Enterprise Data Enhancement for Planning through Geospatial Enabled Linear Referencing

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Project Key Items

- Document exemplary practices utilized by MPOs who used “Linear Referenced”, or LRS data for building Modeling Network
- Support MPO to utilize All Road Network of Linear Referenced Data (ARNOLD) initiatives for TDM Network building
- Develop and test methodologies that can guide MPOs to utilize ARNOLD for TDM modeling

Interviewed MPOs with Exemplary Practices

1. Regional Transportation Council (RTC) Las Vegas, NV
2. Southern California Council of Governments(SCAG) Los Angeles, CA
3. La Cross Area Planning Committee (LAPC) La Crosse, WI
4. Southeast Michigan Council of Governments (SEMCOG) Detroit, MI
5. Denver Regional Council of Governments (DRCOG) Denver, CO
6. New Orleans Regional Planning Commission (NORPC) New Orleans, LA
7. Atlanta Regional Council (ARC) Atlanta, GA
8. Southwest Michigan Planning Commission (SWMPC) Benton Harbor, MI

Key Takeaways from the Interviews

Typical Uses of LRS by MPO

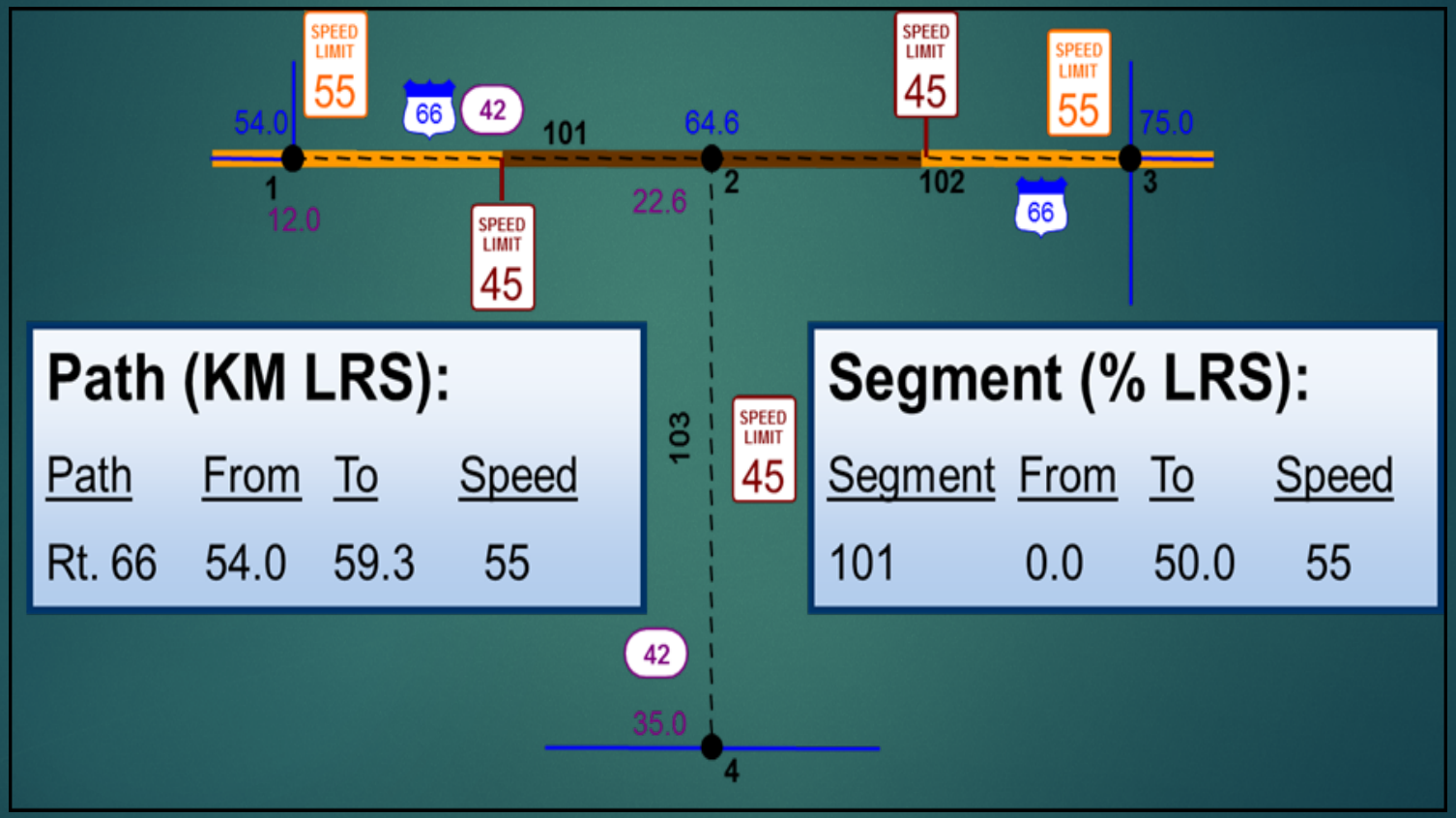
- Transit routes and safety applications
- Asset Management
- Hardly any use of LRS for modeling or to/from attribute sharing.

Today's Agenda

Integrating ARNOLD with MPO Travel Demand Model Network

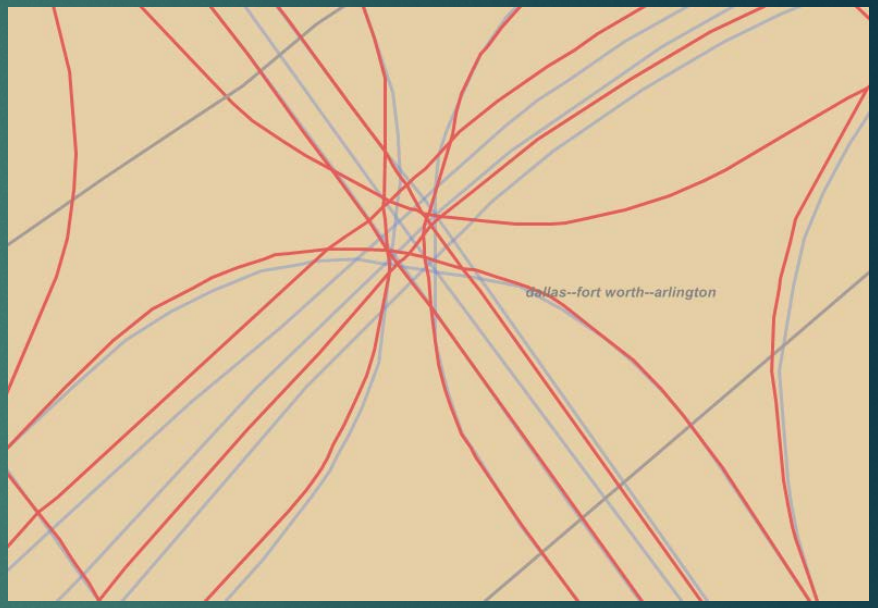
ARNOLD and MPO Travel Demand Network Data Model

- Typical Data Model



Integrating Existing Travel Demand Model Network with ARNOLD: Challenges

- ARNOLD topological issue (non-existence link-node connectivity)

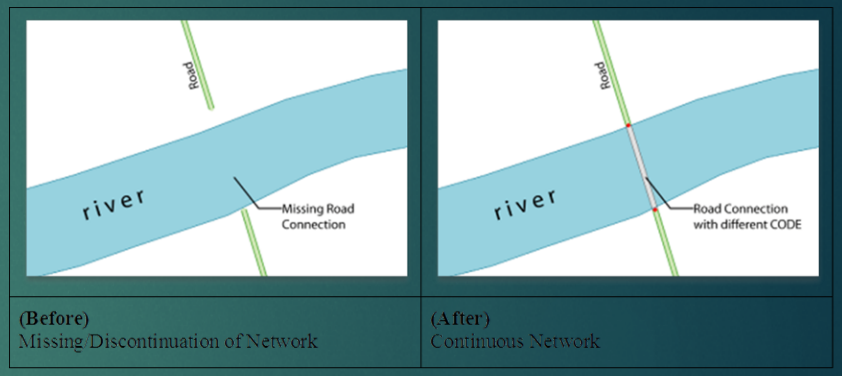


- Dealing with ARNOLD ramps and dualization for typical centerline based TDM network

