

# AEGIST: Applications of Enterprise GIS in Transportation

## Geospatial Data Engineering and Data Science for Transportation Planning

CTPP Conference, June 7-9: Applying Census Data For Transportation Planning

Joe Hausman, FHWA Office of Planning

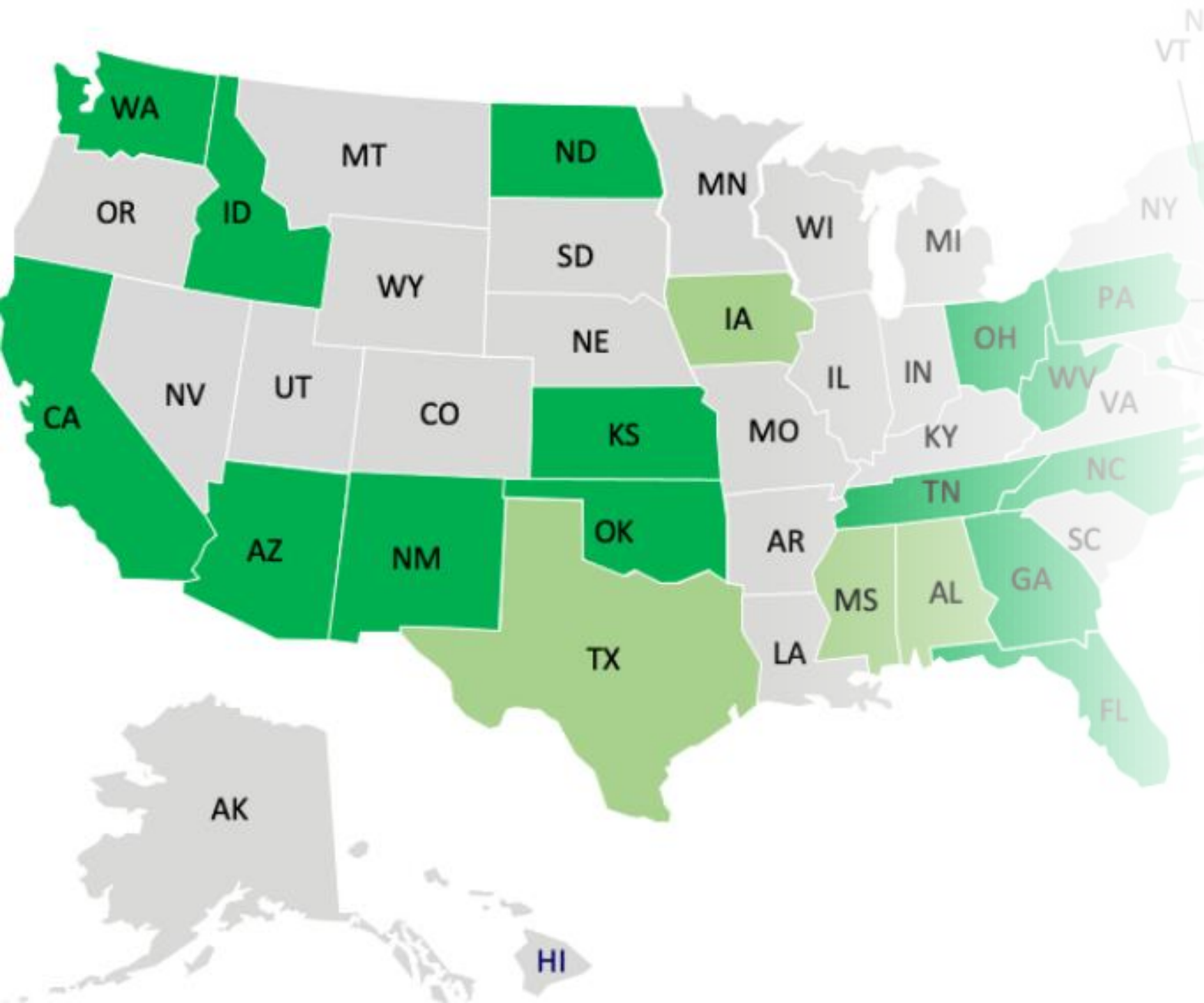
Abhishek Bhargava, Data Scientist

June 2022

For Questions Contact:  
[joseph.hausman@dot.gov](mailto:joseph.hausman@dot.gov)

*Disclaimer: Information in this deck is subject to change during the AEGIST Project (2019 – 2024)*

# AEGIST Pooled Fund Program



- FHWA Offices of Planning & Safety
- 18 States; 5 more engaged
- Local Agencies
- Federal Lands Management Agency
- National and International Standard Development Organizations
- Software vendors, Data vendors and agency consultants

Engaged to deploy best practices and standards for utilizing geospatial data & applications

# Why AEGIST?

Enabling Data Offices/Councils & Geospatial Information System Units at State DOTs to meet Agency Performance Goals and Objectives of Business Units at their Agencies

## Project Planning & Programming

Project  
Selection &  
Evaluation

Highway  
Economic  
Requirements  
Analysis

Statewide  
Transportation  
Improvement  
Program

## Asset Management

*(Operations and Maintenance)*

Pavement Life  
Cycle Plan

Bridge Life  
Cycle Plan

Maintenance  
Work Management

Emergency  
Response

Asset Inventory & Routine  
Inspection Operations

Data Office, Data Governance Council, Data Analytics Unit  
Information Technology (IT) Unit,  
Geospatial Information Systems (GIS) Unit

## Design & Construction: Digital Delivery

Survey  
(Ground Survey,  
Mobile Lidar,  
Aerial Imagery &  
Lidar)

Environmental Planning,  
Design and Fabrication

Construction  
Management

## Traffic and Safety

Travel Demand  
Modeling

Highway Safety  
Analysis

Freight / Truck  
Routing

Congestion  
Management

Traffic Systems Operations and  
Management

# AEGIST Data Integration and Engineering for Analytics

- State Agency Data Sources

- » Linear Referencing Systems (LRS) and/or Local Roads Inventory System (e.g. NG-911 Road Centerlines)
- » Highway Performance Monitoring System (HPMS)
- » Asset Management Systems (including Geospatial Asset Inventory, Inspection and Work Mgmt. Systems)
- » Project Planning and Programming Systems
- » Traffic and Safety Analysis Systems

- Open Data Sources:

