOT SHA

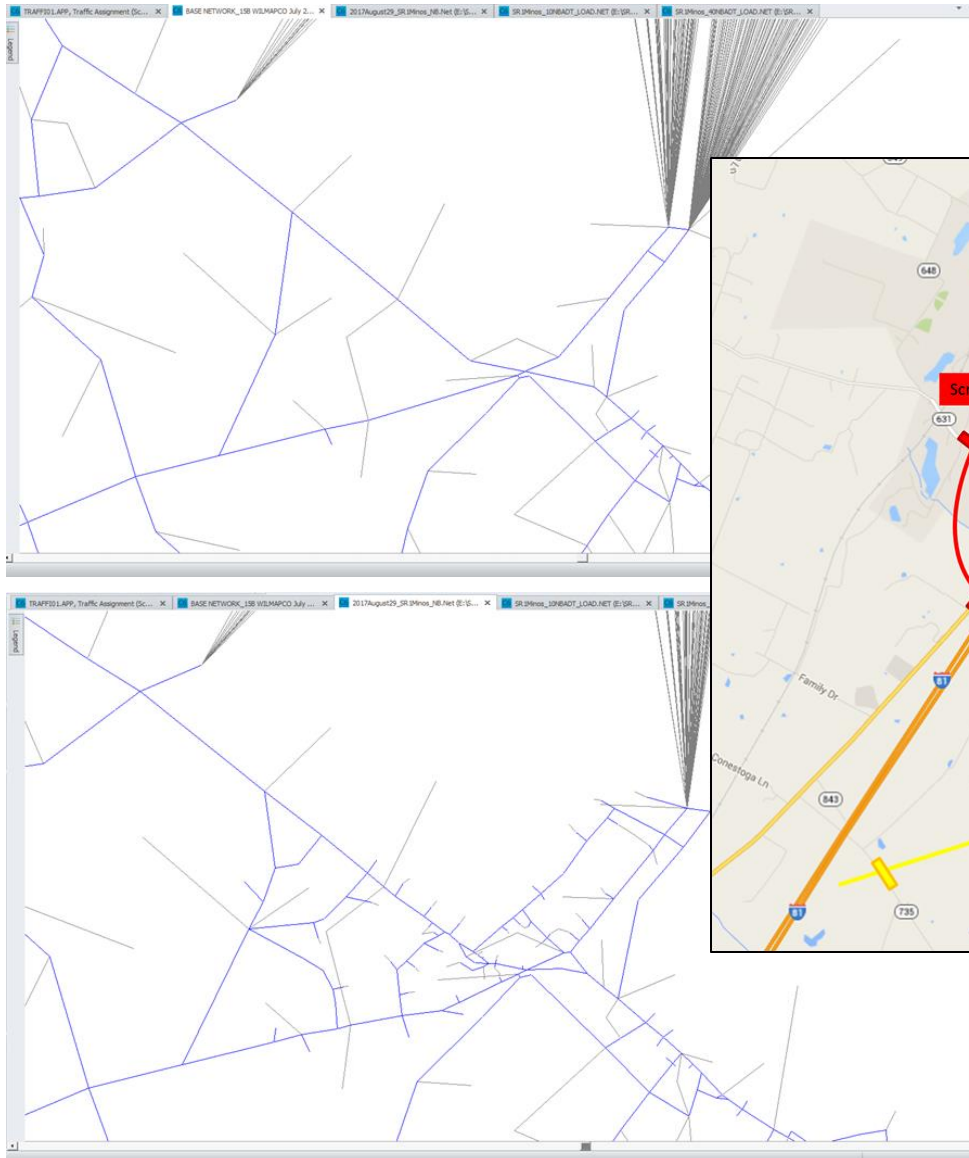
- Link Travel Network to Centerline File and Data
- Software Neutral Dataset
- Create Inputs
 - Four Step Model
 - Activity Based Model
 - DTA Model
 - Microsimulation Models
- Project Evaluation Model
- Evacuation Models
- Expedite Project Forecasting
- Performance Measurement Dashboard

Forecasting

- Challenges with using travel demand model outputs for traffic forecasting:
 - Network detail and accuracy
 - Accuracy of land use and access points
 - Scale of projects