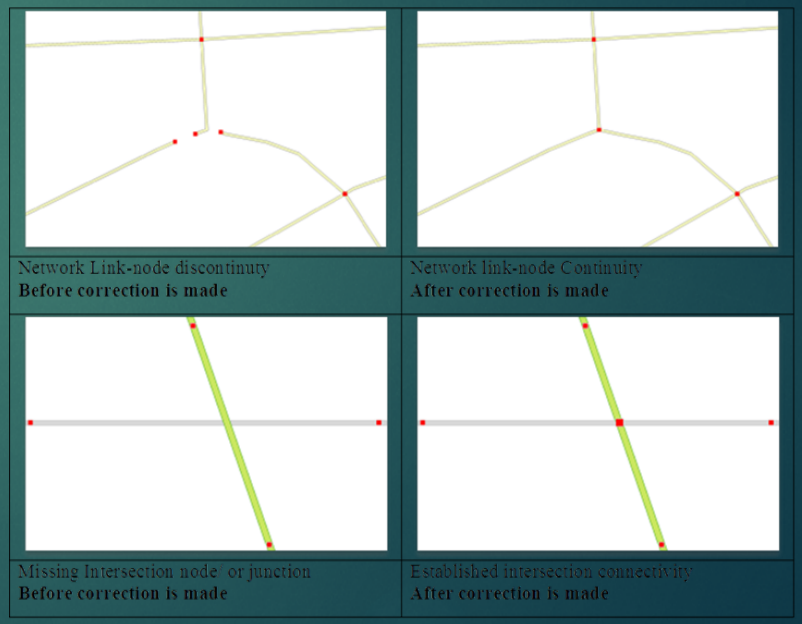
- Overpass and underpass (route overlapping without connectivity)

Integrating Existing Travel Demand Model Network with ARNOLD: Challenges (Continue)

- Network Gaps on LRS due to Ferry, Bridges and shared routes



- Multiple routes on a non-intersected model segment

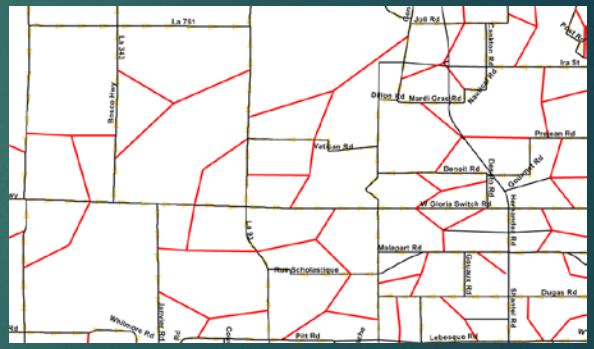


- Discrepancy between ARNOLD and model network topology direction (mile-marker start and end direction)

Integrating Existing Travel Demand Model Network with ARNOLD: Challenges (Continue)

- There may be a wide-variation among (Positional Accuracy) model and Arnold Geospatial accuracy (direct conflation not possible)

- Presence of dummy links which have no ARNOLD representation



- Lack of common reference (naming convention) between ARNOLD segment and the model segment

What ARNOLD Offers for Modeler?

- Roadway segments with mile marker
- “Some” Attributes but options for “Many”
- Readily accessible or available to MPO for Structured Geospatial data model for all public roads (urban and rural)

What Modeler Wants?

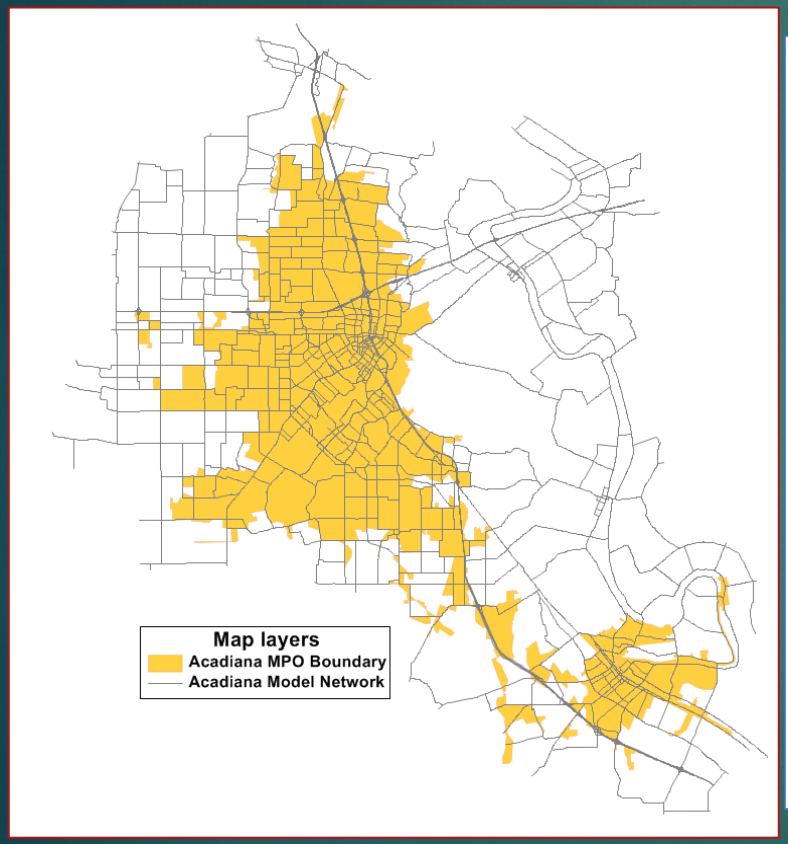
- A topologically connected “Routable” Network with defined link and node
- “Some” Attributes that described the physical and operational character of the link and node
- A “Trip” origin and destination database that tied to the said “Routable Network”

Research Objectives

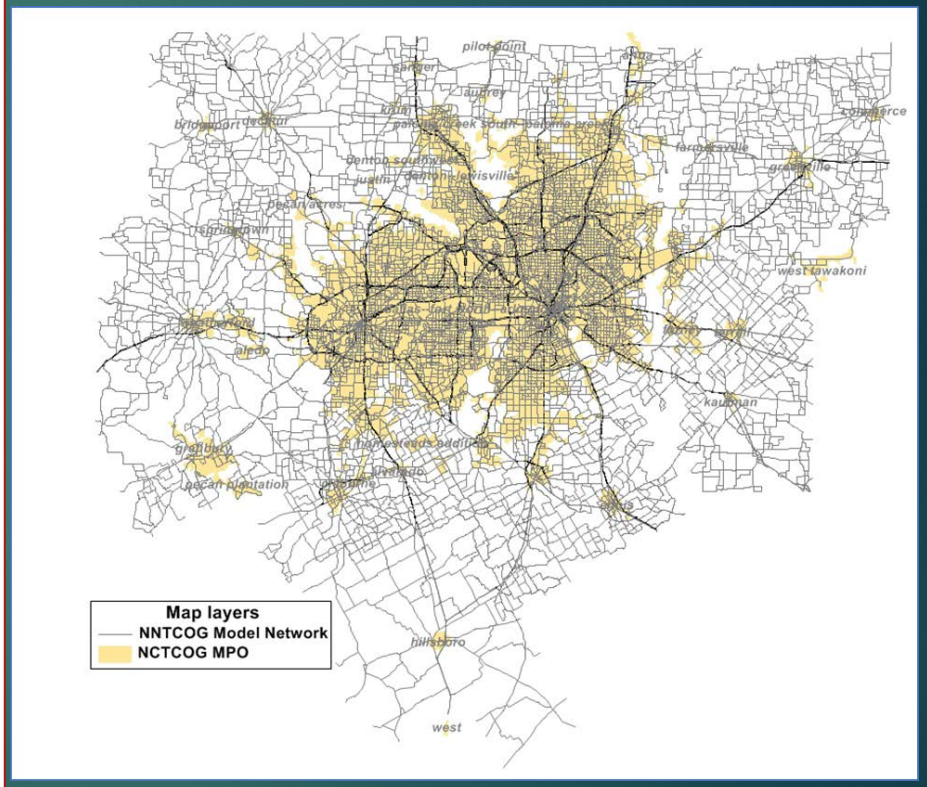
- Develop methodology to transfer ARNOLD LRS data reference schema onto existing or future RTA model links or segments in terms of ARNOLD LRS Route ID, Beginning Mile-marker and End Mile-marker
- Where possible, enhance the spatial accuracy of the RTA model network with the ARNOLD GIS database;
- Establish methodology/guidebook material and testing plan for large scale deployment.
- Use Pilot Projects to test the concept and scalability scalability