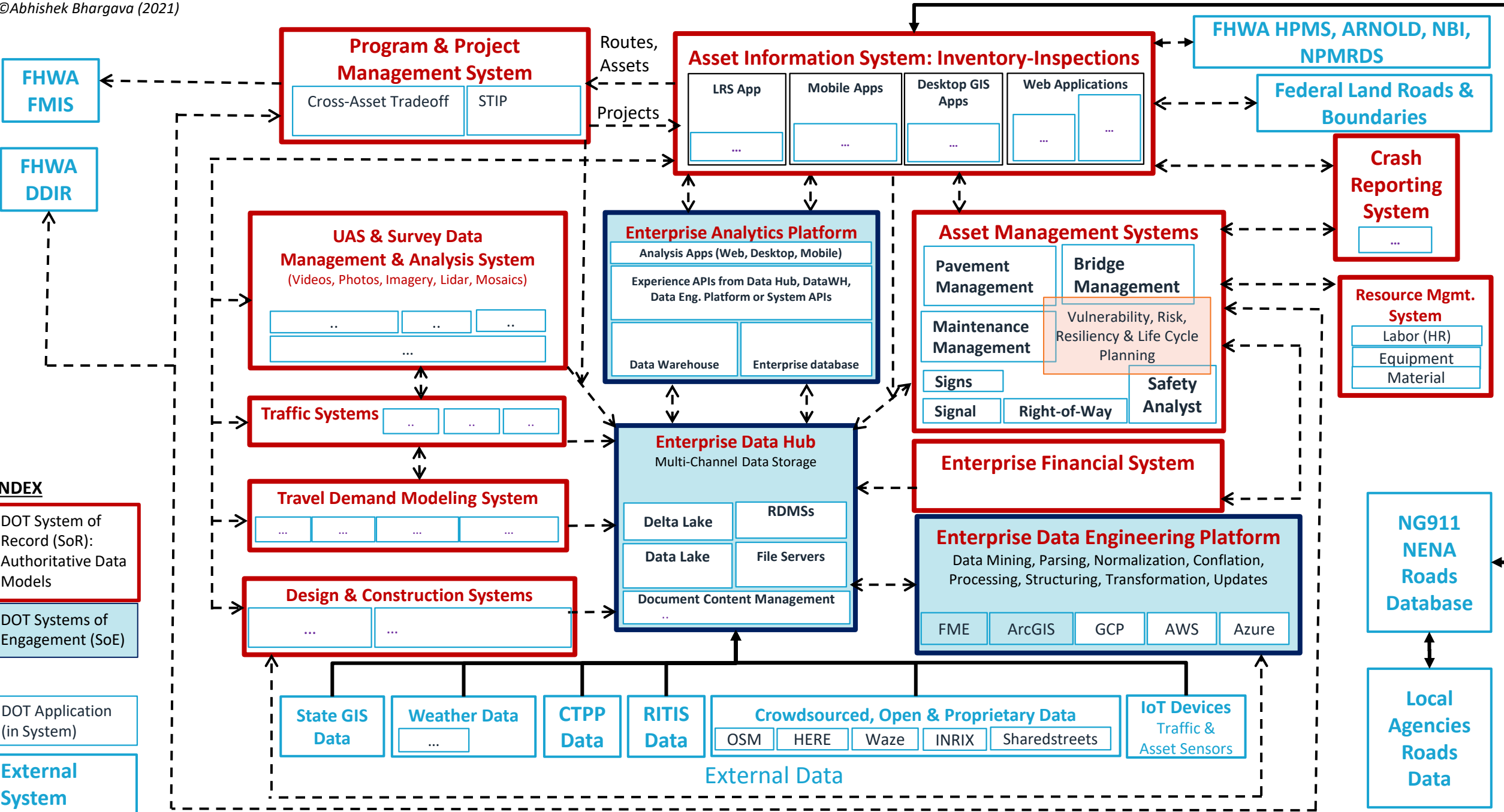
- » FHWA All Roads Network of Linearly Referenced Dataset (ARNOLD)
- » FHWA National Bridge Inventory (NBI)
- » National Performance Measurement Roads Dataset (NPMRDS)
- » Regional Integrated Transportation Information System (RITIS)
- » Census Transportation Planning Products (CTPP)
- » Open Street Maps (OSM)

- Proprietary Data Sources

- » HERE, Geotab, INRIX, Waze, etc.

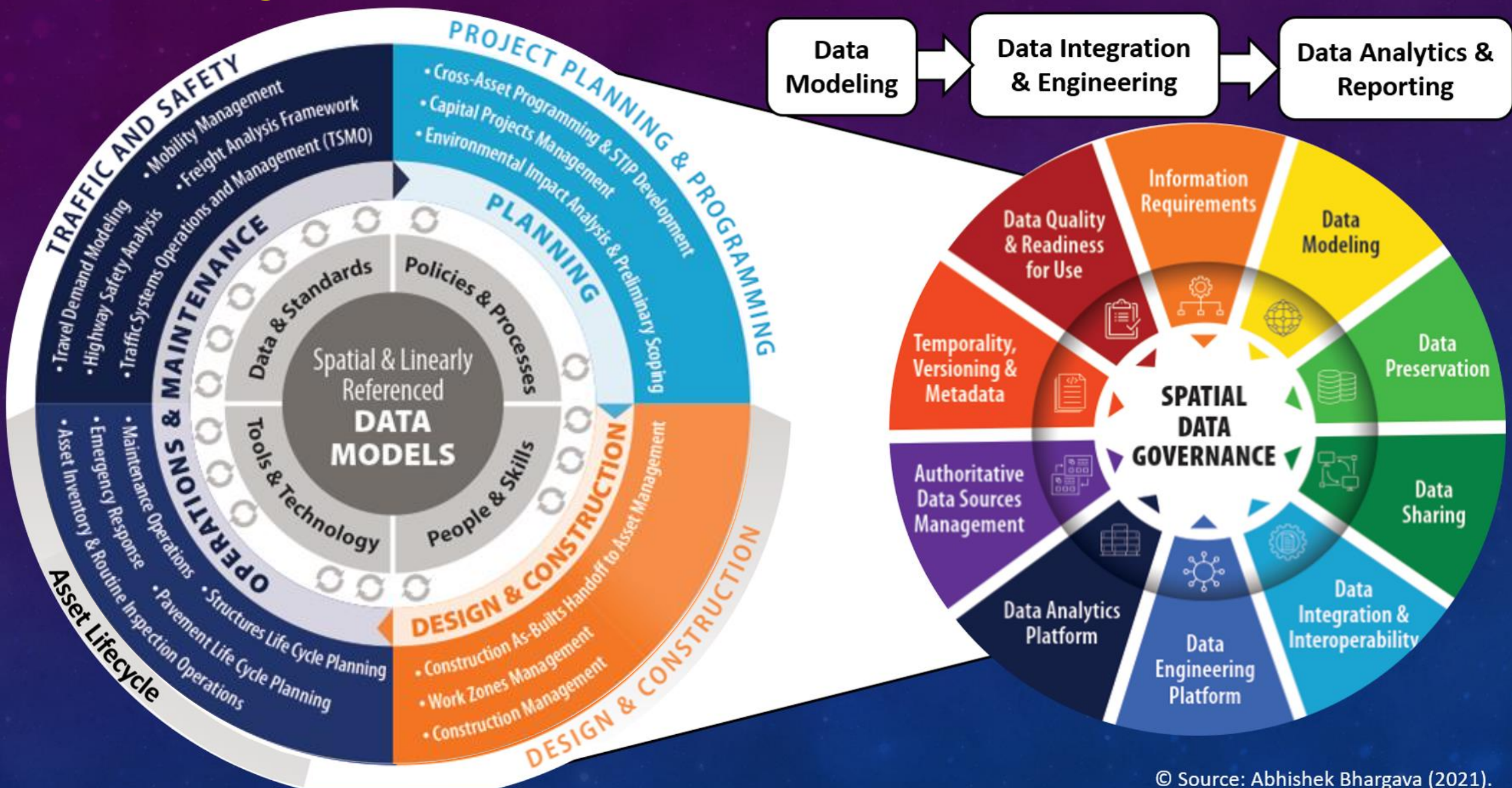
# Building Information Modeling (BIM): Enterprise Systems, Applications, Tools and Processes Deployment Activities

©Abhishek Bhargava (2021)



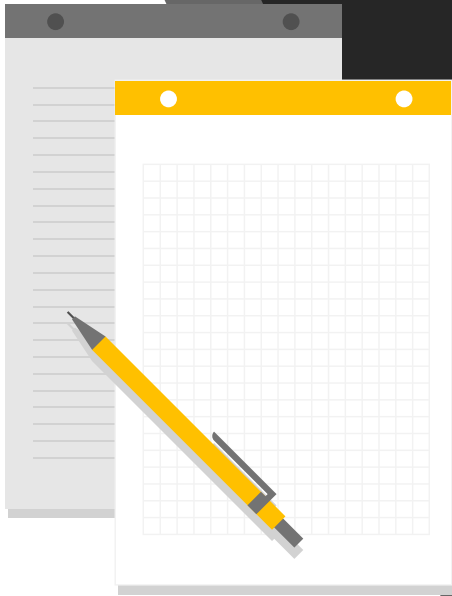


# Data Management and Governance



# AEGIST Beneficiaries

- **Planners** (AEGIST modeled data + traditional census data)
  - Land use and transport modeling, impact assessments (resilience, environmental justice), complete streets design, investment analysis
  - Travel demand modeling and vehicle routing
- **Roadway Inventory & Geospatial Information Systems Unit**
  - Federal reporting: HPMS, ARNOLD, MIRE
  - Data quality automation, GIS products teams
- **Safety engineers**
  - Roadway Improvement Data Program Deployment
  - Roadway safety analysis, Intersection safety analysis,
  - Pedestrian, Bike network for safety analysis
- **Asset Managers**
  - Asset Information Management, Data governance (roads/bridges/safety), digital twins, better lifecycle data integration
- **Digital Delivery: Design, Construction Management**
  - Hand-off As-Built Asset and Roadway Characteristics data to Asset Managers, thereby improving quality of data reported to FHWA