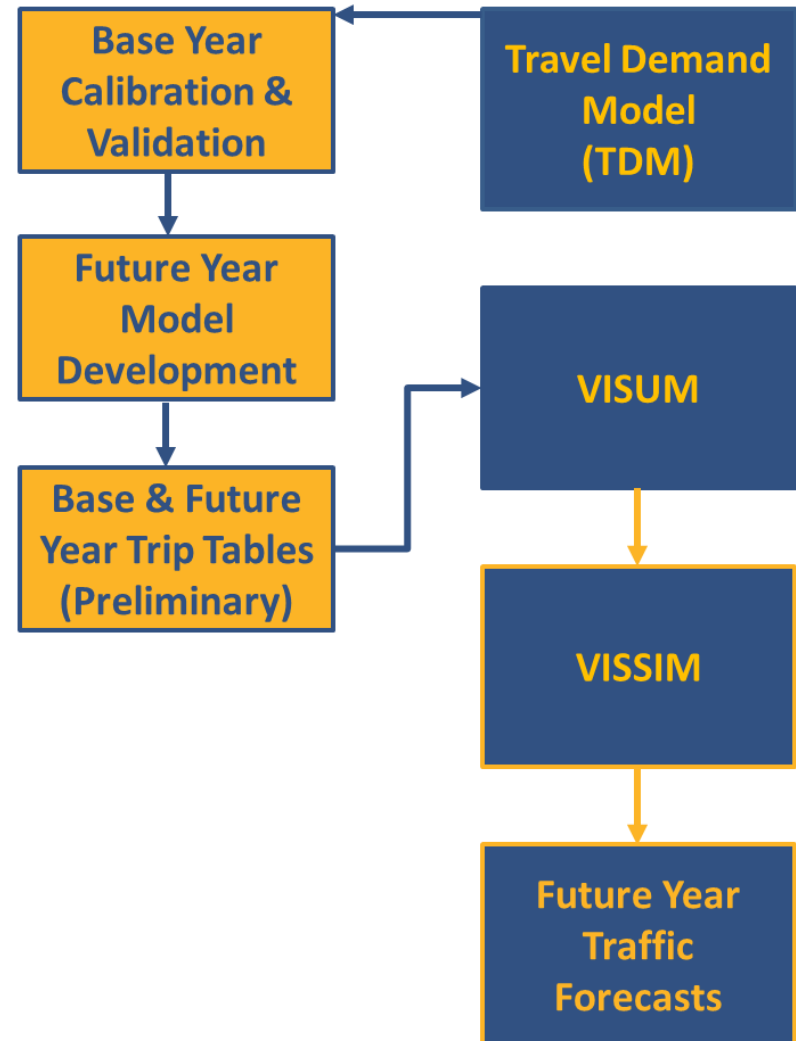


Forecasting



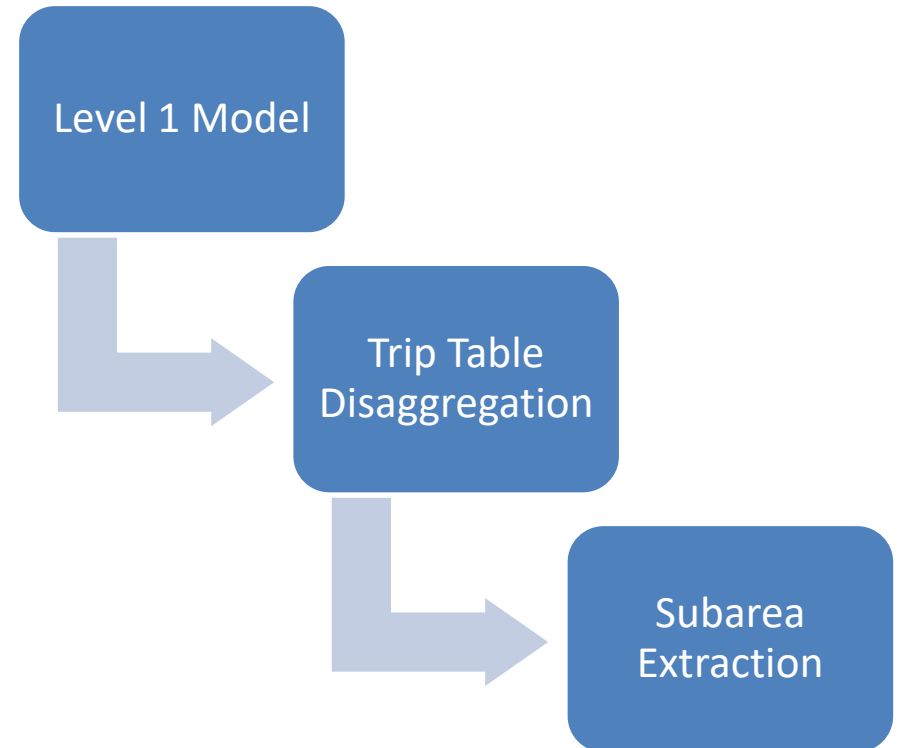
Forecasting – Multi Resolution

- Base year calibration and validation conducted to meet target values (traffic counts) for study area segments and regional screenlines
- Model refinements may include:
 - Link additions
 - Link speed and/or capacity modifications
 - Centroid connector modifications
 - Traffic analysis zones (TAZs) disaggregation
- Base and future year no build models reviewed to reflect highway and transit improvements for the appropriate year
- For future year build, study project (or alternatives) coded into model network to determine traffic impacts
- Base & future year trip tables (daily and/or peak period) used as the seed matrices for VISUM modeling



Forecasting – Multi Resolution

- Use of Multi Resolution modeling framework to create subarea trip tables for input to operational analysis modeling



Project Prioritization

- Even playing field for all project types
- Operational projects in context of macro assignment
 - Capacity adjustments
 - Roadway functional class improvements
- Consistency

MD - Project Overview

- Legislative mandate directing the Maryland DOT to develop a project-based scoring model for evaluating major highway and transit capacity projects over \$5 million in the Draft and Final CTP.
- Nine goals and twenty-three measures shall be evaluated against in the project-based scoring model (Chapter 30).
- All major transportation projects must be scored using the Chapter 30 Model in order to be considered for funding in the CTP.

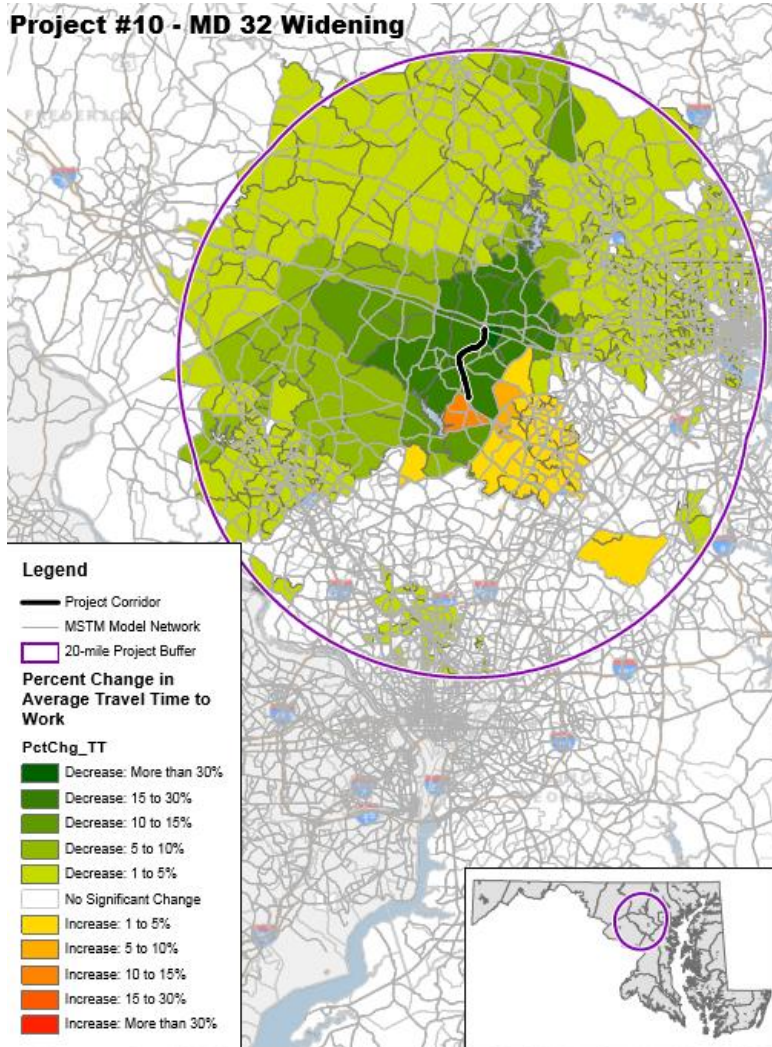
	Job Accessibility	Fuel Savings	Travel Time Savings
Congestion	X		X
Environmental		X	
Economic	X		
Equitable Access	X		
Cost Effectiveness			X