Pilot MPOs

Acadia MPO: 1,300 miles



NCTCOG MPO: 20,00 miles



Methodological Assumptions

- Arnold topology and LRS has same inventory data collection direction. Both topology and the data inventory have the same chainage direction, i.e., South to North or West to East.
- The methodology is limited to centerline-based network with the exclusion of detail interchange configuration. However, the method will work for a dual carriageway, if each directional route has a unique Route ID.
- Both source and target geospatial data has a comparable positional accuracy. If not, then there must exist at least one attribute that can be used to build linkage between source and target segment (SIGN or Street Name).

Methodological Assumptions (Continue)

- That there is a segment break where ARNOLD LRS Route_ID changes
- That both MPO model network (target data) and the ARNOLD (Source Data) has the similar coverage. If routes are trimmed at the network boundary, it's mile-marker has been recalibrated

Methodological Steps: Preprocessing Preference (Wishlist)

In order of preference, the expected minimum requirements of both source and target data should be as follows:

- The first preference is to have the LRS Route_ID already embedded onto MPO model network segment
- If the first preference is not available, then the 2nd preference is to have accurate topology where a given segment (s) from both databases overlapped 100%.
- The 3rd preference where both ARNOLD and MPO link at least have one attribute with a common denominator (i.e., SIGN or Street Name).

Methodological Steps: Preprocessing Preference (Wishlist)-- Continue

In order of preference, the expected minimum requirements of both source and target data should be as follows:

- The 4th preference is that MPO define their travel demand link with an ARNOLD link using a cross-reference attribute field. In other words, an attribute that cross-reference a given street (s) with corresponding ARNOLD segment (s).
- If none of these preferences are available, the proposed methodology will attempt to conflate the data using the geospatial references and report errors where georeferencing is not possible.

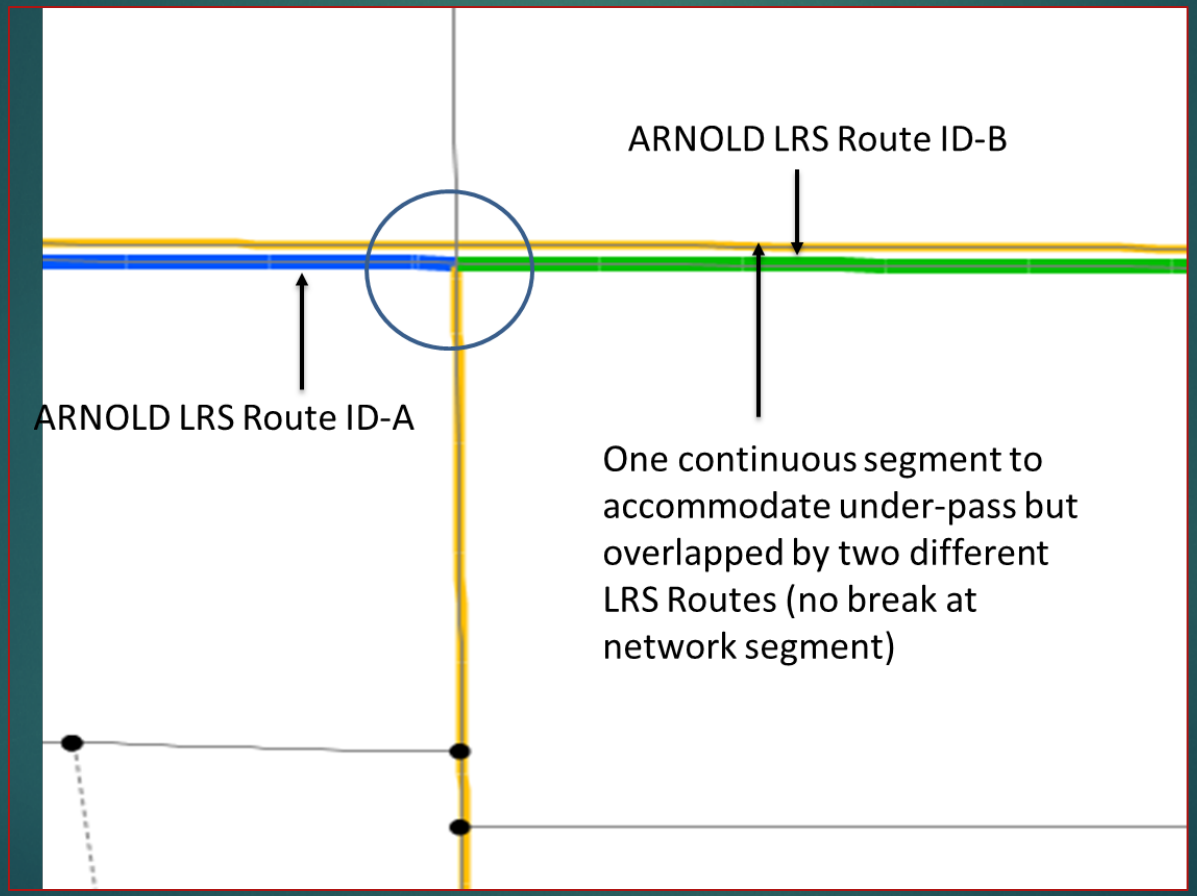
Methodological Steps: Preprocessing Topology (Requirements)

- The MPO segment (s) must end or start at the beginning or ending of a given ARNOLD LRS Route or Vise-Versa
- ARNOLD LRS Gap may exist but must not have the same begin and end mile-marker.
- All segments within a given LRS ID must be connected unless it is route gap with new starting mile-marker.
- The MPO Network must be 100% routable (at least for the entire routes)