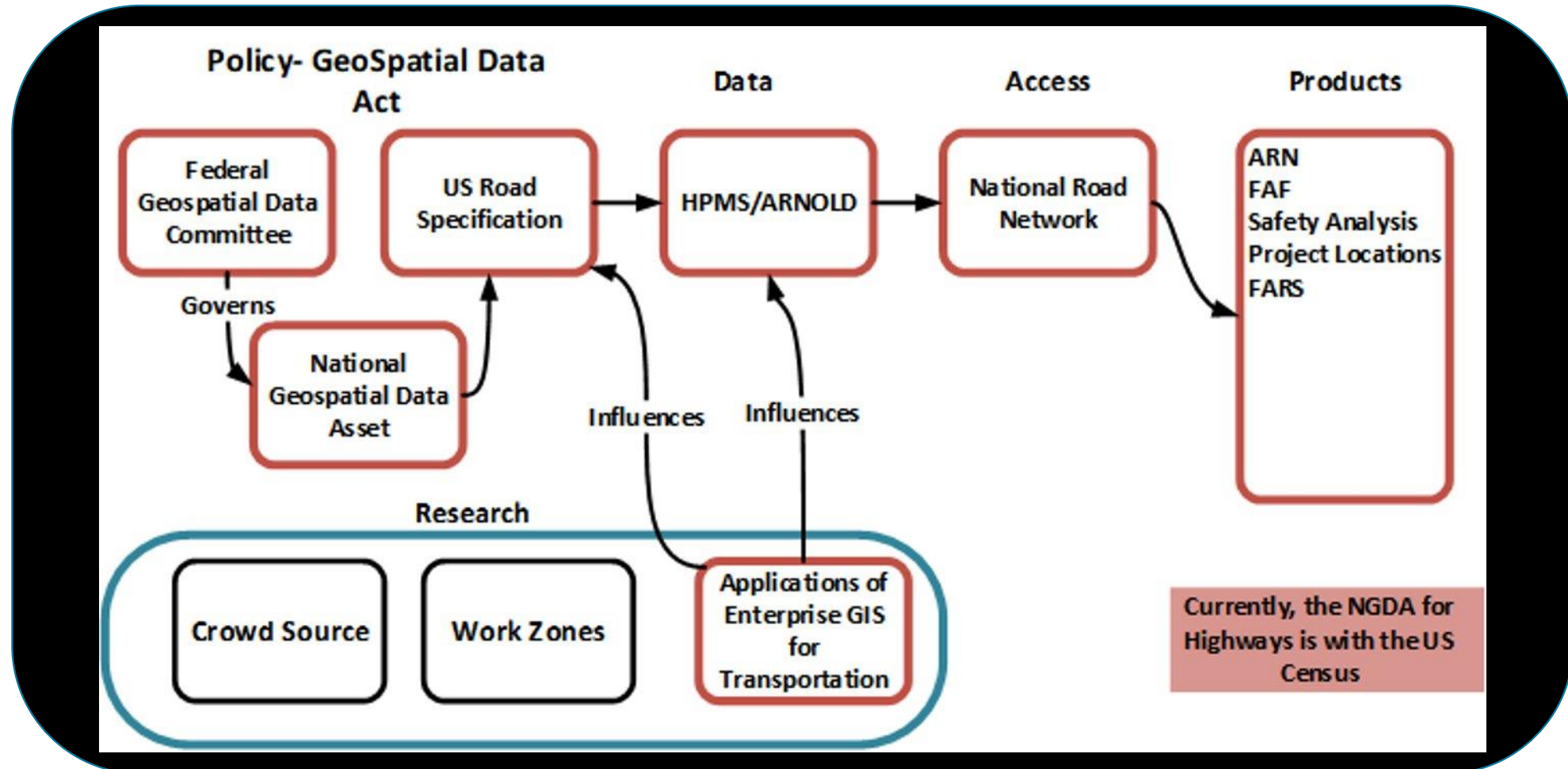
# AEGIST Beneficiaries

- **Federal agencies**
  - Better data reporting from States for HPMS 9, MIRE, ARNOLD, Federal-Aid projects data submission
  - Decentralized national road network data creation
  - Development of National standards for road data modeling
- **Local agencies**
  - Roadway Mileage Reporting
  - Pavement condition information tracking
  - Safety analysis using comprehensive roadway inventory data
  - Transportation improvement programs data standards
- **Emergency management agencies**
  - NG911 and ARNOLD Road Centerline data integration methodology, approach and proof-of-concept pilots
- **Federal Lands Management Agency:** Roads data integration
- **Private Sector: Governance of Emerging Data Technologies**
  - Integrate Connected Vehicle Environment (CVE), Unmanned Aerial Systems and Mobile Survey data in enterprise asset systems





# AEGIST Building Data Modeling, Engineering and Data Science Standards at National Level







## Legend

## Maryland Road-Separated Bicycle Routes



## MDOT SHA Roadway Centerline

## Route Prefix Name

- County Route
- Crossover Route
- Government Route
- Interchange Ramp
- Interstate Route
- Maryland State Route
- Municipal Route
- Other Public Route
- Other State Agency Maintained Route
- United States Route
- others