MSTM Chapter 30 Multi Resolution Framework

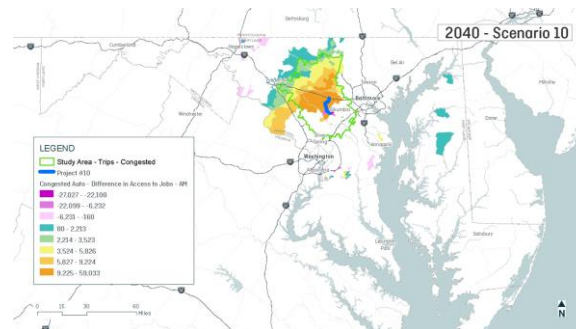
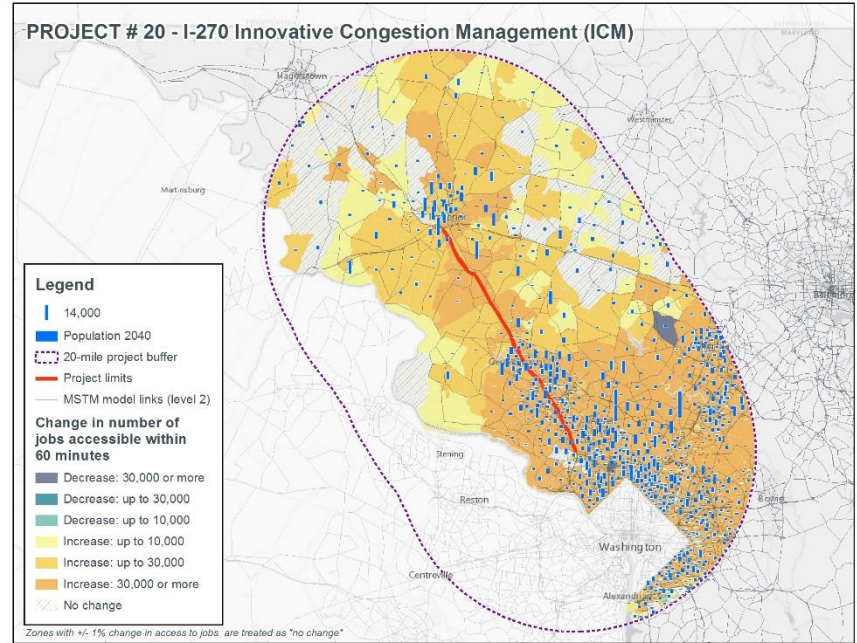
- Assumptions of Chapter 30
 - Fixed Demand
 - No Build Supply Assumption
 - Consistent Platform
 - Calculation of Metrics
 - Consistent approach for all projects (urban vs rural and improvement vs new facilities)
- Project Challenges
 - Time Constraint and Volume of Projects
 - Consistency in Approach: projects, mode and consultants
 - Resolution of performance measures

Resolution Requirement

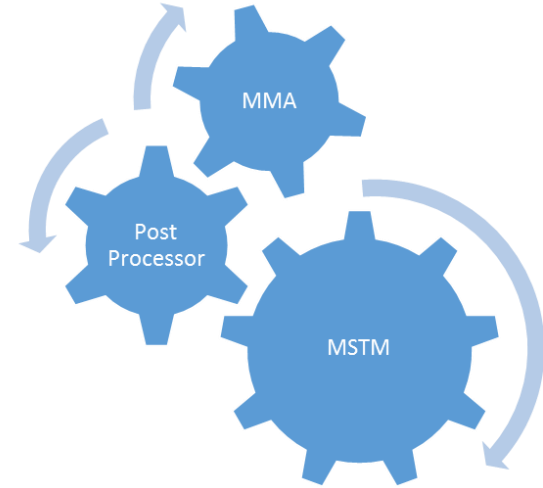
Project #10 - MD 32 Widening



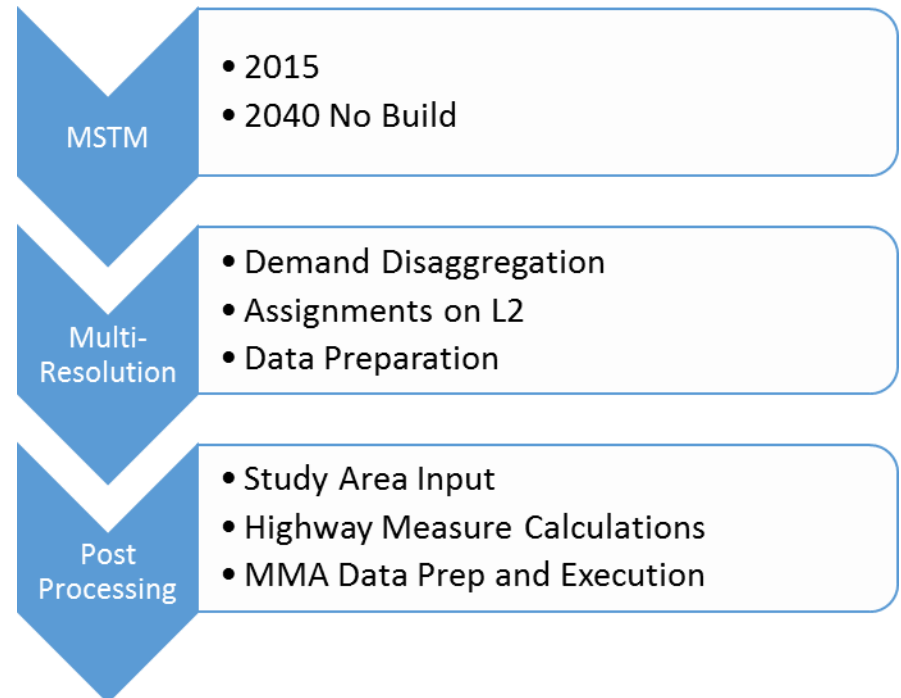
PROJECT # 20 - I-270 Innovative Congestion Management (ICM)



