



Assuring Connectivity in an Electric Utility GIS Distribution Model

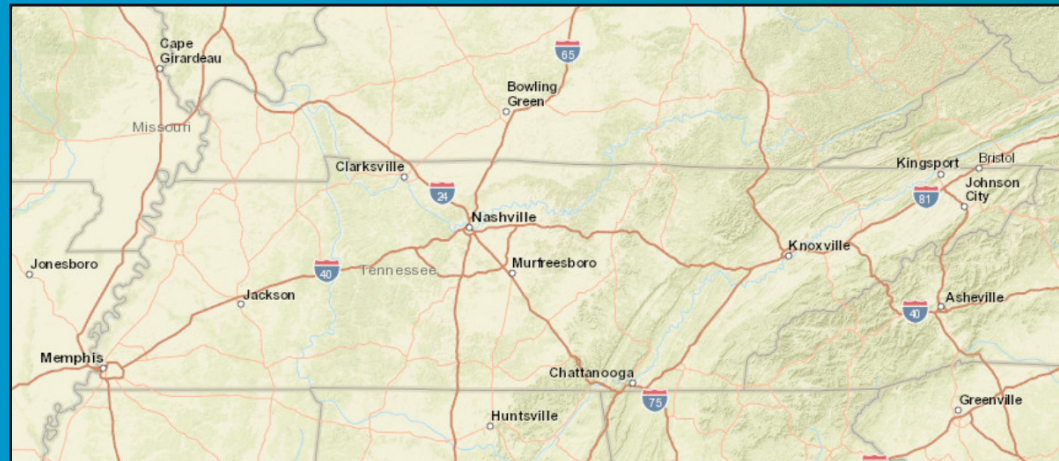
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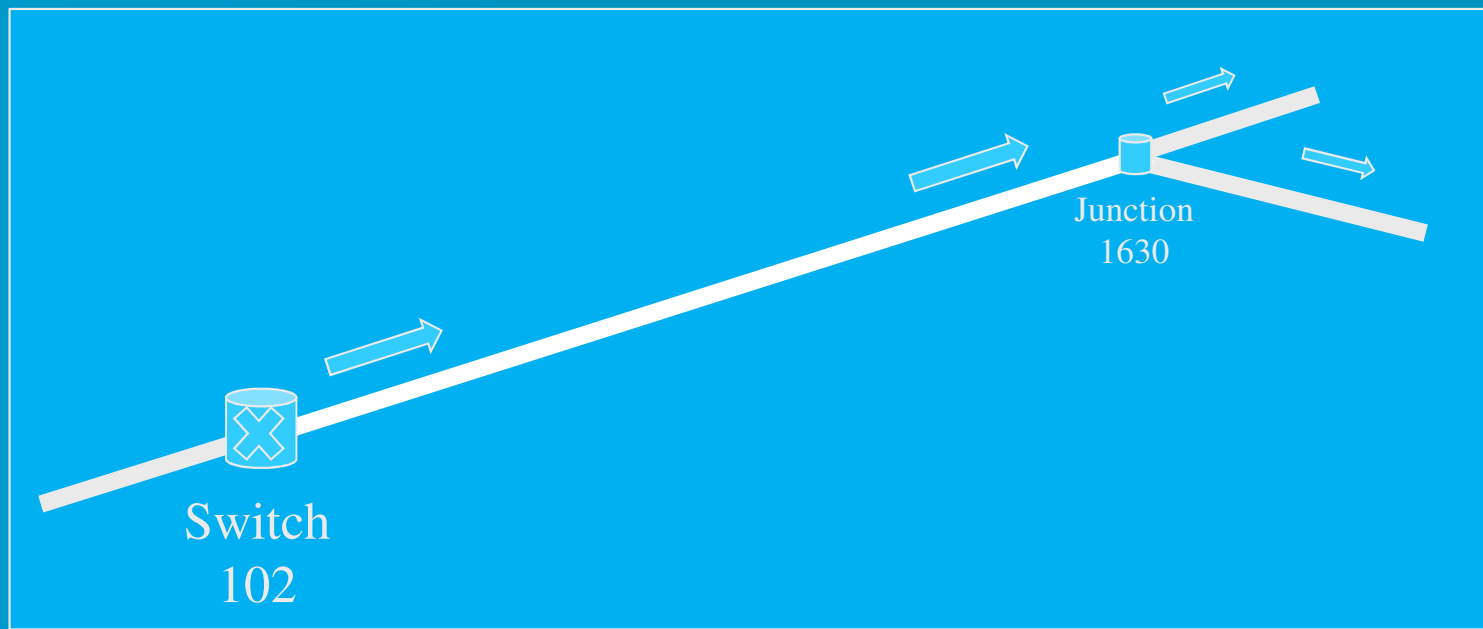
Murfreesboro Electric Department