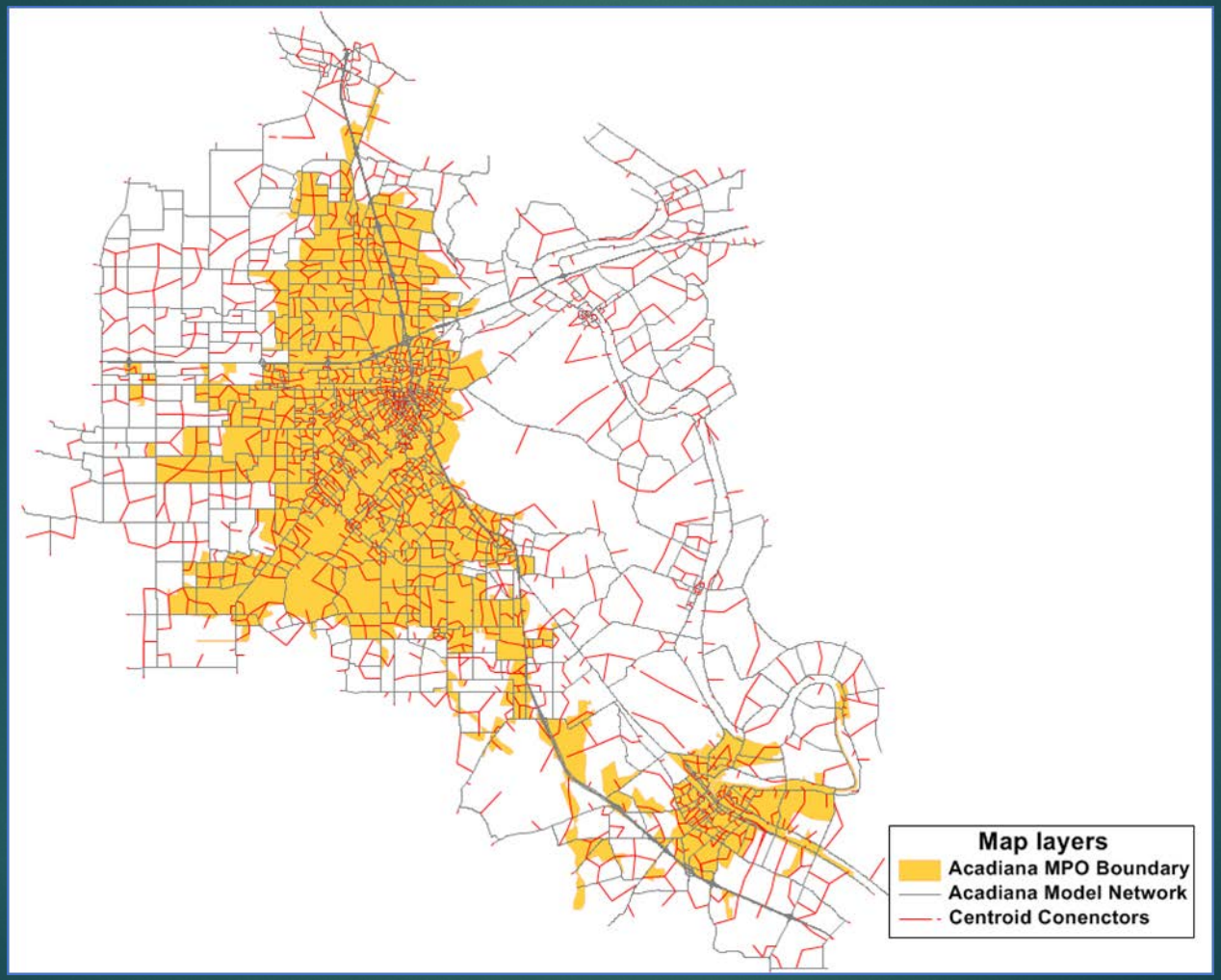
Methodological Steps: Preprocessing Topology (Requirements)--continue

- Exclude all non-highway segments (dummy links) from MPO Model Network
- Circuity within model network must not exists
- Least number of topological errors
- Roundabout must have more than one segment

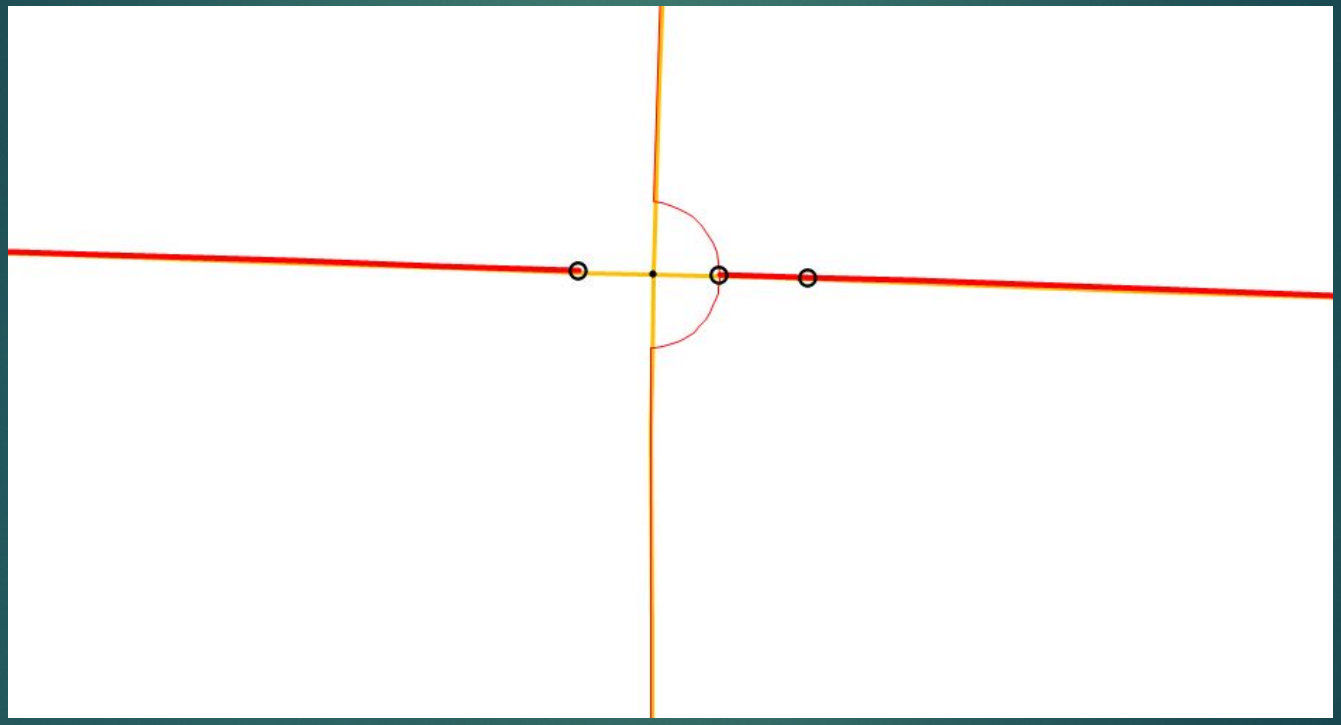
The MPO segment (s) must end or start at the beginning or ending of a given ARNOLD LRS Route or Vise-Versa



Exclude all non-highway segments (dummy links) from MPO Model Network



Typical Topological Error/Gap in ARNOLD



High Level Methodological Steps:

- Step 1: Using a geospatial software, choose an ARNOLD ROUTE_ID then select all ARNOLD links that have the identical ROUTE_ID value. Call this ARNOLD Link Selection Set

- Step 2: Select MPO Links by Vicinity of the ARNOLD Link Selection Set. The selection criteria only select MPO links that are within the predefine tolerance that ARNOLD selected route ID set in step 1.

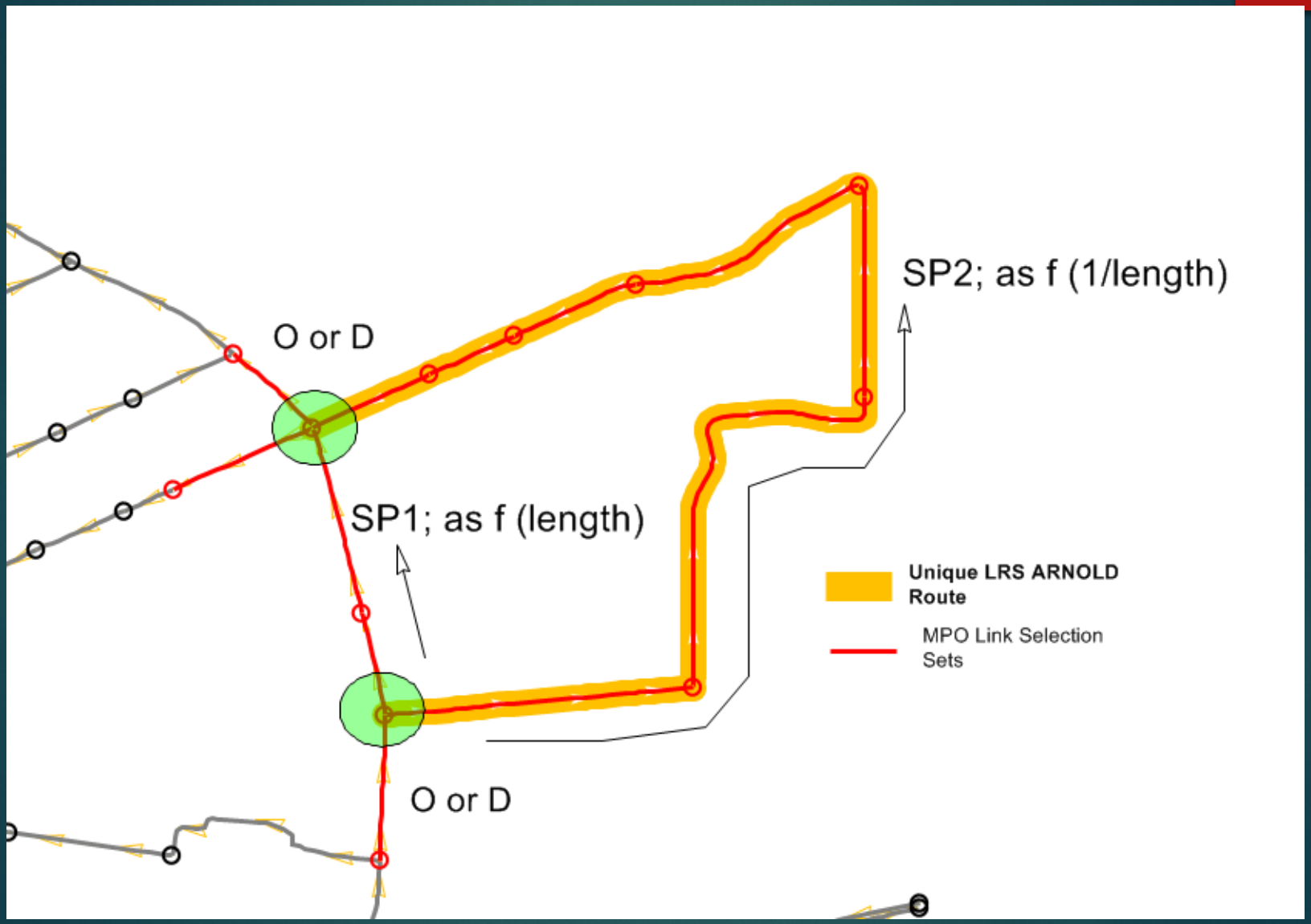
- Step 3: Find all ARNOLD nodes that have only one link attached to it and call it O-D nodes