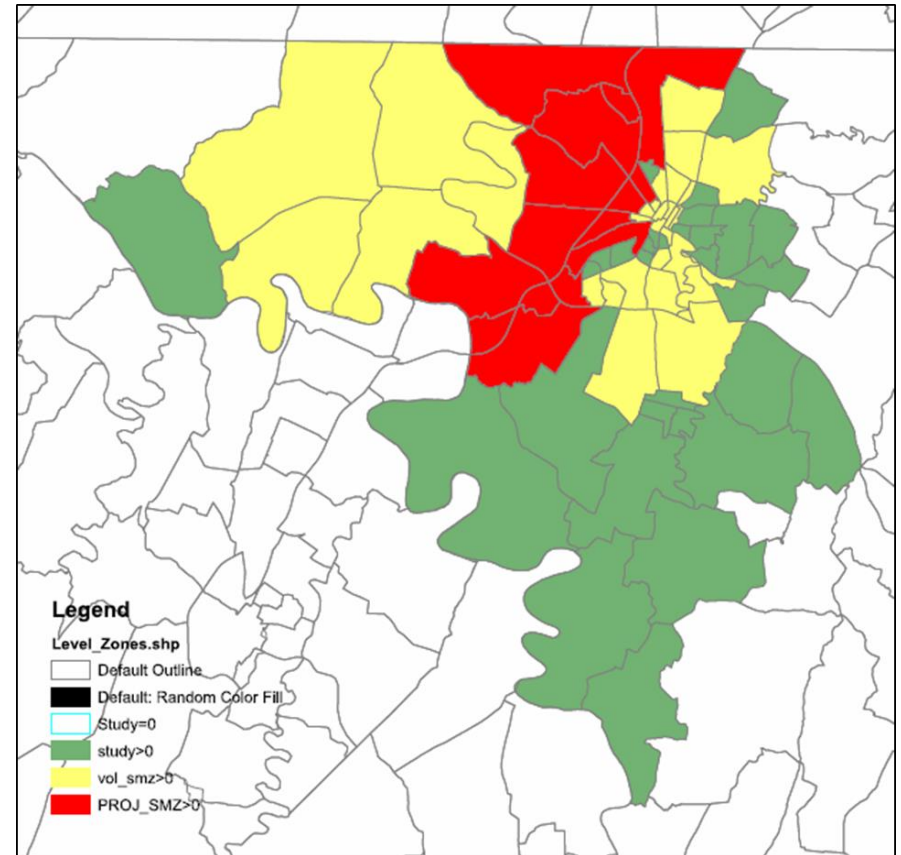
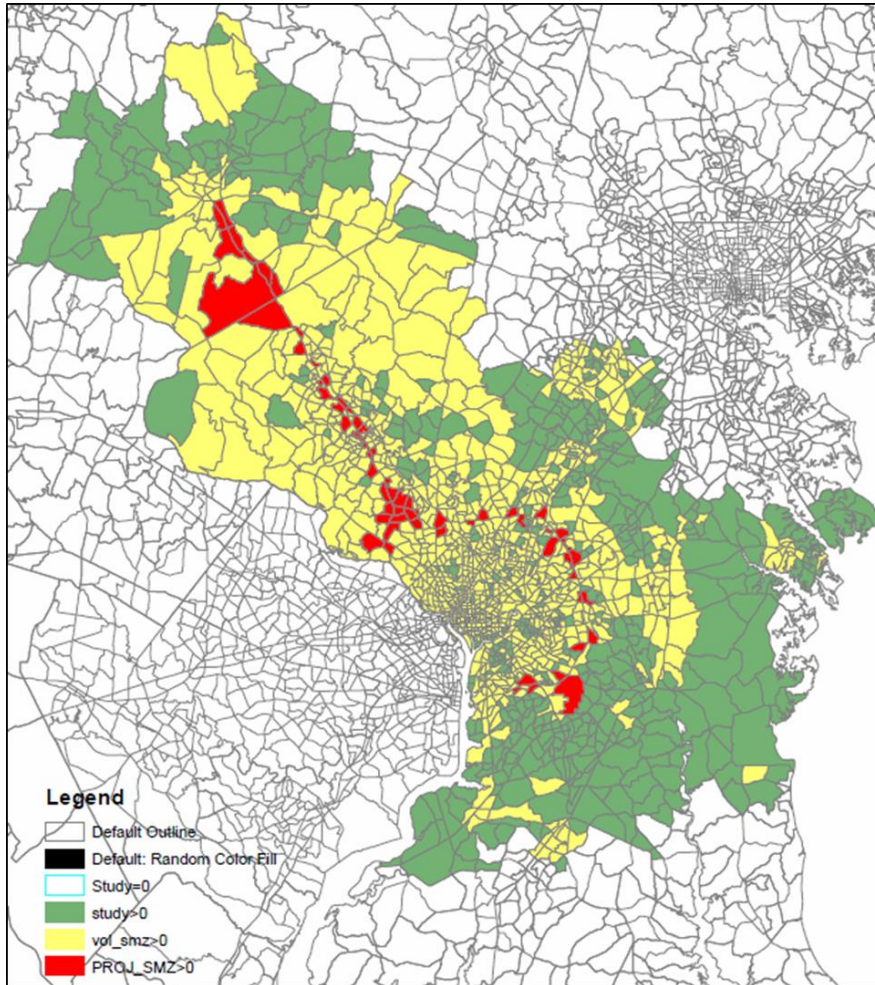
MSTM Chapter 30 Multi Resolution Framework



- Builds upon MSTM
 - Use of Trip Tables and Network Structure
- Consistent methodology
 - Speed and Capacity logic
 - Assignment methodology (trip purposes, tolling, period definitions)
- Flexibility in resolution
- Focused to network changes
- Linkage to Chapter 30 Scoring
- Multi Resolution Framework brings
 - Sensitivity to the network
 - Impacts of land use by smaller TAZs
 - Resolution of the performance measures



MSTM Chapter 30 Multi Resolution Framework



Resolution to Support Scoring

- Vehicle Miles Traveled
 - Link level calculation and aggregation of auto and truck VMT across a consistent study area under build and no build conditions
- Travel Time Savings
 - Calculation of vehicles hours traveled
 - By Auto and Truck
 - By Purpose
 - By Period Congestion
 - Delay: Congested VHT – Free Flow VHT
 - Build Delay – No Build Delay
- Fuel Savings
 - Vehicle Miles Traveled by Speed
 - Auto and Truck
 - Aggregated across a consistent study area for build and no-build conditions

DE - Project Overview

- Delaware's use of the multi resolution modeling framework includes:
 - Developing traffic forecasts
 - Non Motorized Accessibility
 - Project Prioritization
- Project Prioritization: adding the economic benefit to the measures currently used with TREDIS
 - County level analysis
 - Evaluation of the CTP Projects (2021 to 2026) of different project magnitudes
 - New Roadways
 - Major Widening
 - Intersection improvements
 - Non motorized / transit projects

DE – Project Overview

Model

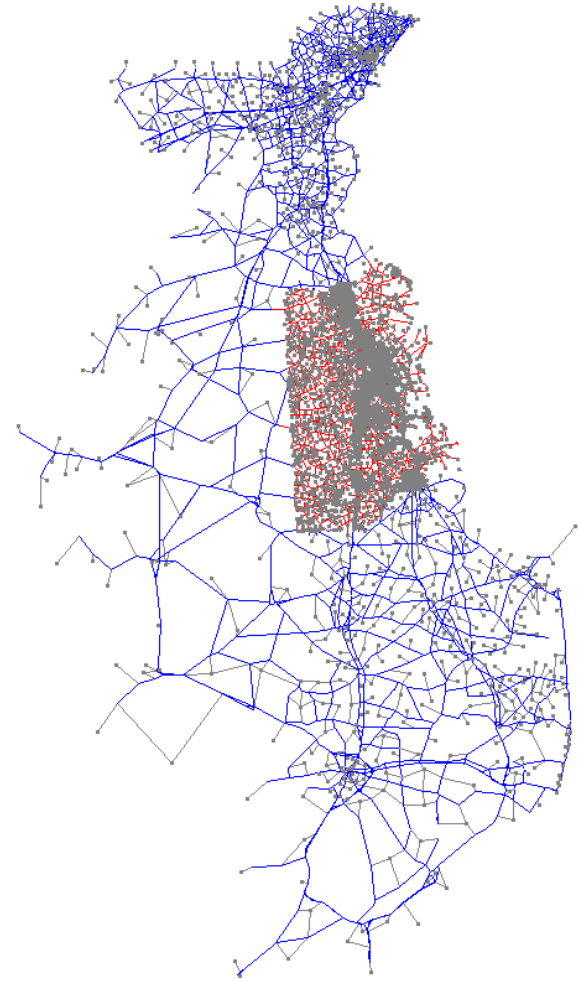
- Generate Trip Tables using No Build Network

Matrix

- Disaggregation of Matrix by County

Assign

- Build vs No Build Assignments
- VMT, VHT, Delay by Geography (II, OI/IO, OO)



DE – Level of Traffic Stress

- Looks at Existing and Proposed Bicycle Connectivity to
 - Transit
 - Schools
 - Community Centers
 - Employment Centers
 - Parks
- Looks at improvements at different *Levels of Traffic Stress*
- Allows us to directly compare the value of projects, for connecting people to places.