- Primary responsibilities include server configuration, maintenance of the GIS model, and posting of work orders



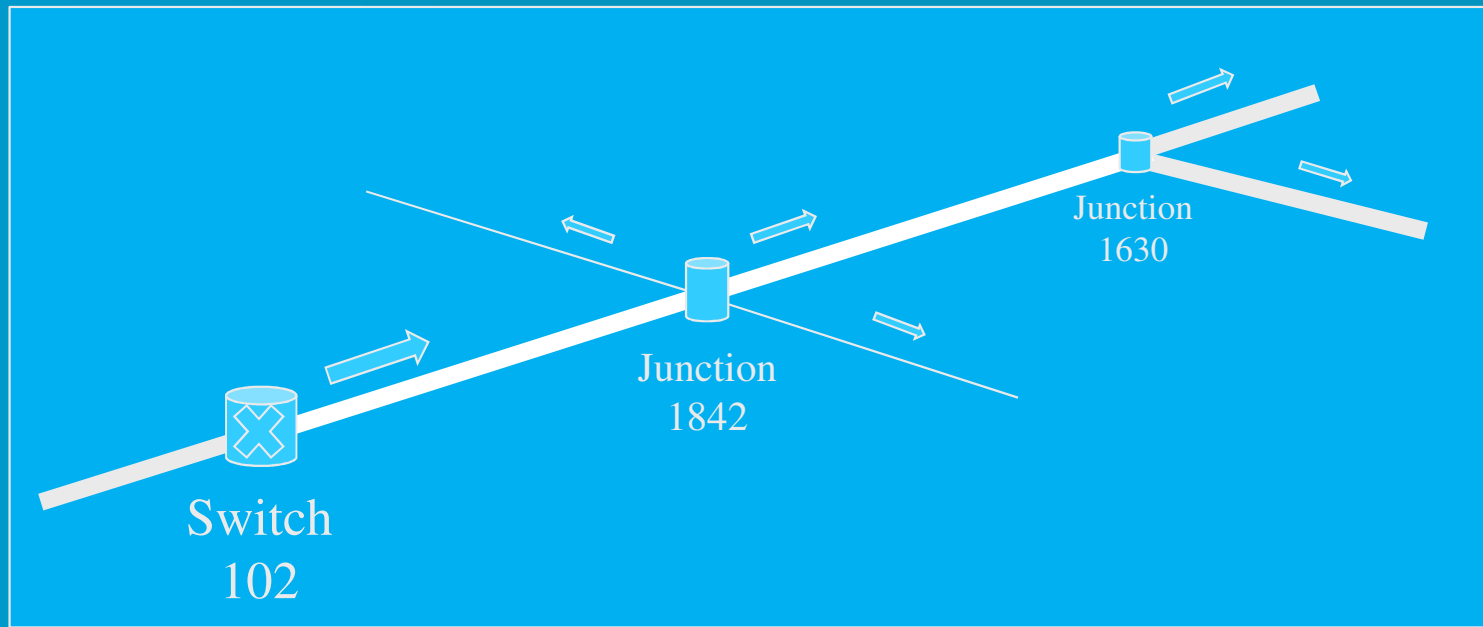
Spans and Edges

- Example of Simple Edge



Spans and Edges

- Example of Complex Edge



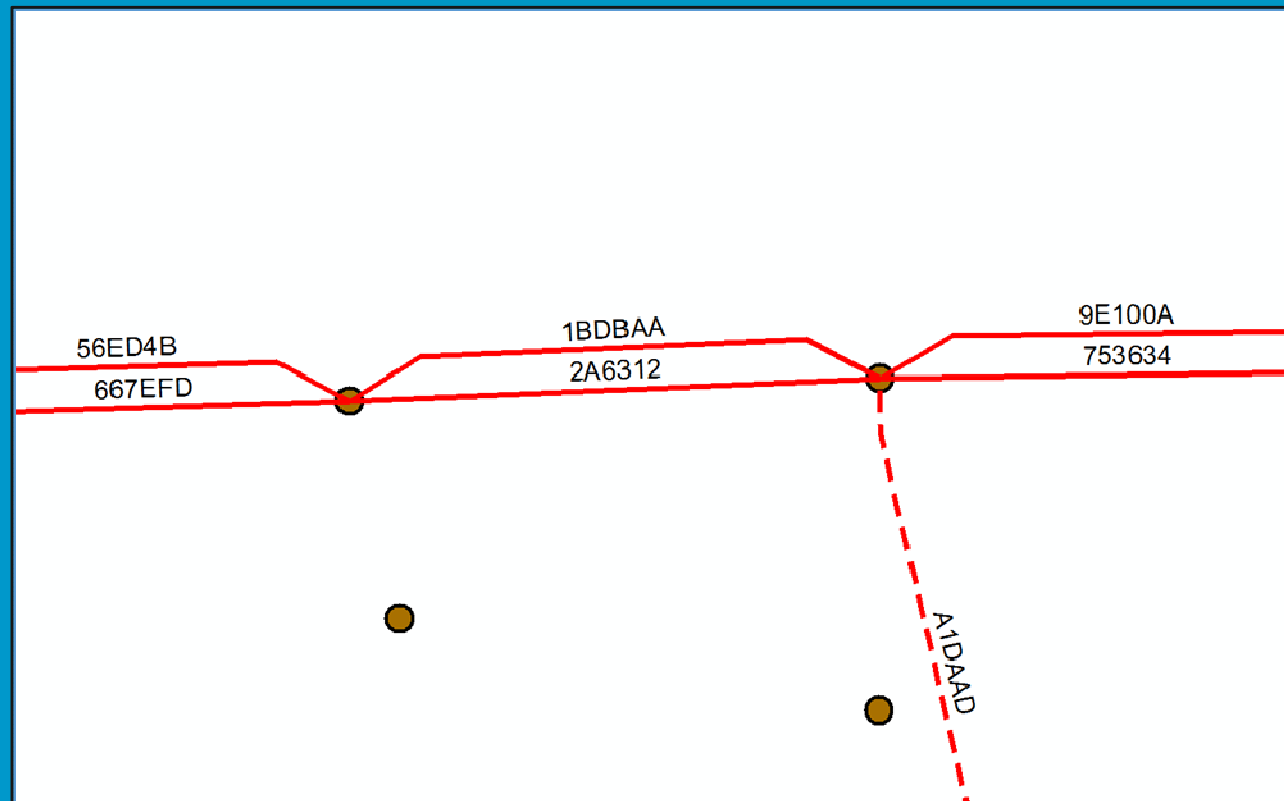
Background

- Traditional GIS used an attribute-based numbering system for electrical lines
- Newer systems have moved toward a GUID-based approach
- Database tables are designed to be normalized and to help prevent unwanted data changes

Conversion

- Legacy GIS used non-intersecting spans
- ESRI-based system requires spans to be snapped together
- Connectivity is our focus
- Other systems rely on GIS data, so accuracy is key