- Step 4: Locate the nearest MPO nodes from both the ARNOLD selected O-D nodes in step 3 using a small buffer. These will become the MPO Origin and Destination Nodes that are associated with a series of network segments associated with a given ARNOLD unique Route

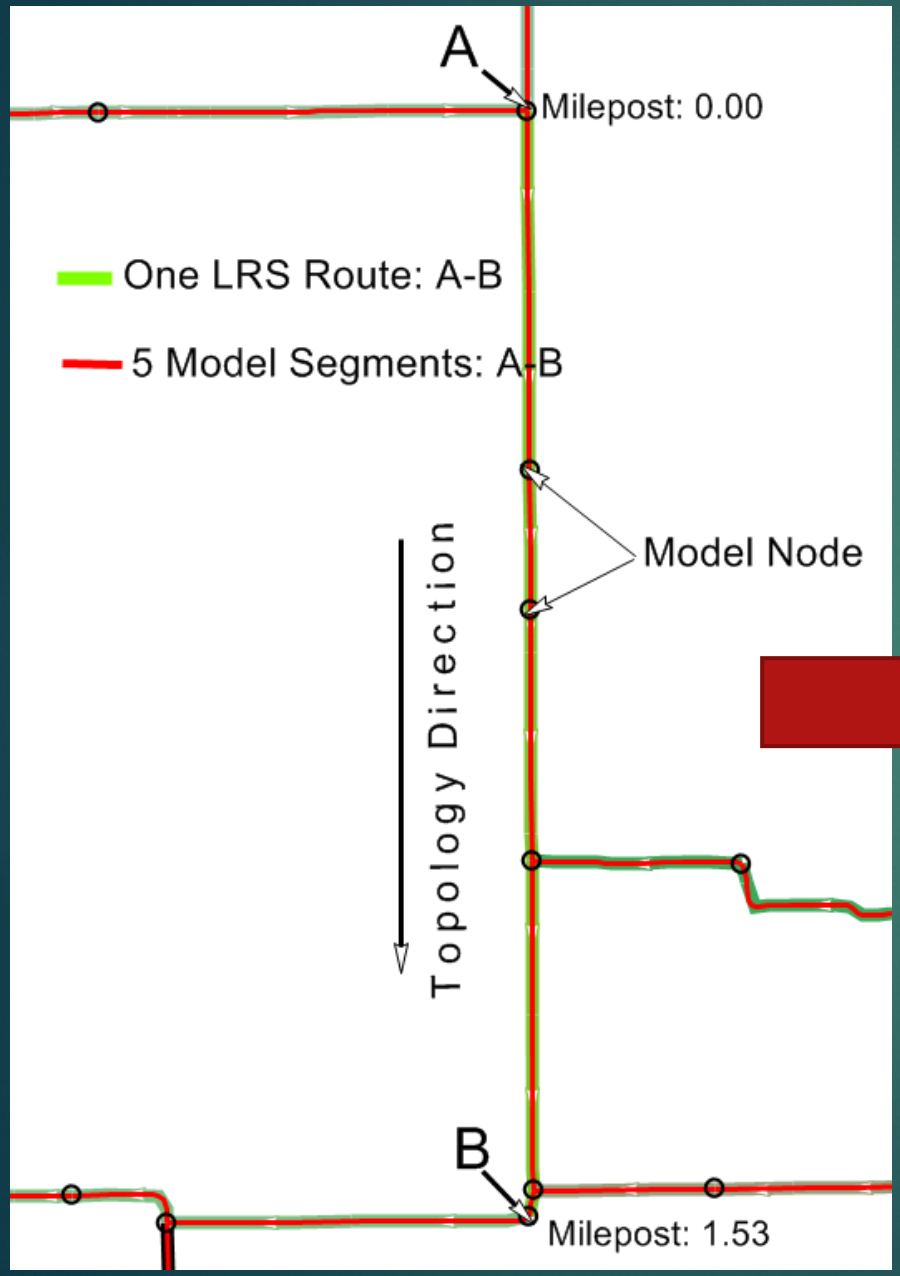
High Level Methodological Steps:

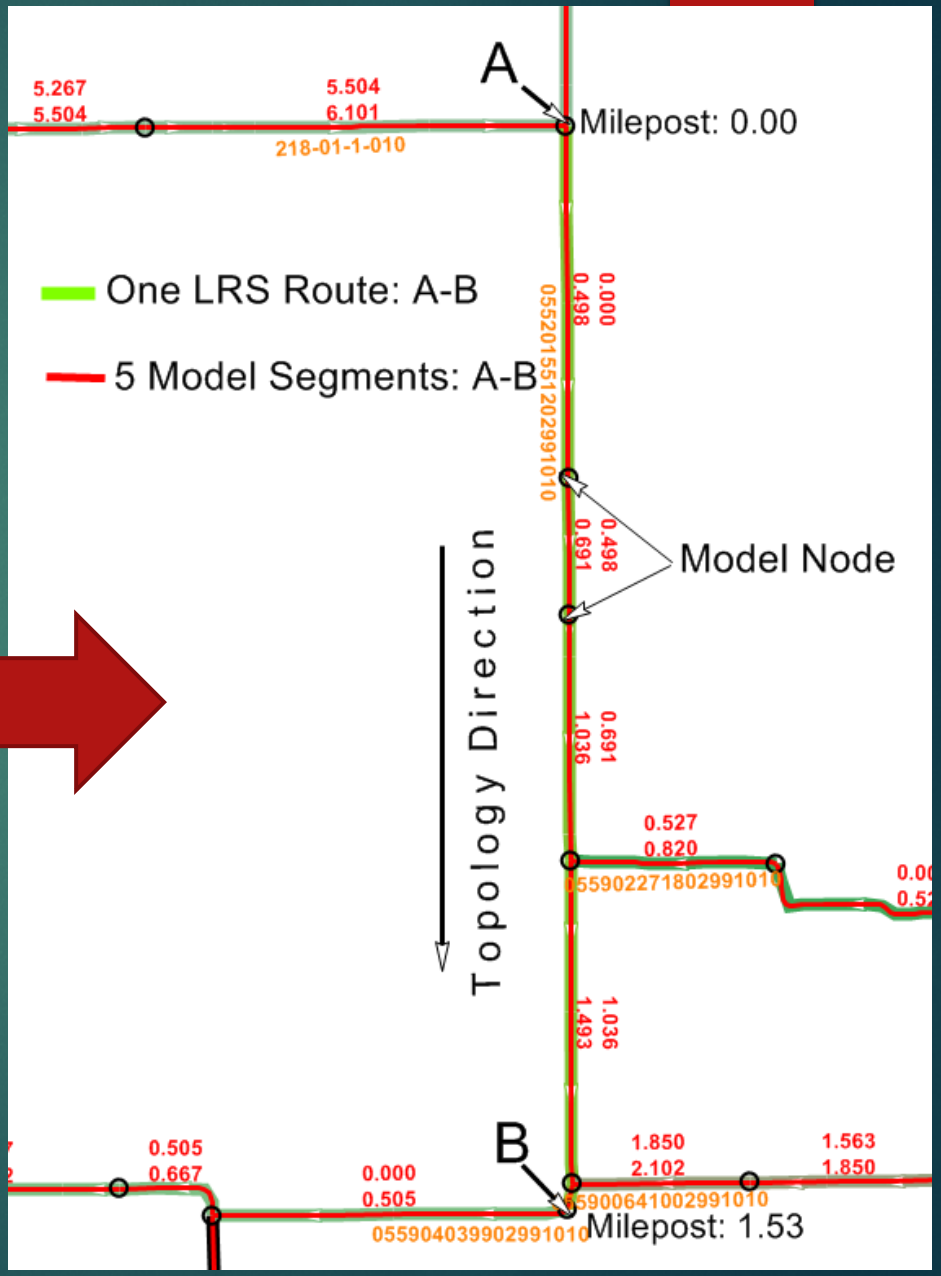
- Step 5: Run the shortest path between MPO Origin and Destination node using selected set of network in step 4.
- Step 6. Test the shortest paths (two sets—minimize length and minimize 1/length).
- Step 7: If a valid shortest path connection is made, sequence the MPO links from the Origin node to Destination node based on the beginning ARNOLD Begin_Point value or starting point or ARNOLD LRS topology direction.
- Step 8: Assign LRS_ID and corresponding mile-marker values at the MPO model segment level
- Step 9. Calibrate the mile marker assigned in step 8 proportionally so that total mileage equals the total LRS mileage for a given unique ARNOLD Route_ID.