DE – Level of Traffic Stress

- A metric of suitability of a roadway for cycling
- Each level relates to a **type of rider**
- Allows us to view mobility from perspective of casual cyclists and understand **barriers** to a useful, connected network
- Level of Traffic Stress
 - LTS1: 12-year-old child
 - LTS2: typical person able to bike
 - LTS3: enthusiastic and willing to tolerate some stressful roadways and intersection
 - LTS4: aggressive and willing to bike anywhere

INCREASING LEVEL OF COMFORT, SAFETY, AND INTEREST IN BICYCLING FOR TRANSPORTATION

LTS 4
No bike lane on a busy street



LTS 3
Narrow bike lane or shoulder on a busy street



LTS 2
Buffered bike lane on a calm street

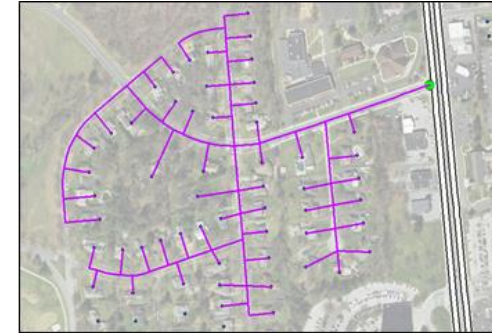


LTS 1
Separated bike lane

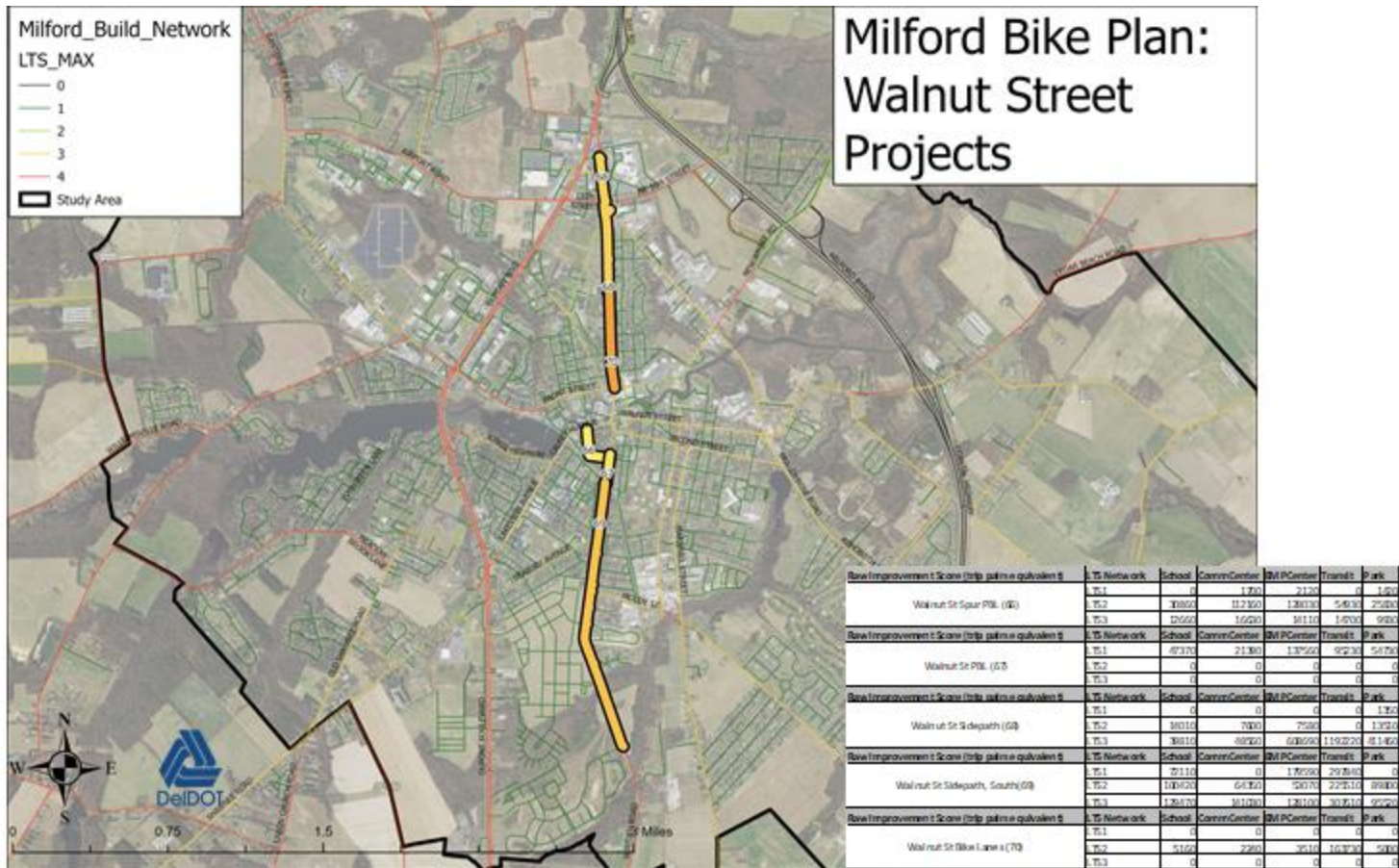