Connectivity



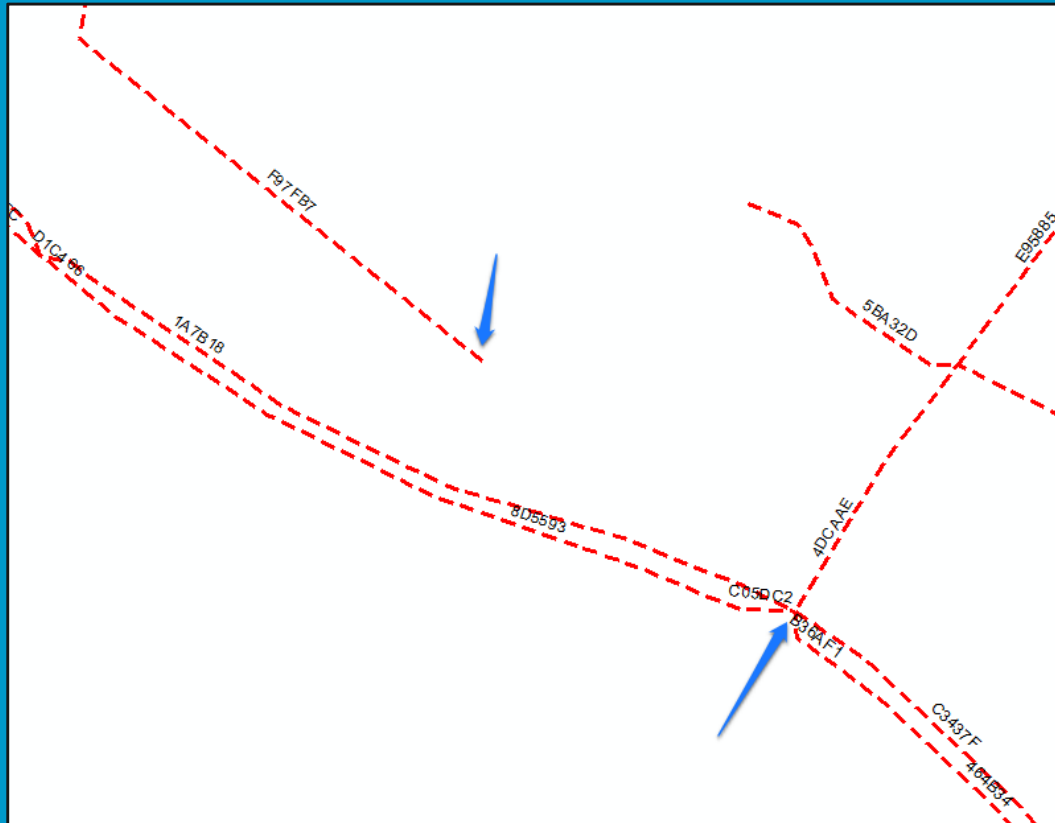
Connectivity

- Relationships, endpoints, and insertion points are important
- Feature dataset table with a related stand-alone table which governs connectivity
- Two sources must be in agreement for connectivity to work properly

Dilemma

- Many instances of disagreement between two data sources
- Occurred during the Transformation phase of the ETL (Conversion) process
- Difficult to detect until each instance is found through editing
- Span endpoints may be inches or feet apart

Application Operation - Example



Application Operation - Example

- all_relationships table indicates no issues with the connectivity

The image shows two screenshots of a database application. The top screenshot displays the 'all_relation' table with three columns: 'Abbrev_span_id', 'Abbrev_upstream_relationship_id', and 'Abbrev_relationship_id'. The data rows are:

| Abbrev_span_id | Abbrev_upstream_relationship_id | Abbrev_relationship_id |
|----------------|---------------------------------|------------------------|
| F97FB7 | 6365C4 | F46AB7 |
| C05DC2 | 802960 | 6365C4 |
| * | | |

The bottom screenshot displays the 'relationships' table with four columns: 'Start_X_Coordinate', 'Start_Y_Coordinate', 'End_X_Coordinate', and 'End_Y_Coordinate'. The data rows are:

| Start_X_Coordinate | Start_Y_Coordinate | End_X_Coordinate | End_Y_Coordinate |
|--------------------|--------------------|------------------|------------------|
| 1820287.91995342 | 556884.480061933 | 1820005.02998437 | 557063.130041575 |
| 1820372.51429072 | 556741.041913141 | 1820412.91995342 | 556736.480061933 |