## MDOT SHA Roadway Access Control - Full Access Control

## Access Control

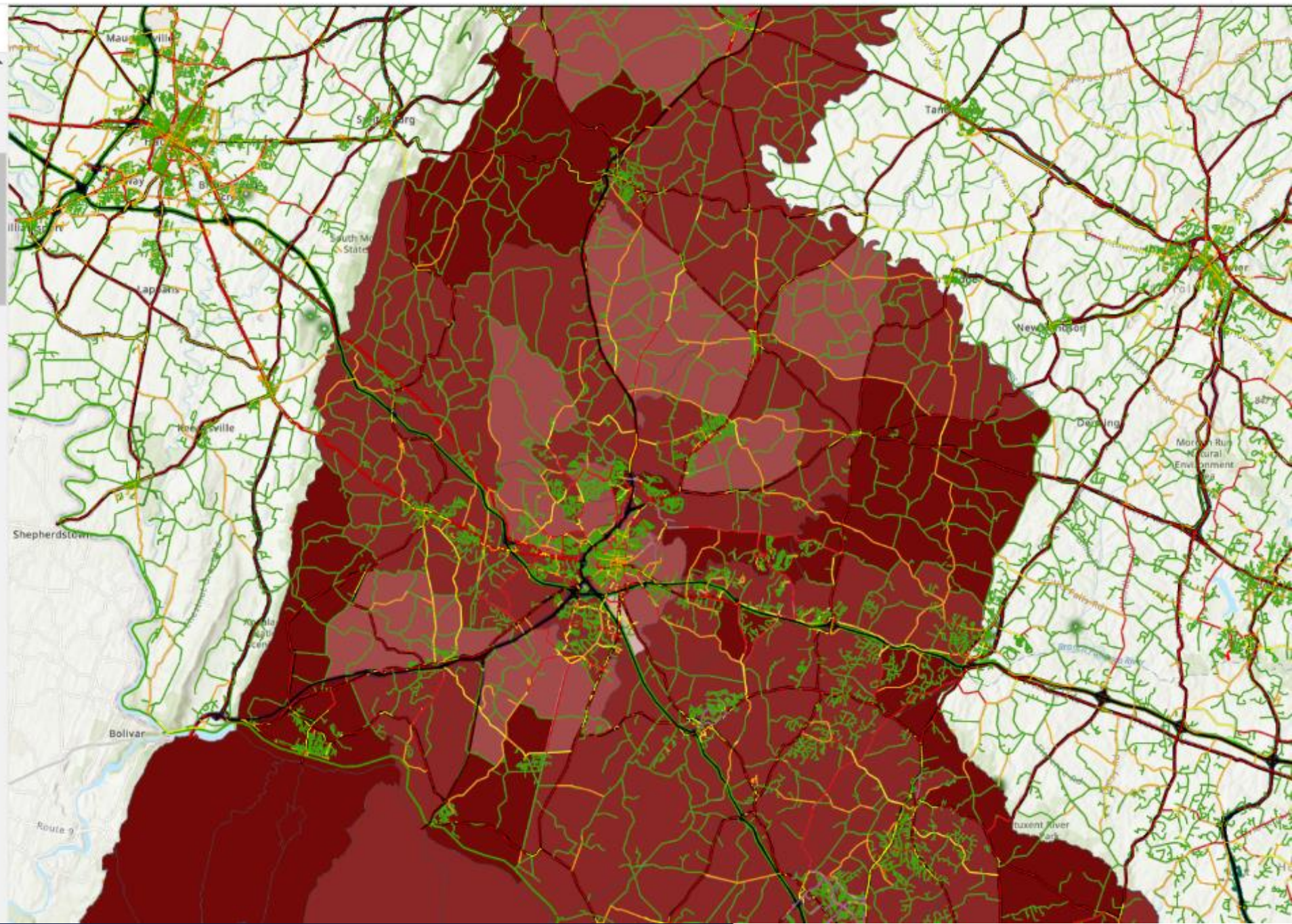
- Full Access Control

## Census Transportation Planning Products (CTPP) - TPB Planning Area

## Average Travel Time

Mean Travel Time by Means of Transportation - Place of Residence TAZ (in minutes)

- 41 and over
- 31 to 40
- 21 to 30
- 11 to 20
- 0 to 10



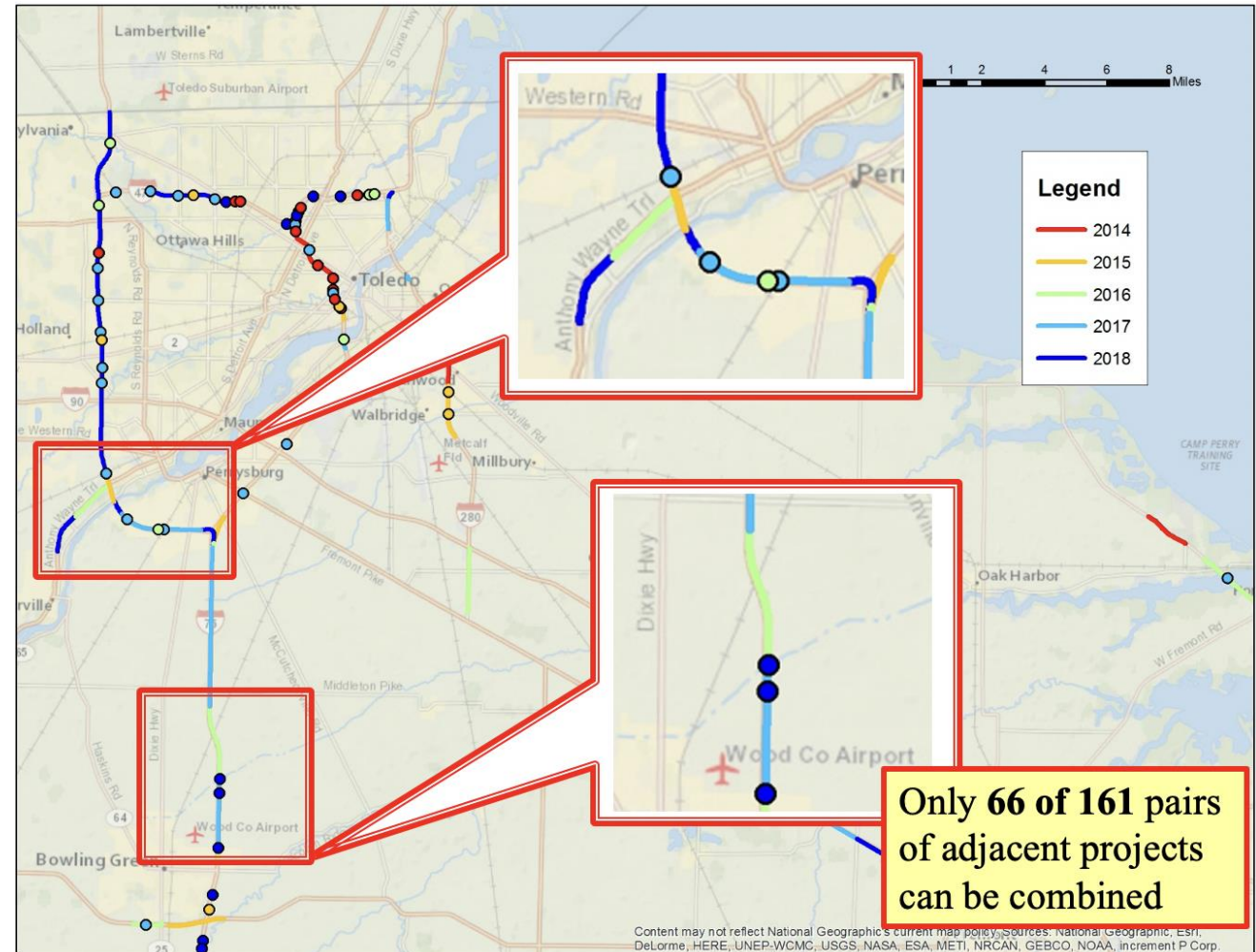


# Project Planning and Programming

## Use Case PL-03: Cross-Asset Tradeoff Analysis and Transportation Improvement Program Development with Equity Considerations

**Corridor Analysis:** Prioritizing & Scheduling Bridge, Pavement, Safety, Mobility and other Asset Projects based on Socio-Economic Impact Analysis using CTPP Data Products

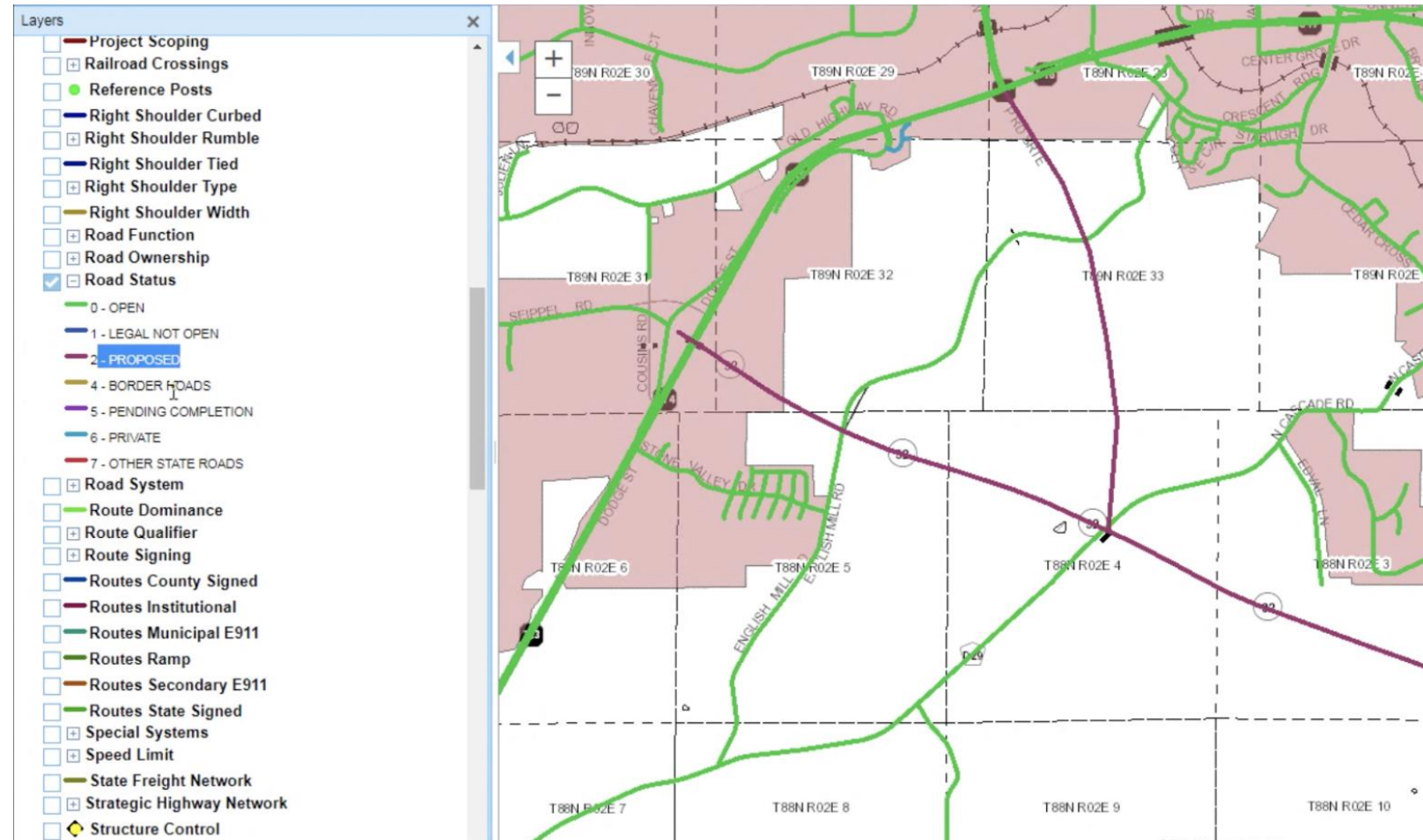
- Addressing the problem of uncoordinated projects
- Corridor Mobility Analysis: Fixing functionally obsolete bridges on the STRAHNET
- Economic Cost Analysis: Agency and User Cost (Vehicle Operating cost, Accident Cost) on STRAHNET