DE – Level of Traffic Stress

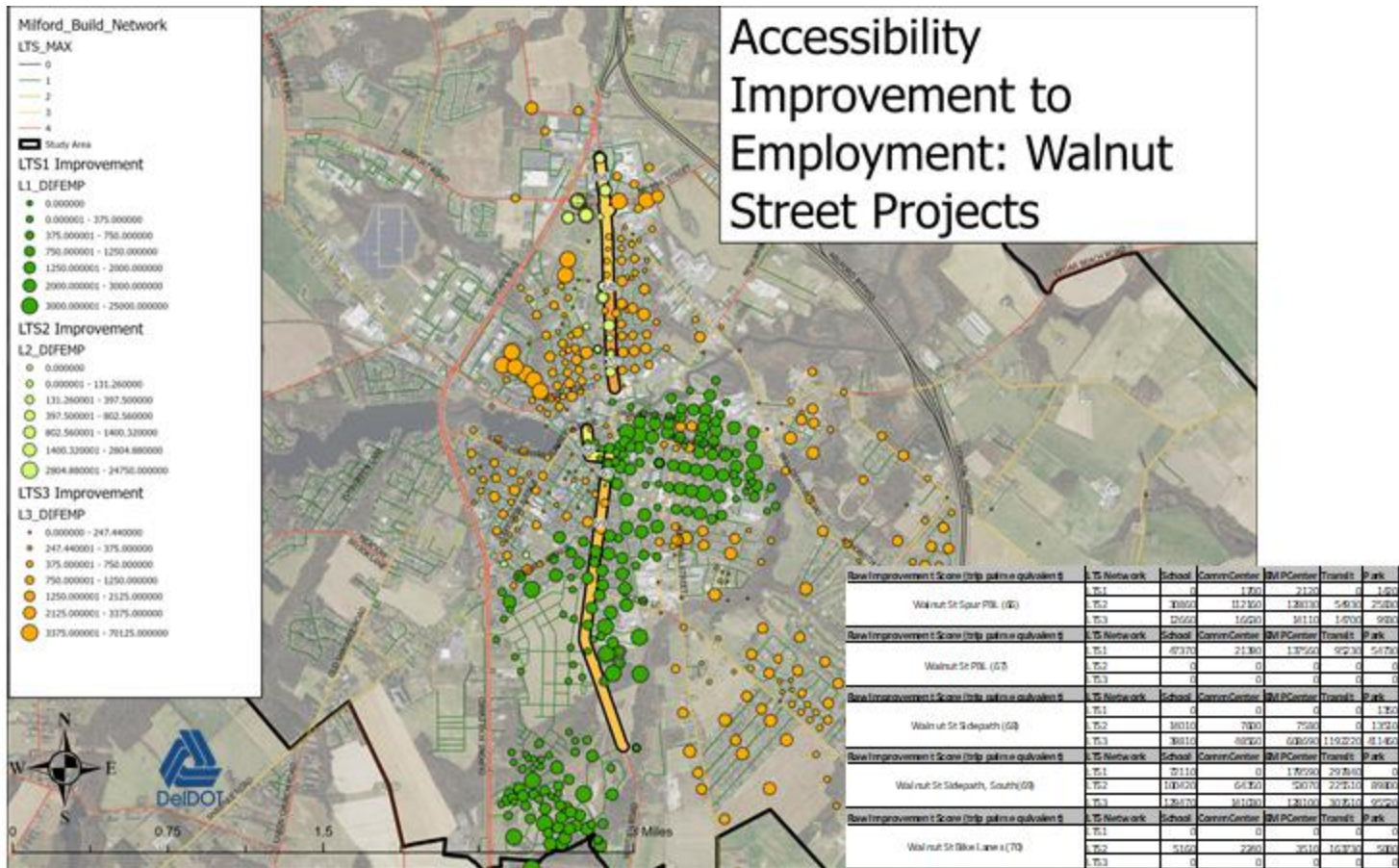
- Origin-to-Destination (OD) routing, on each LTS level
- Evaluates **Propensity Score** (0-1), for each OD Pair, based on *route distance* and *detour from shortest possible route*
- Measure **improvement** between different scenarios
- Results scaled and ranked relative to one another



DE – Level of Traffic Stress



DE – Level of Traffic Stress





Multi-Resolution Modeling

IMPLEMENTATION

Options Considered in Design

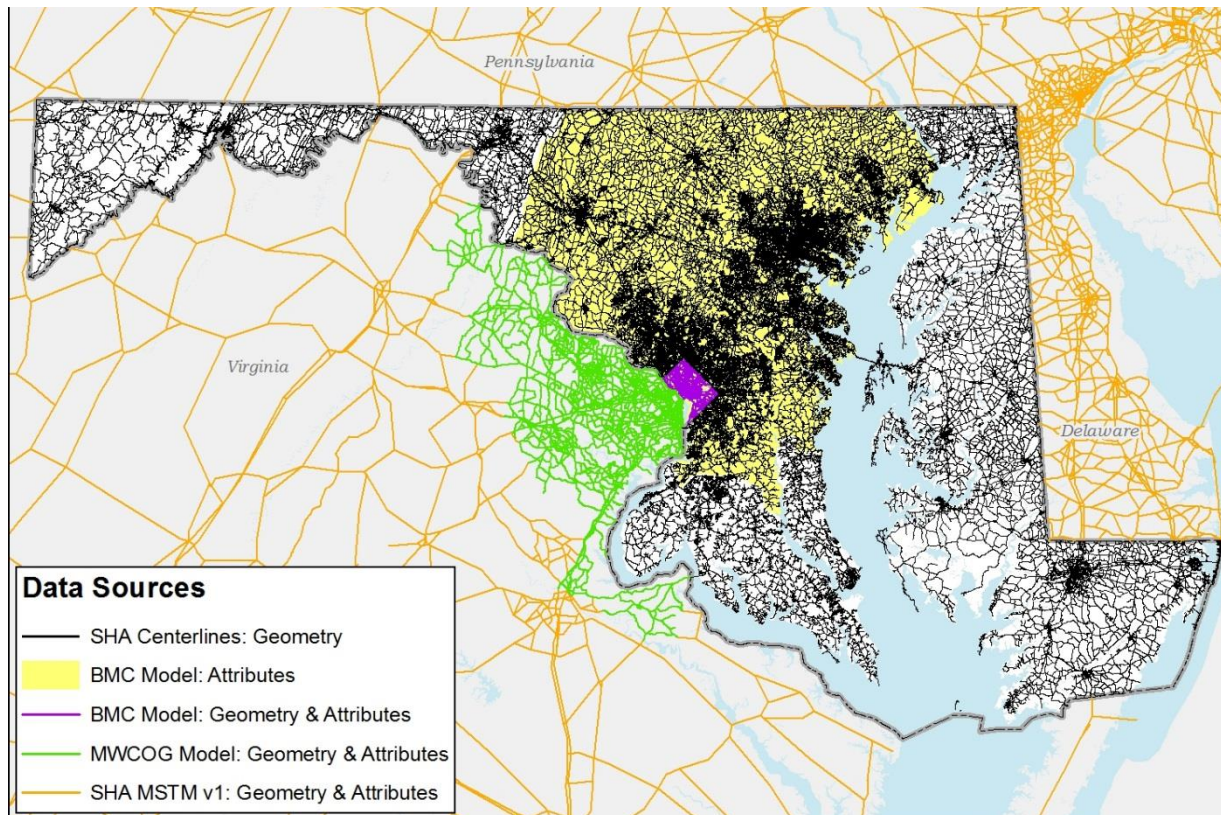
- Model Software
 - Travel demand model to manage network data as either binary network or in a geodatabase
- GIS
 - Manage data in a GIS environment with routines to export to software specific formats
- 3rd Party
 - Use of licensed third party networks