High Level Methodological Steps: (Example Steps 1-6)

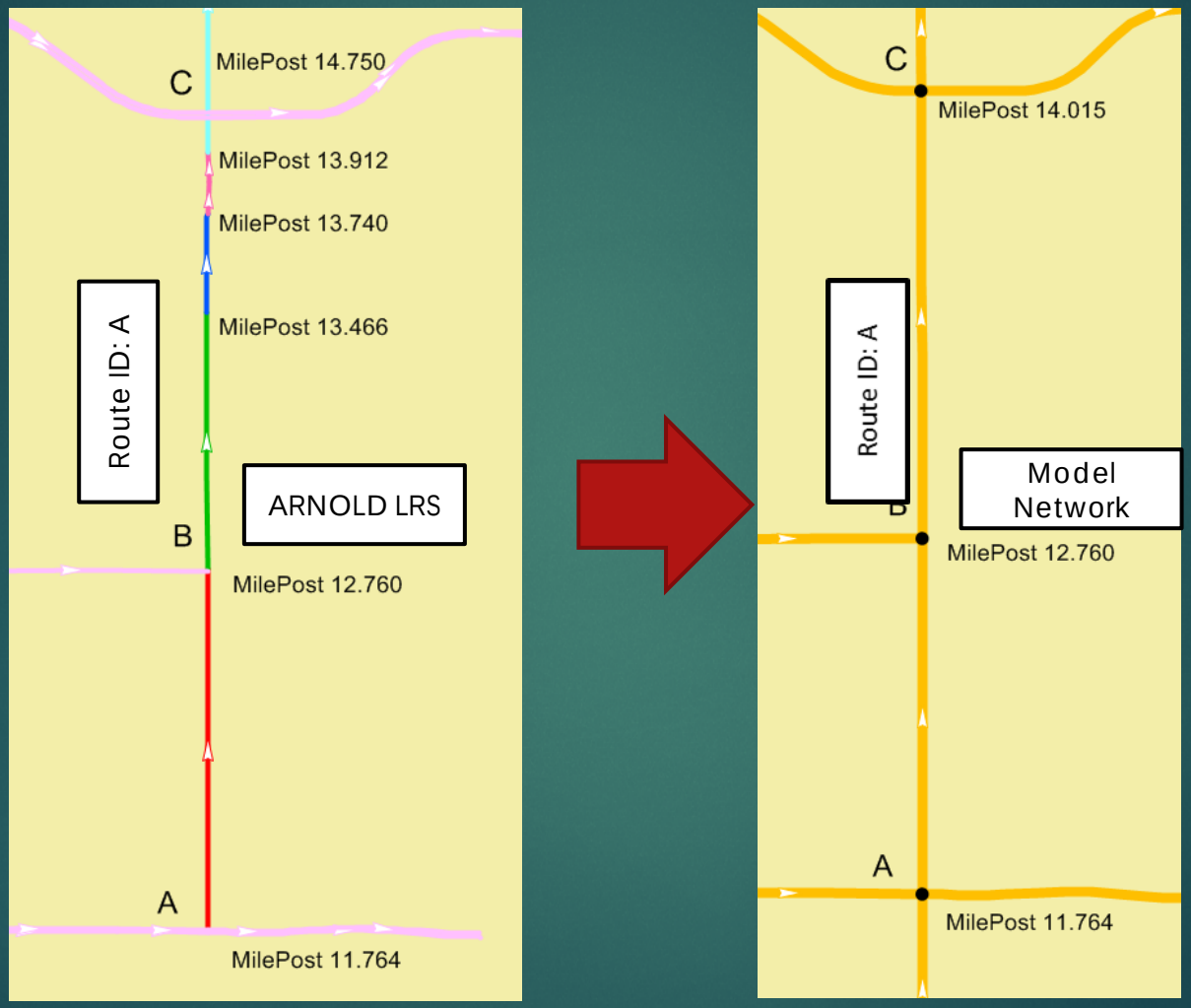


LRS Data Transformation to Model Network (ACADIA)