# Project Planning and Programming

**Use Case PL-02:** Identifying Proposed Road Segments that are going to open to traffic in different years and tracking status of as-designed, as-built roads over time using temporal data editing and status tracking (asynchronous editing allowed)

Source: Iowa DOT





# AEGIST Intersection Model

OGC Geographic Data Format (GDF), CityGML, buildingSMART IFC, Generalized Modeling Network Specification (GMNS) and MIRE Standards Compliant

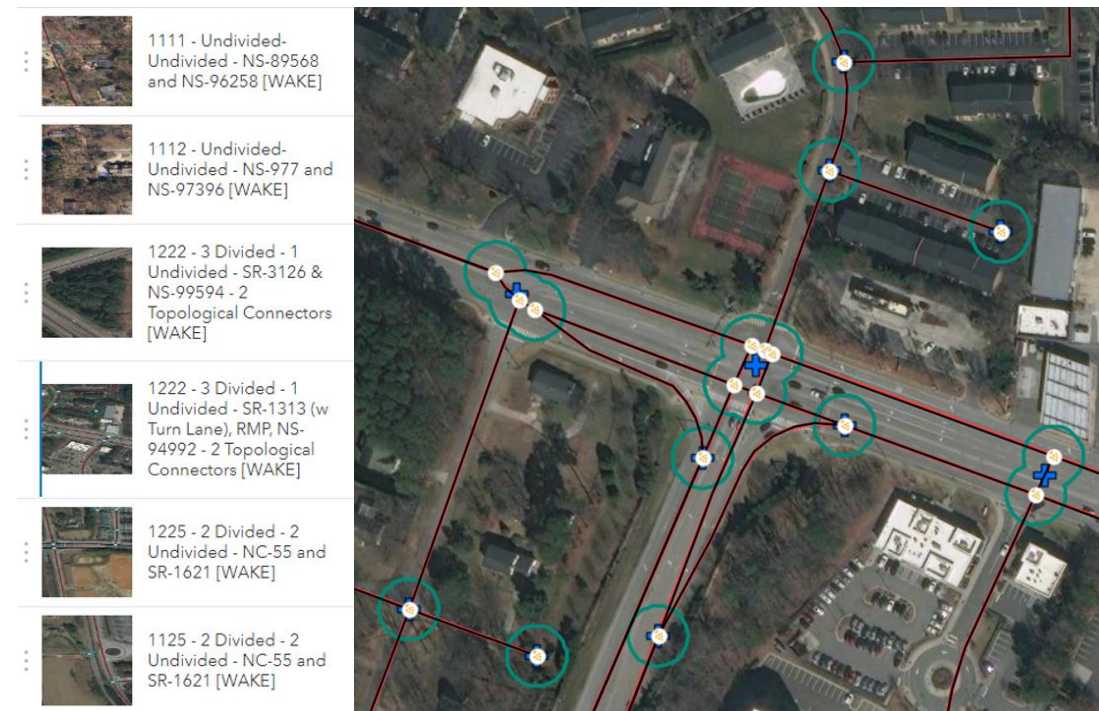
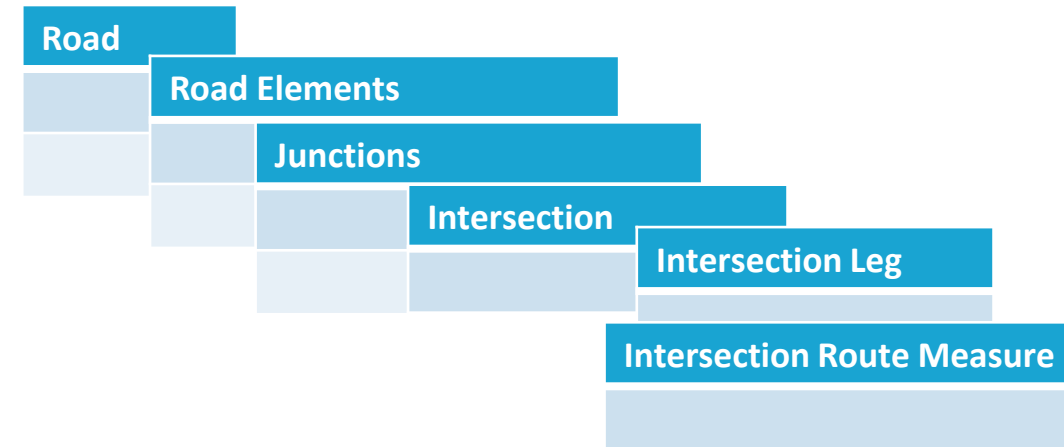
- LRS Route, Centerline (Datum), Route-Centerline (M:N)
- Intersection Features

- » **Junctions (Nodes):** At Intersections, TAZ Centroid\*, Bridge, Access Points, Median Cuts, Intersection Median Ends, Intersection Leg Begin/End, State/County/Town/Parish Boundaries (Snap Points). Setup as LRS Event.
- » **Intersection Point** at Centroid, at a perpendicular offset from LRS Route (e.g.: *Median Cut Intersection, MIRE-126*). Setup as GIS Feature.
- » **Road Segment:** Junction to Junction. Setup as LRS Event. Ideally aligned with NG911 Road Centerlines, with MIRE and NG911 attribution.
- » **Intersection Leg:** MIRE compliant road approaches.