Application Operation - Example

- all_relationships table indicates no issues with the connectivity

The image shows two screenshots from a data application. The top screenshot displays a table titled 'all_relation' with three columns: 'Abbrev span id', 'Abbrev_upstream_relationship_id', and 'Abbrev_relationship_id'. The first row has values 'F97FB7', '6365C4', and 'F46AB7'. The second row has values 'C05DC2', '802960', and '6365C4'. A red box highlights the 'F97FB7' value. Below the table is a control bar with 'Record: 3 of 3', 'No Filter', and a 'Search' field. The bottom screenshot shows a table titled 'relationships' with four columns: 'Start_X_Coordinate', 'Start_Y_Coordinate', 'End_X_Coordinate', and 'End_Y_Coordinate'. The first row contains the values 1820287.91995342, 556884.480061933, 1820005.02998437, and 557063.130041575. The second row contains 1820372.51429072, 556741.041913141, 1820412.91995342, and 556736.480061933.

| Abbrev span id | Abbrev_upstream_relationship_id | Abbrev_relationship_id |
|----------------|---------------------------------|------------------------|
| F97FB7 | 6365C4 | F46AB7 |
| C05DC2 | 802960 | 6365C4 |
| * | | |

Record: 3 of 3 No Filter Search

| Start_X_Coordinate | Start_Y_Coordinate | End_X_Coordinate | End_Y_Coordinate |
|--------------------|--------------------|------------------|------------------|
| 1820287.91995342 | 556884.480061933 | 1820005.02998437 | 557063.130041575 |
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Application Operation - Example

- all_relationships table indicates no issues with the connectivity

The image shows two screenshots from a software application. The top screenshot displays a table titled "all_relation" with the following data:

| Abbrev_span_id | Abbrev upstream relationship id | Abbrev_relationship_id |
|----------------|---------------------------------|------------------------|
| F97FB7 | 6365C4 | F46AB7 |
| C05DC2 | 802960 | 6365C4 |
| * | | |

The value "6365C4" in the second column of the first row is highlighted with a blue box. Below the table is a control bar showing "Record: 3 of 3", "No Filter", and a "Search" button.

The bottom screenshot displays a table titled "relationships" with the following data:

| Start_X_Coordinate | Start_Y_Coordinate | End_X_Coordinate | End_Y_Coordinate |
|--------------------|--------------------|------------------|------------------|
| 1820287.91995342 | 556884.480061933 | 1820005.02998437 | 557063.130041575 |
| 1820372.51429072 | 556741.041913141 | 1820412.91995342 | 556736.480061933 |

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| * | | |

The bottom screenshot displays a table titled 'relationships' with four columns: 'Start_X_Coordinate', 'Start_Y_Coordinate', 'End_X_Coordinate', and 'End_Y_Coordinate'. The data rows are:

| Start_X_Coordinate | Start_Y_Coordinate | End_X_Coordinate | End_Y_Coordinate |
|--------------------|--------------------|------------------|------------------|
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| 1820372.51429072 | 556741.041913141 | 1820412.91995342 | 556736.480061933 |

Application Operation - Example

- all_relationships table indicates no issues with the connectivity

The image shows two screenshots from a database application. The top screenshot displays the 'all_relation' table with three columns: 'Abbrev_span_id', 'Abbrev_upstream_relationship_id', and 'Abbrev_relationship_id'. The second row contains the values 'C05DC2', '802960', and '6365C4', which are highlighted with a red and a blue box respectively. The bottom screenshot displays the 'relationships' table with four columns: 'Start_X_Coordinate', 'Start_Y_Coordinate', 'End_X_Coordinate', and 'End_Y_Coordinate'. It contains two rows of coordinate data.