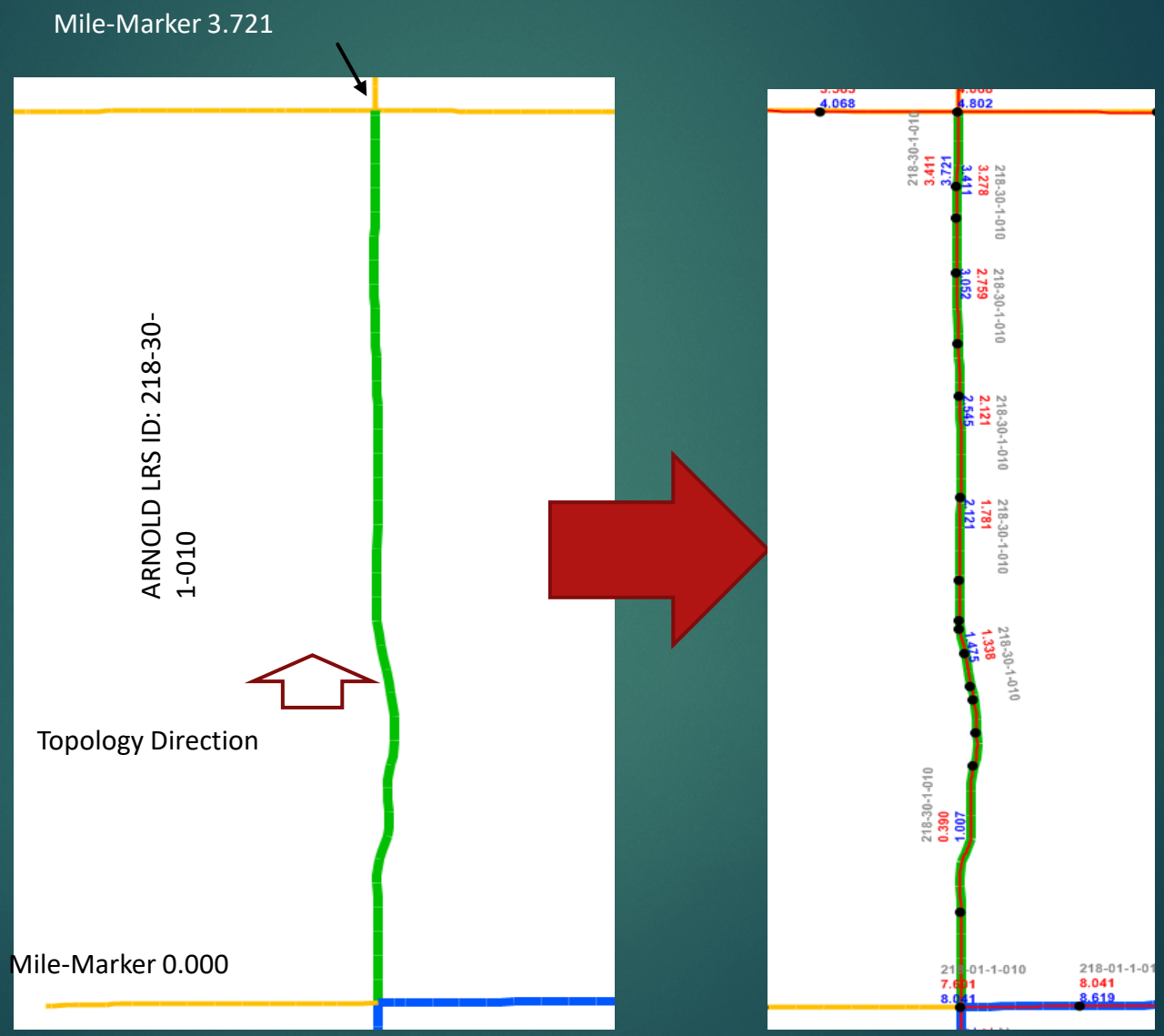




LRS Data Transformation to Model Network : Multipart LRS to Model Links.



LRS Data Transformation to Model Network: Single LRS to Multi-part Model Links



Methodological Outputs: What MPOs are Expecting

- Step by step processes
- A set of geospatial data preprocessing tools
- Pseudo-codes/logic (developed in TransCAD GISDK)
- Geospatial data (source/target) preprocessing Guidebook-based on the outcomes of NCTCOG and ACADIA MPO Pilot assignments.
- Pseudo-code/logic for HPMS/ANOLD to/from MPO network data transfer

Methodological Outputs: A set of geospatial data preprocessing tools

- Data validation and Simplify tool
- Arc Topology Calibration (directionality) tool
- GISDK Psedo-Codes: LRS-ID and Mile-Post Migration Tool
- Mile-marker Calibration tool
- Data Transfer SQL simplified techniques

Data Validation Simplify Line Tool

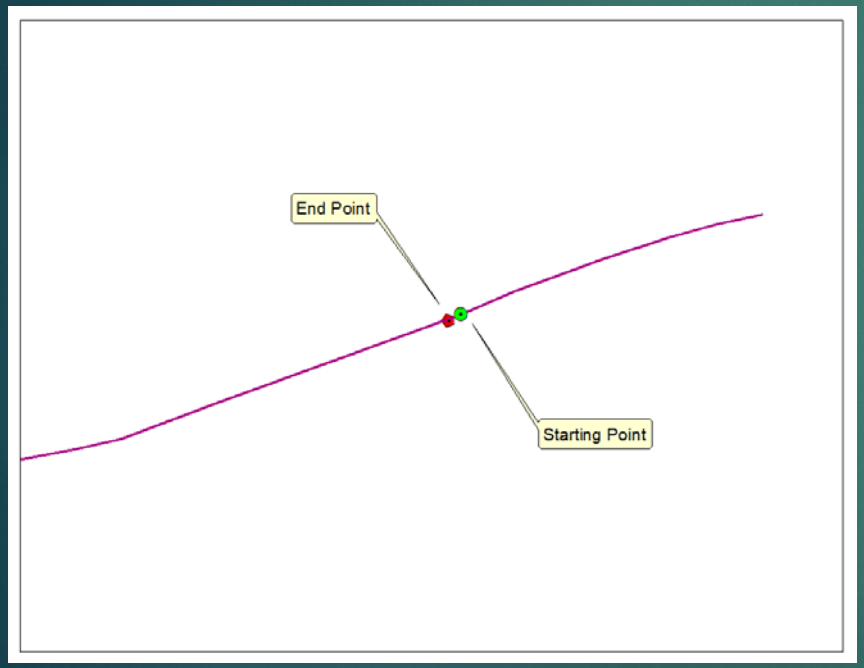
What it does?

- Removes zero length segments from polylines
- Merges polyline parts at endpoints that only connect to each other
- Reorients segments that are pointing against the prevailing orientation for a part.

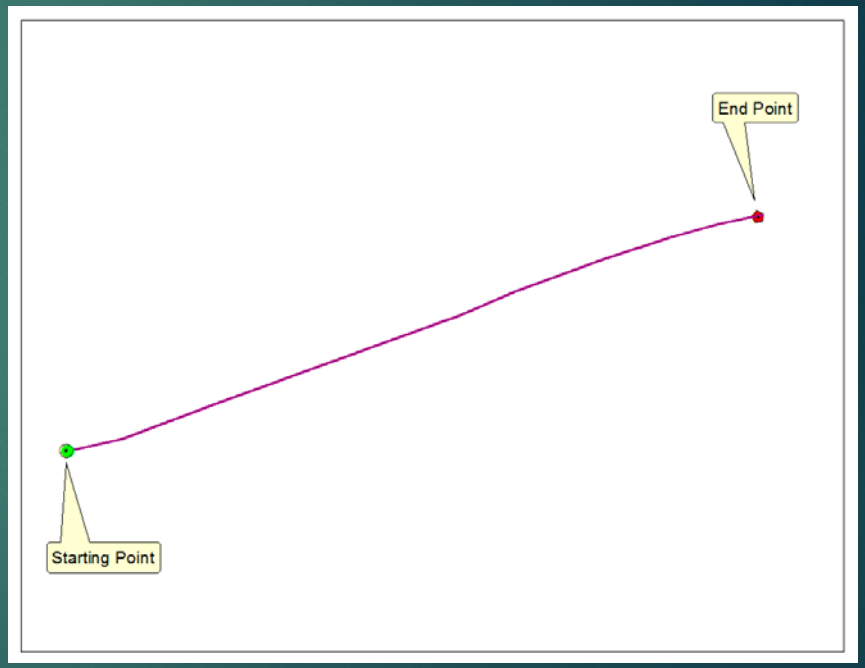
Why?

- To check and have a clean ARNOLD data

Data Validation Simplify Line Tool Examples



Before



After

Arc Topology Calibration Tool

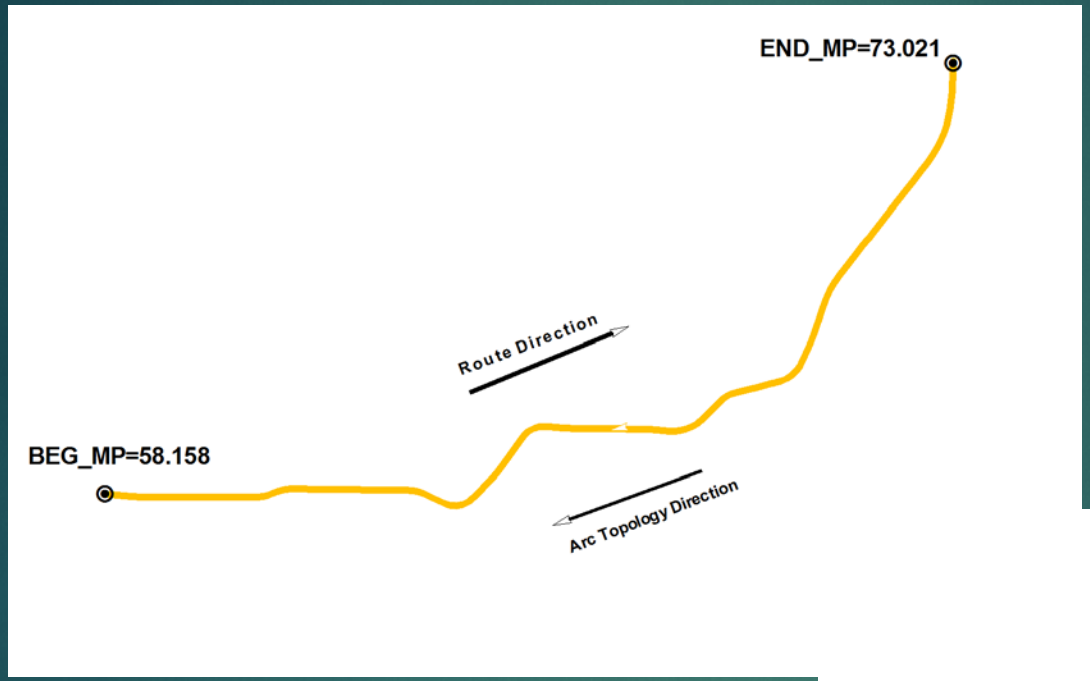
What it does?