- Topological Segments (GIS features)
  - » Intersection Connectors
  - » Turn Segments/Lanes (HPMS 12, 13)
  - » Median Crossovers (MIRE-62)

## Connectivity, Topology:

- Road Segments and Intersection Parent-Child Data Relationship
- Junctions (Nodes) with Road Segments, Connectors, Turn Segments/Lanes, Median Crossovers, Reverse Route Segments, Inventory Routes, Continuity Intersection Points







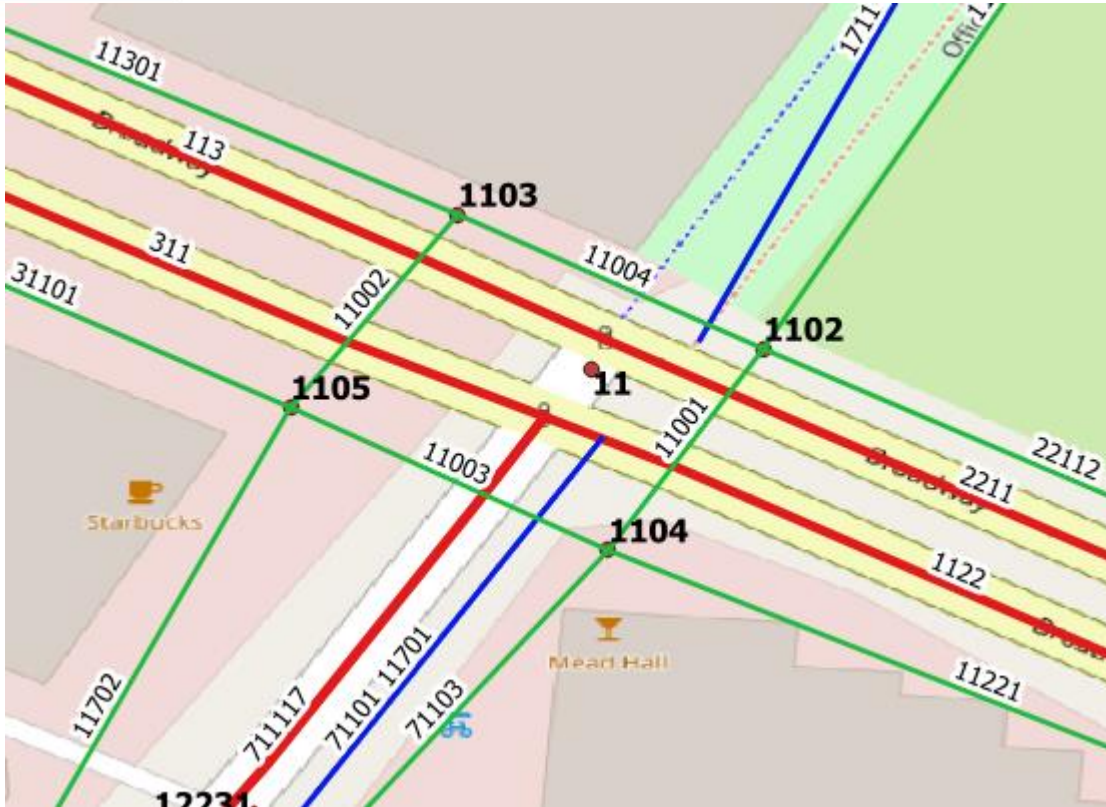
# DIGITAL TWIN FOR COMPLETE STREETS

- Routes: Motorists, Pedestrians, Trails, Transit (Bus, Rail), Managed Lanes
- Sidewalks
- Bike lanes (or wide paved shoulders)
- Special bus lanes
- Comfortable and accessible Public transportation stops
- Frequent and safe crossing opportunities
- Median islands
- Accessible pedestrian signals
- Curb extensions
- Narrower Travel Lanes
- Roundabouts

and more Transportation Right-of-Way Assets



# AEGIS Incorporating GMNS Standard for Modeling Multimodal, MIRE-Compliant Signalized Intersection from ARNOLD and NG911 Roads