| Abbrev_span_id | Abbrev_upstream_relationship_id | Abbrev_relationship_id |
|----------------|---------------------------------|------------------------|
| F97FB7 | 6365C4 | F46AB7 |
| C05DC2 | 802960 | 6365C4 |

| Start_X_Coordinate | Start_Y_Coordinate | End_X_Coordinate | End_Y_Coordinate |
|--------------------|--------------------|------------------|------------------|
| 1820287.91995342 | 556884.480061933 | 1820005.02998437 | 557063.130041575 |
| 1820372.51429072 | 556741.041913141 | 1820412.91995342 | 556736.480061933 |

Application Operation - Example

- End point of the upstream line does not match the start point of the downstream line

The image shows two screenshots from a data application. The top screenshot, titled 'all_relation', displays a table with three columns: 'Abbrev_span_id', 'Abbrev_upstream_relationship_id', and 'Abbrev_relationship_id'. The data rows are:

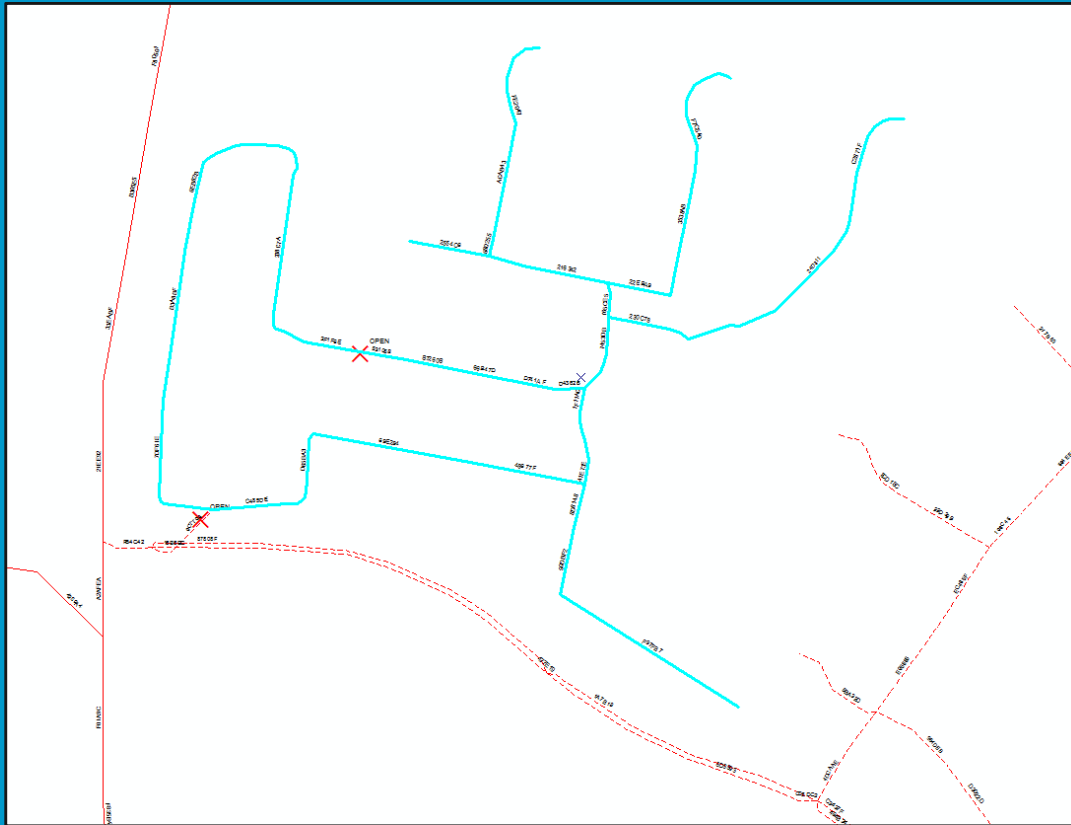
| Abbrev_span_id | Abbrev_upstream_relationship_id | Abbrev_relationship_id |
|----------------|---------------------------------|------------------------|
| F97FB7 | 6365C4 | F46AB7 |
| C05DC2 | 802960 | 6365C4 |