Options Considered in Design

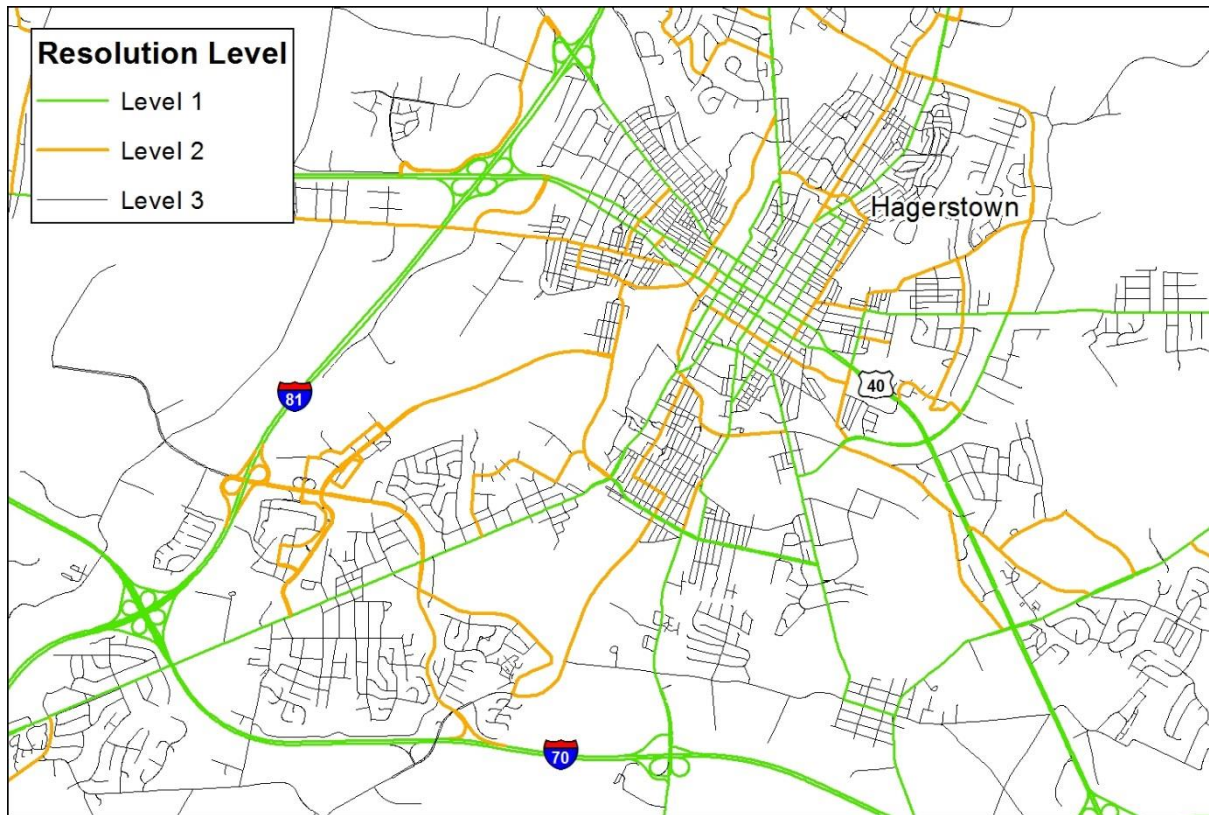
	Travel Demand Software	GIS	3 rd Party Network
Software Neutral	Low	High	Medium
Data Integration – Long Term Maintenance	Low	High	Low
Flexibility for Post Processing and User Interface	Medium	High	High
Transferability between users	Medium	High	Low

Approach – Data Assembly

- Geography
 - Statewide Centerline and Route Data
 - Current Models
 - Statewide Networks (PA, and DE)
 - ORNL Network
- Attributes
 - Geographic sources
 - Existing Models (x-walk)
 - Centerline data