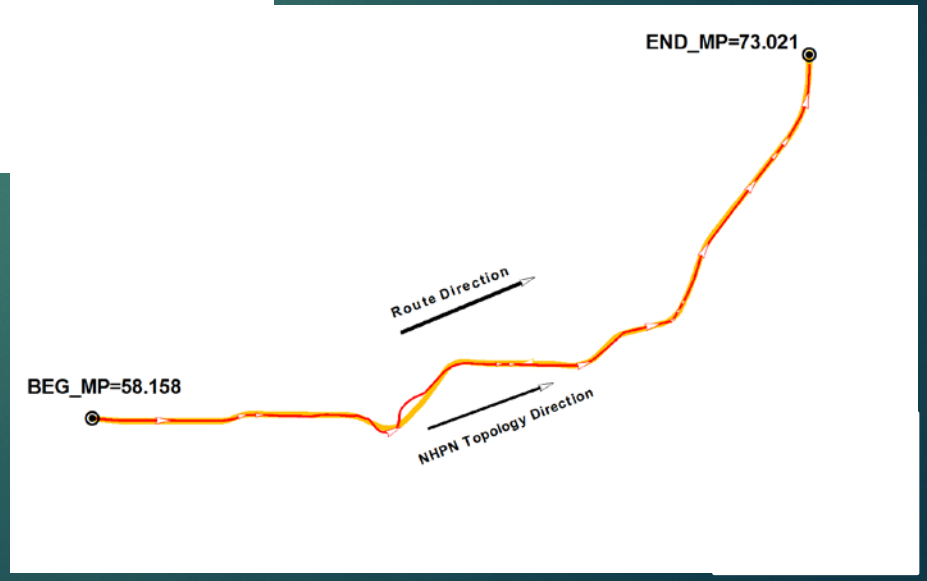
- Compare topology direction with arc increasing measures
- Assigns the topological directionality of the arc polyline along the increasing direction of arc measures

Why?

- To correct some topological errors due to the way polylines were created.
- To make polylines compatible with the LRS milepost calibration tool

Arc Topology Calibration Tool Example





GISDK Psedo-Codes: LRS-ID and Mile-Post Migration Tool

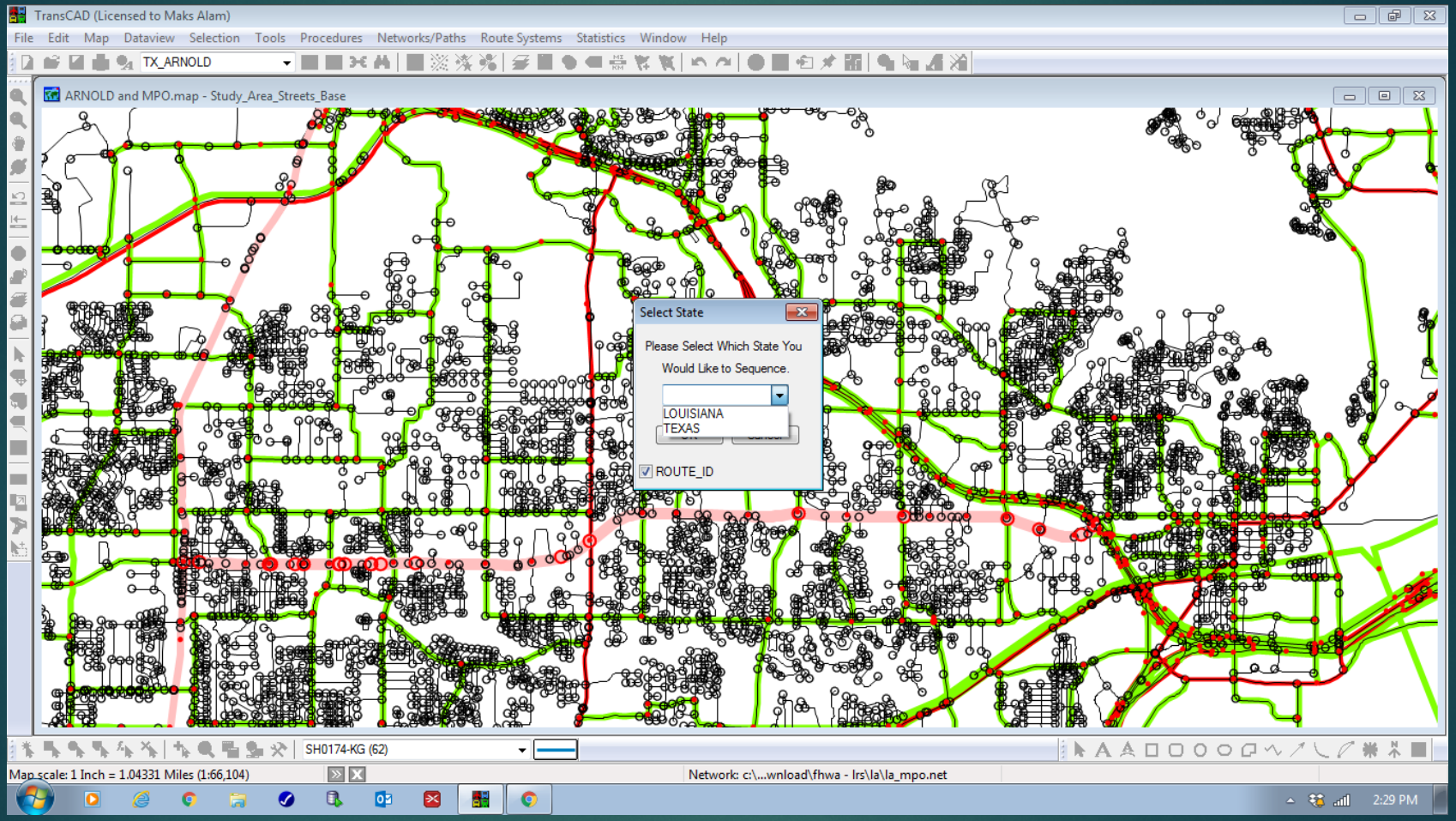
What it does?

- Identify and confirm the LRS Route equivalent set of MPO network segments
- Assigns the LRS-ID and Mile-Post values to each MPO Segment for the set

Why?

- To establish one to one relationship between ARNOLD database and its Equivalent MPO Model Network.

GISDK Psedo-Codes: LRS-ID and Mile-Post Migration Tool



LRS Milepost Calibration Tool

What it does?

- Calibrates LRS milepost values
- Assigns the topological directionality of the polylines to either south to north or west to east based on arc mile-marker

Why?

- To have identical LRS milepost onto calibrated MPO links

Pilot State Update

- Completed for ACADIA with 99% success
  - High accuracy was possible due to matched positional accuracy
- NCTCOG: Nearly Completed with 70% success
  - Varying positional accuracy
  - Missing segment break where ARNOLD LRS Route_ID changes
  - Presence of ramps and dualize segments

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