The bottom screenshot, titled 'relationships', displays a table with four columns: 'Start_X Coordinate', 'Start_Y Coordinate', 'End_X Coordinate', and 'End_Y Coordinate'. The data rows are:

| Start_X Coordinate | Start_Y Coordinate | End_X Coordinate | End_Y Coordinate |
|--------------------|--------------------|------------------|------------------|
| 1820287.91995342 | 556884.480061933 | 1820005.02998437 | 557063.130041575 |
| 1820372.51429072 | 556741.041913141 | 1820412.91995342 | 556736.480061933 |

Red boxes highlight the 'Start_X Coordinate' value '1820287.91995342' in the first row and the 'End_X Coordinate' value '1820412.91995342' in the second row. Green boxes highlight the 'Start_Y Coordinate' value '556884.480061933' in the first row and the 'End_Y Coordinate' value '556736.480061933' in the second row.

Application Operation - Example



Custom Application

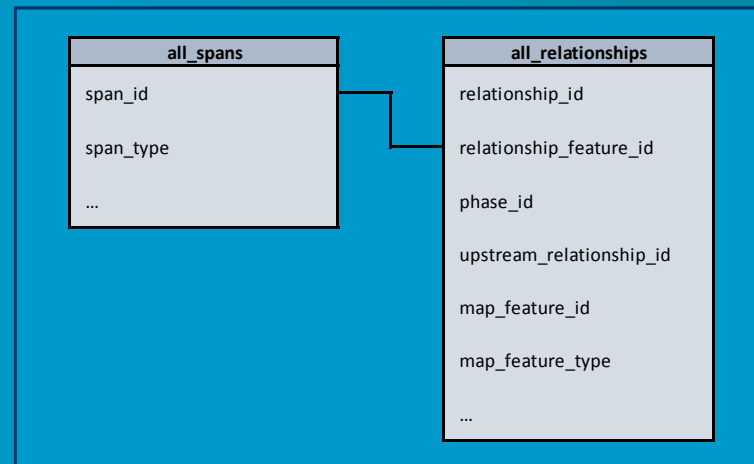
- Custom solution is needed to identify issues
- Secondary network issues may potentially be identified as application is developed
- Exported data will be operated upon and return a separate feature dataset for Overlay Analysis in GIS

Custom Application

- Use of vendor-supplied tools to correct broken connectivity
- New dataset to have attribute for tracking when corrections have taken place

Custom Application

- Entity Relationship Diagram (ERD)
- Relates the all_spans feature dataset to the all_relationships connectivity table



Application Operation

- Begins at the substation (source)
- Junctions with multiple downstream spans must be remembered
- At the end of each branch, program begins on next unprocessed branch
- Program continues until each branch has been checked, then starts on next circuit

Application Goals

- Detect issues with connectivity
- Mark those errors for manual correction
- Facilitate correction and minimal tracking for editor convenience
- Increase confidence in the OMS
- Increase confidence in the Engineering Model to accurately predict growth

Application – Return on Investment

- Errors of this type cannot be automatically detected without the application
- Estimates
 - Manual correction (after research) can take between 5 and 10 minutes
 - Number of system-wide errors may range from 500 to 1,000

Application – Return on Investment

- Research per Primary spans
 - $((0.5 \text{ min} * 22,500 \text{ spans}) / 60 \text{ min per hour}) = 187.5 \text{ work hours}$
- Error Repair for Primary spans
 - $((10 \text{ min} * 1,000 \text{ errors}) / 60 \text{ min per hour}) = 166.67 \text{ work hours}$
- Total of 354.17 work hours or approximately 8.8 work weeks (10 – 12 weeks more realistic?)

Application – What's down the road?

- Conversion from Microsoft Access' Visual Basic for Applications (VBA) to C# (.NET)
- Possible move from storage of data in MS Access to MS SQL Server
- Improved tracking in program development
- Increased execution speed
- Ability to interact with the map document



Questions?

Sources

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