Approach – MDOT SHA

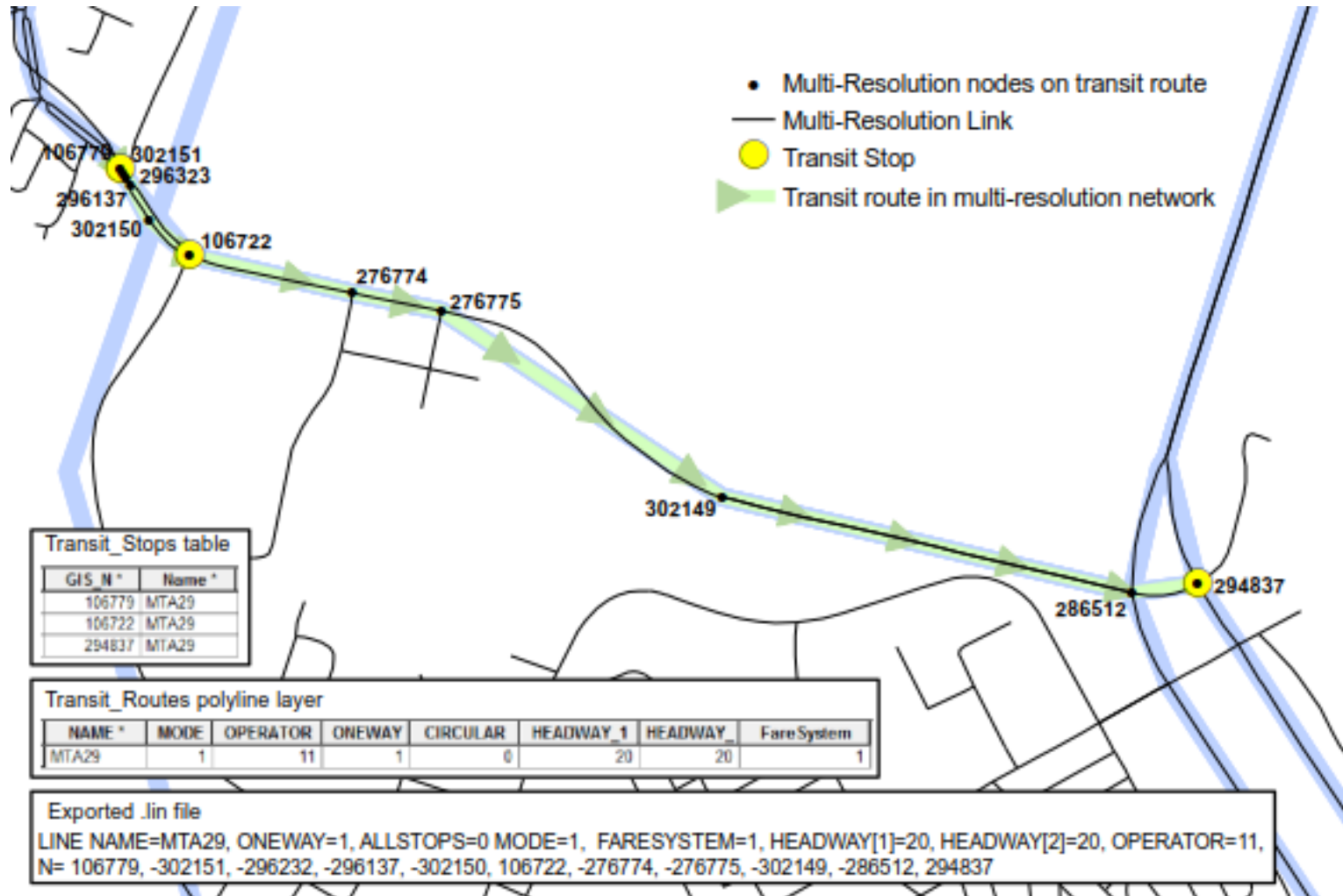


- Built from Centerline file
 - Association of Route, MSTM v1 and other source datasets to Centerline segmentation
- Creation of segmentation to support model network requirements

Approach – MDOT SHA



Approach – MDOT SHA



Application – MDOT SHA

- Graphical User Interface
 - Selection of resolution
 - Definition of buffer area for resolution transition
 - Management of selectin process
 - Selection of attribute scheme
 - Model year, and scenario
 - Include transit data

Multi-Resolution Network Export

Current Save Location: C:\Users\whaubert\Documents\MultiResolutionExport Change Folder

Resolution Level

Less Detail | More | Less

Level 1

Level 2

Level 3

More Detail | Level 4

Zone buffer distance (feet):

Zones selected:

Level 1	0
Level 2	0
Level 3	0
Level 4	0
Total	0

Select Zones Clear Selection

Target Model

MSTM

InSite

Scenario Year

Base Year Base year:

Future Year

Scenario Year

Base Year Enter year:

Future Year CLRPP

Include Transit?

Yes

No

EXPORT Cancel Done

Application – MDOT SHA

The screenshot displays the ArcMap interface with a map of a multi-resolution network. The map shows a dense network of black lines representing roads and blue lines representing water features. The 'Table Of Contents' on the left lists several layers, including 'Multi-Resolution Network', 'Centroids', 'Connectors', 'Nodes', 'Links', 'Zones', and 'Level1_Zones' through 'Level3_Zones'. The 'Multi-Resolution Network Export' dialog box is open on the right, showing the current save location as 'C:\Users\whaubert\Documents\MultiResolutionExport'. The dialog includes options for 'Resolution Level' (Level 1 to 4), 'Target Model' (MSTM or InSite), 'Scenario Year' (Base Year or Future Year), and 'Include Transit?'. The 'Zone buffer distance (feet)' is set to 200. The 'Zones selected' table shows 0 zones selected for all levels. The 'EXPORT' button is highlighted.

MultiResolution_ModelGeneration.mxd - ArcMap

File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help

1:300,000

Snapping

Table Of Contents

- Layers
 - Future Projects
 - Multi-Resolution Network
 - Centroids
 - Connectors
 - Nodes
 - Links
 - Zones
 - Level1_Zones
 - Level2_Zones
 - Level3_Zones

Multi-Resolution Network Export

Current Save Location: C:\Users\whaubert\Documents\MultiResolutionExport

Change Folder

Resolution Level

	More	Less
Level 1	<input type="radio"/>	<input checked="" type="radio"/>
Level 2	<input type="radio"/>	<input type="radio"/>
Level 3	<input checked="" type="radio"/>	<input type="radio"/>
Level 4	<input type="radio"/>	<input type="radio"/>

Zone buffer distance (feet): 200

Zones selected:

Level 1	0
Level 2	0
Level 3	0
Level 4	0
Total	0

Select Zones Clear Selection

Target Model

MSTM

InSite

Scenario Year

Base Year Base year: 2012

Future Year

Include Transit?

Yes

No

EXPORT Cancel Done

Application – MDOT SHA

The screenshot displays the ArcMap interface with a multi-resolution network export dialog box open. The map shows a road network with a central area highlighted in red and orange. The dialog box, titled "Multi-Resolution Network Export", is positioned in the bottom right corner. It includes a "Table Of Contents" on the left side of the map area, showing layers such as "Future Projects", "Multi-Resolution Network", "Centroids", "Connectors", "Nodes", "Links", "SelectedZones_LeastResolution", "SelectedZones_MidResolution", "SelectedZones_MostResolution", and "Zones".

The dialog box contains the following settings:

- Current Save Location:** C:\Users\whaubert\Documents\MultiResolutionExport
- Resolution Level:** Level 1 (radio button), Level 2 (radio button), Level 3 (radio button), Level 4 (radio button). The "More" side is selected.
- Target Model:** MSTM (radio button), InSite (radio button, selected).
- Scenario Year:** Base Year (radio button, selected), Future Year (radio button). Base year: 2012.
- Zone buffer distance (feet):** 200
- Zones selected:**

Level 1	1696
Level 2	63
Level 3	1069
Level 4	0
Total	2828
- Include Transit?:** Yes (radio button), No (radio button, selected).

Buttons include "Select Zones", "Clear Selection", "EXPORT", "Cancel", and "Done". A status message at the bottom reads "Zone selection complete".

Approach – MDOT SHA

MultiResolution_ModelGeneration.mxd - ArcMap

File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help

1:500,000 Snapping

Table Of Contents

- Layers
 - Nodes_InSite
 - Links_InSite
 - Future Projects
 - Multi-Resolution Network
 - Centroids
 - Connectors
 - Nodes
 - Links
 - SelectedZones_LeastResolution
 - SelectedZones_MidResolution
 - SelectedZones_MostResolution
 - Zones

Multi-Resolution Network Export

Current Save Location: C:\Users\whaubert\Documents\MultiResolutionExport [Change Folder](#)

Resolution Level

Less Detail | More | Less

Level 1

Level 2

Level 3

More Detail | Level 4

Zone buffer distance (feet):

Zones selected:

Level 1	1696
Level 2	63
Level 3	1069
Level 4	0
Total	2828

[Select Zones](#) [Clear Selection](#)

Target Model

MSTM

InSite

Scenario Year

Base Year Base year:

Future Year

Include Transit?

Yes

No

[EXPORT](#) [Cancel](#) [Done](#)

Export complete. Start time: 08:28:50 End time: 08:38:31

Closing Thoughts – ODOT Network Solution

- Challenges
 - Ability to build off multiple data-sources
 - Centerline
 - MPO
 - Etc.
 - Identification of projects to include in network
 - State projects
 - MPO & other local projects
 - Network coding
 - How to manage in group environment
 - Network management
 - Networks for different purposes
 - Different combinations of projects in a given scenario

Questions



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