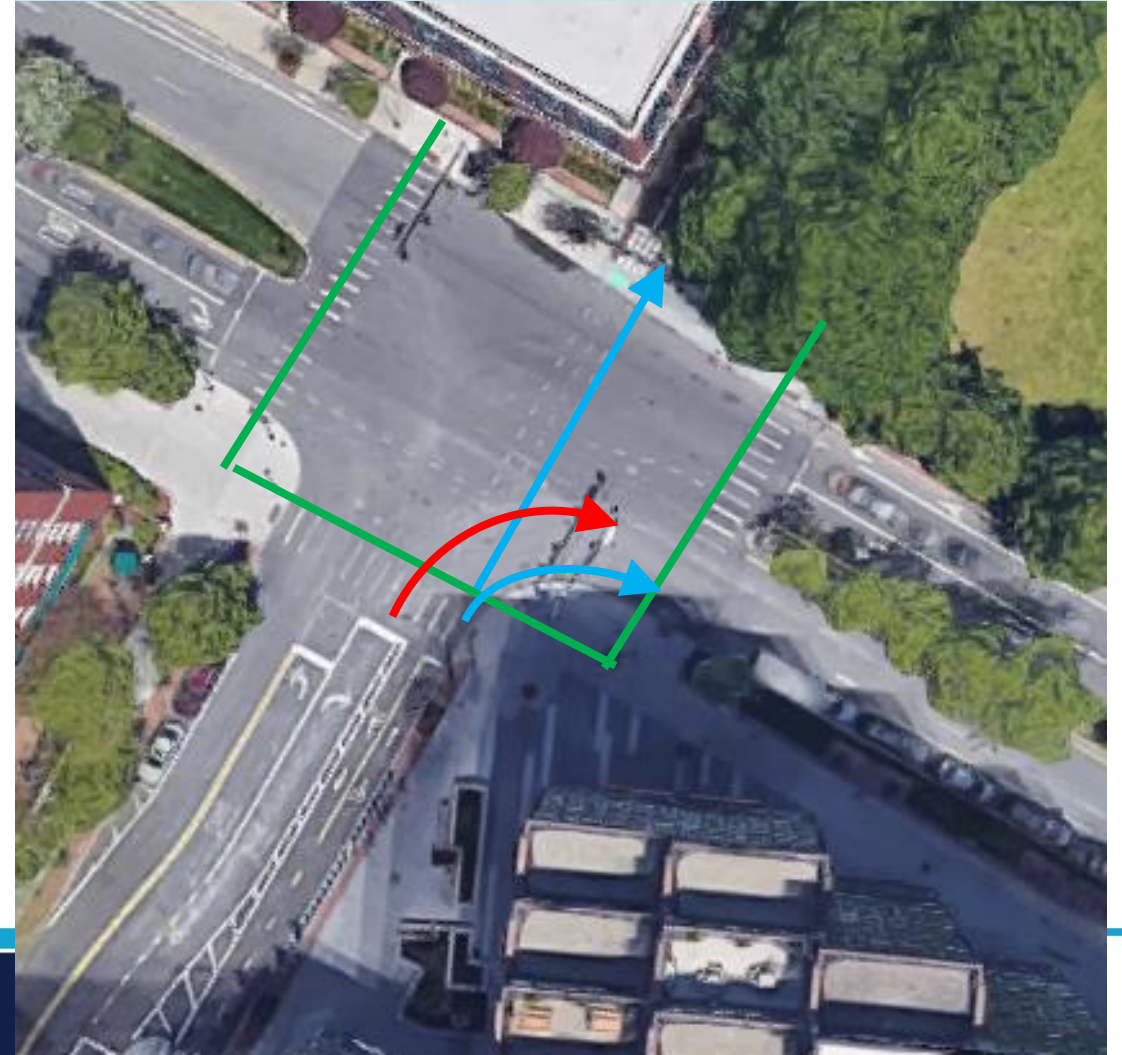


**Red: Vehicle links and movements**

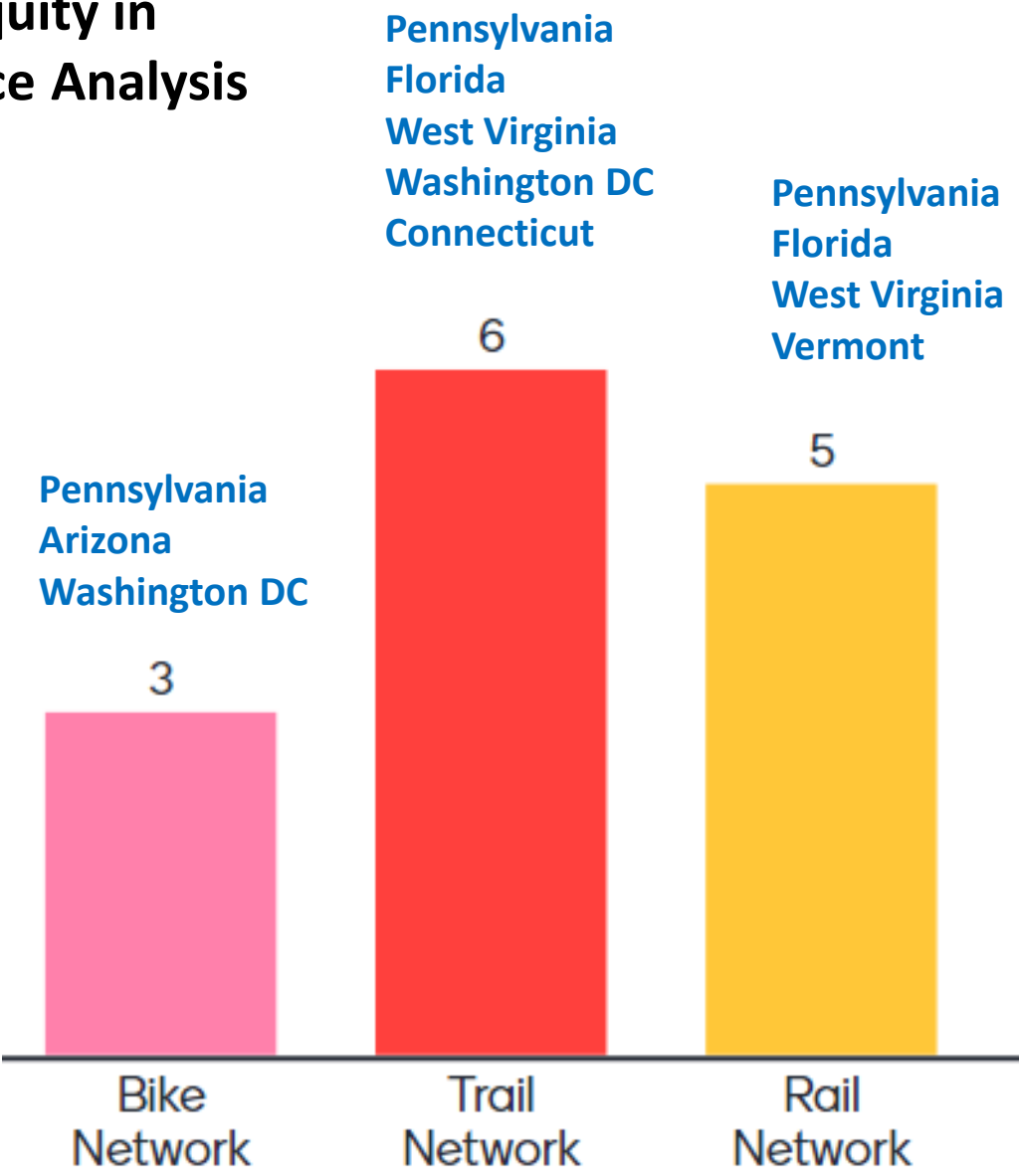
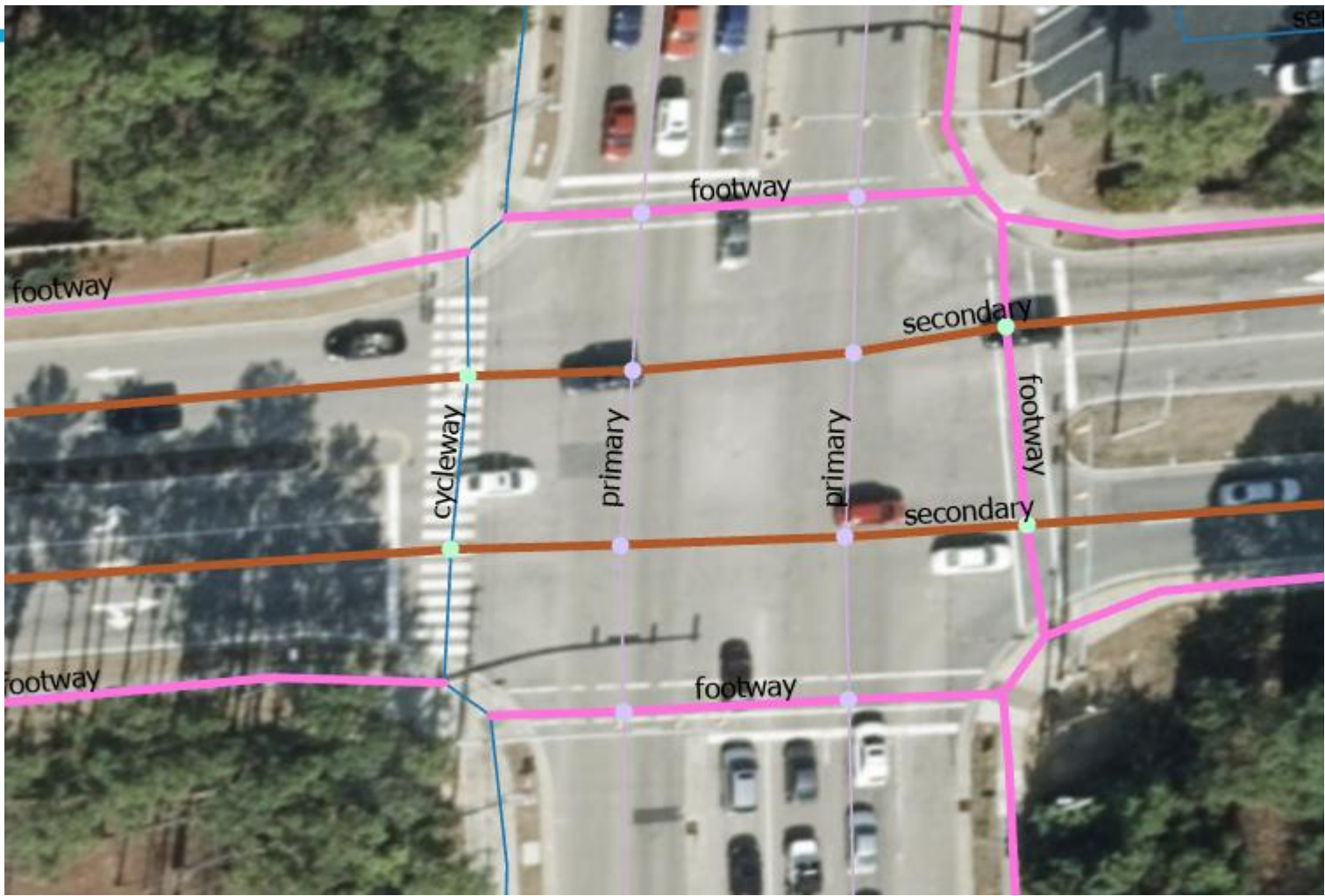
**Blue: Cycle track links and movements**

**Green: Pedestrian links and crosswalks**

Selected Movements from Ames St.



# Vehicle, Bike and Pedestrian Route Network Modeling for Equity in Transportation Planning using Safety, Mobility & Performance Analysis



Number of Responses: 9



# Use Case: Travel Demand Modeling

## Links, Nodes & Roadway Characteristics

**Linear  
Referencing  
System**

- [1] Road Segments (Links)
- [2] Junctions (Nodes)
- [3] Intersection

**Travel Demand  
Modeling  
System**

Link Attributes
ID
From Node ID
To Node ID
Direction
Length
Functional Class
Facility Type/Link Type
Area Type
Auto/Truck tolls
Number of Lanes
Parking Restriction
Truck/HOV Usage
Median
Access Control
Signal Density
Turn Lane
Ramp Type
Bridge, Tunnel,...

Software default fields

Important general classification,  
used to calculate link speed and  
capacity

Components of generalized cost  
used for model path-building

Time of day characteristics used  
to build period networks

Model specific attributes used to  
compute the appropriate  
physical link types together with  
attribute listed above

Link Attributes
Road Segment ID
Begin Junction ID
End Junction ID
Direction
Length
HPMS-01 - Functional Class
HPMS-03 - Facility Type/Link Type
HPMS-02 - Urban Code
Auto/Truck tolls
HPMS-07 - Through Lanes
Parking Restriction
HPMS 08-11 - HOV/HOT/Toll
Median
HPMS 05 - Access Control
Signal Density
HPMS 12/13 - Turn Lane
Ramp Type
Bridge, Tunnel,...

### MIRE Road Segments Attributes for Safety

- 13. Segment Length <sup>FDE</sup>
- 14. Route Signing
- 15. Route Signing Qualifier
- 16. Coinciding Route Indicator
- 17. Coinciding Route - Minor Route Information
- 18. Direction of Inventory <sup>FDE</sup>
- 19. Functional Class <sup>FDE</sup>
- 20. Rural/Urban Designation <sup>FDE</sup>
- 21. Federal Aid <sup>FDE</sup>
- 22. Route Type <sup>FDE</sup>
- 23. Access Control <sup>FDE</sup>
- 24. Surface Type <sup>FDE</sup>
- 25. Total Paved Surface Width
- 26. Surface Friction
- 27. Surface Friction Date
- 28. International Roughness Index (IRI)
- 29. International Roughness Index (IRI) Date
- 30. Pavement Condition (Present Serviceability Rating [PSR])
- 31. Pavement Condition (PSR) Date
- 32. Number of Through Lanes <sup>FDE</sup>
- 33. Outside Through Lane Width
- 34. Inside Through Lane Width
- 35. Cross Slope
- 36. Auxiliary Lane Presence/Type
- 37. Auxiliary Lane Length
- 38. High-occupancy Vehicle (HOV) Lane Presence/Type

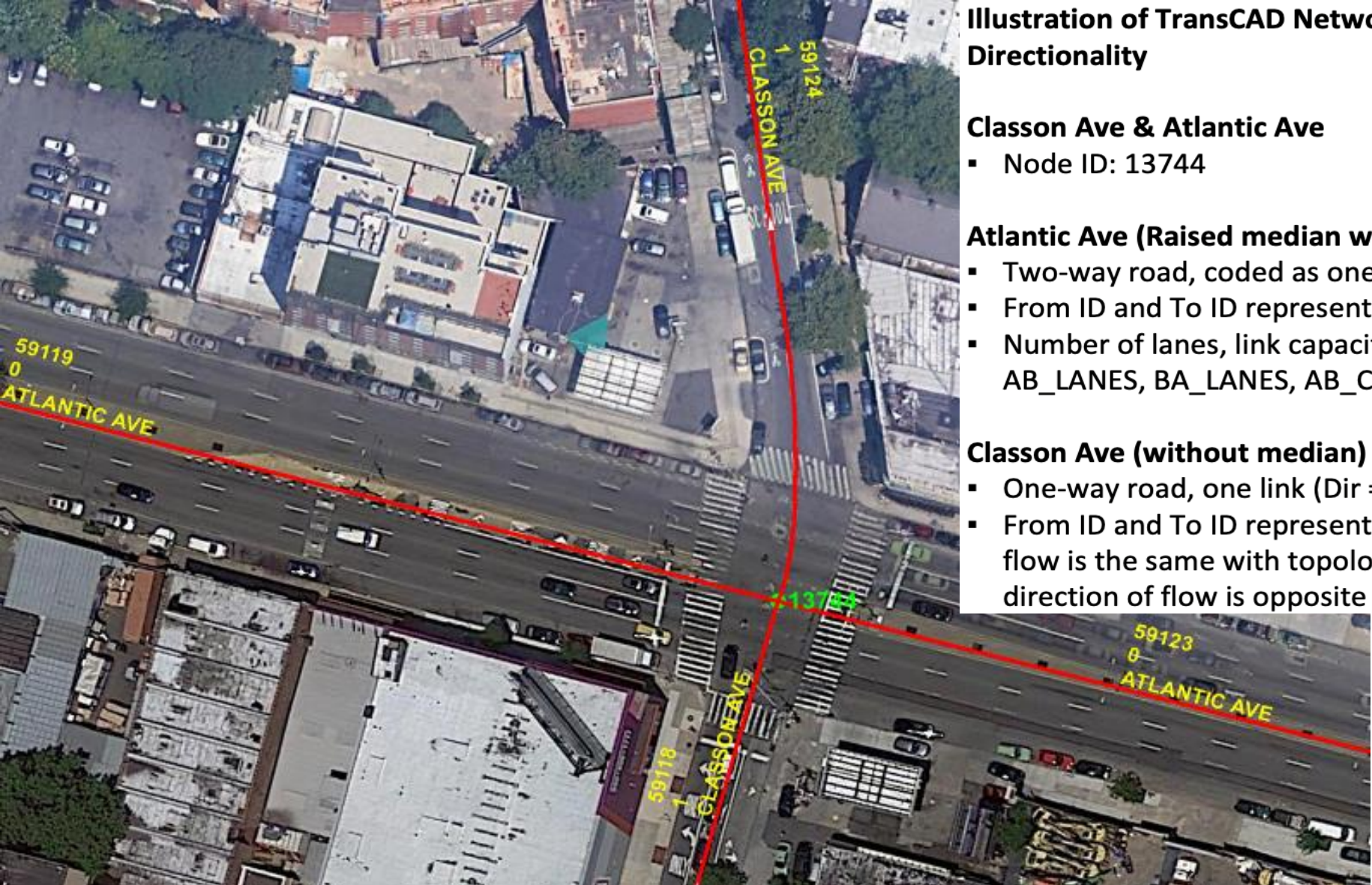


Illustration of TransCAD Network Link IDs, Topological and Flow Directionality

Classon Ave & Atlantic Ave

- Node ID: 13744

Atlantic Ave (Raised median with curb)

- Two-way road, coded as one bidirectional link (Dir = 0)
- From ID and To ID represent topological direction.
- Number of lanes, link capacity, ect. are coded in the format AB\_LANES, BA\_LANES, AB\_Capacity, BA\_Capacity

Classon Ave (without median)

- One-way road, one link (Dir =1)
- From ID and To ID represent topological direction. If the direction of flow is the same with topological direction, then Dir =1, if the direction of flow is opposite to the topological direction, then Dir=-1.

[From ID]	[To ID]	ID	Dir	Length	LID	NAME1	COUNTY	FCLASS	DESIGN	MEDIAN	ACCESS	SIGNAL	DRIVEWAY	TURN	TOT_LANE
13619	13744	59119	0	0.17	59119	ATLANTIC AVE	4	14	0 A	N	H	NS	NS		6
13744	13732	59124	1	0.07	59124	CLASSON AVE	4	16	0 N	N	H	NS	NS		2
13744	13873	59123	0	0.16	59123	ATLANTIC AVE	4	14	0 A	N	H	NS	NS		6
13688	13744	59118	1	0.29	59118	CLASSON AVE	4	16	0 N	N	H	NS	NS		1





84.4273949°W 33.8415490°N    Selected Features: 5

MENT    OUT\_Pull11a - ToTerminal    Counties121\_127n

Calculate    Selection:    Select By Attributes    Zoom To    Switch    Clear    Delete    Copy

EdgeSequen	RoadNames	Origin_Des	NumberOfJo	Destinat_4	AvgDistanc
-1692820378713516190,6427226923243275847,7872297807254062231,...	Eugene Talmadge Memorial Bridge,Atlantic Coastal Hig...	South Carolina	374	b12	46.02858918582971
6428011016329063887,2709643821801372940		Fulton	135	b15	10.31696706028589
-3772566523323006118		Fulton	90	b15	12.63517712865134
3883060916671609923	Sullivan Road	Fulton	82	b15	5.724052206339342
2196668876445222640,-1163535265906310948,-1332252725276495092,...	Perimeter	Fulton	78	b15	19.03045369794904
-2356212690051327139,1945594236381943576,8153266790188650595,-...	N Coastal Highway,North Coastal Highway,South Coast...	South Carolina	52	b12	53.62336855189559
1879890688678032704,-4104625364390564628,-2816437862694231411,...	Augusta Road,Bonnybridge Road,North Coastal Highwa...	Effingham	37	b12	22.97700435052828
1879890688678032704,-4104625364390564628,-2816437862694231411,...	Augusta Road,Grange Road	Effingham	36	b12	19.89434431323804
999452697798465524,-2352306268603014173,-2484389090956856686,-...	Perimeter,I 85	Cobb	28	b15	23.08887507768801





Questions