Using An Automated Rules Engine to Support Spatial Data Infrastructure Management and LRS Validation/Conflation

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over 45 years
innovation + development
in Geospatial solutions

Industry Sectors
- Transportation
- Spatial Data Infrastructure
- Telecommunications
- Utilities
- Mapping Authorities
- Government

Global offices
- Cambridge
- Washington
- London
- Sydney
- Dublin
- Paris
- Liege

US Customers

Global Customers

Technology Partners
- Microsoft
- Latitude Geographics
- Oracal
- Autodesk
- Esri
- Safe Software
- Trimble
- ADOT
- Ohio Department of Transportation
- NEBRASKA
- FHWA
- MICHIGAN DEPARTMENT OF TRANSPORTATION
- USGS
Data Validation
Automate manual, time-consuming, subjective QA tasks. Certification required for proof of data quality (SLA’s, legislation)

Data Integration
Maximize ROI through re-use, integration of data across the enterprise

Data Enhancement
Automate cleaning tasks, create new data, construct repeatable, non-subjective corrective actions.
Michigan Spatial Data Infrastructure

Why else build a SDI?

• Billions $$$ Spent on...
  • Redundant Systems, Processes and Workflows
    • Little Coordination between organizations, offices & programs
  • Occurs at all Levels of Government (Local, State, National)
    • City → County → State → Country
• New Requirements require collaboration
  • NG911, ARNOLD/HPMS
• Integration Challenges

GIS DATA LAYERS
Many different types of data can be integrated into a GIS and represented as a map layer.
Examples can include: streets, parcels, zoning, flood zones, client locations, competition, shopping centers, office parks, demographics, etc.

When these layers are drawn on top of one another, undetected spatial trends and relationships often emerge. This allows us to gain insight about relevant characteristics of a location.
SDI – Tremendous benefit….. but not without its challenges

GIS DATA LAYERS

Many different types of data can be integrated into a GIS and represented as a map layer. Examples can include: streets, parcels, zoning, flood zones, client locations, competition, shopping centers, office parks, demographics, etc.

When these layers are drawn on top of one another, undetected spatial trends and relationships often emerge. This allows us to gain insight about relevant characteristics of a location.
Michigan SDI

• Integration of Multiple Data Layers from many sources
  • Roads, Addresses, Boundaries
  • Various State & Local Providers

• Validation

• Change Detection

• Integration

• Conflation

• LRS Validation/Integration
Michigan Process

User Input → Validation → Change Detection → LRS Validation
Validate LRS Systems

• Linear Reference Systems (LRS)
  • Tables - No Geometries
  • Begin LRS and End LRS – Mile\KM Marker where asset starts and ends

• Geospatial Information Systems (GIS)
  • Geometries encoded with M-Measure values
  • Measures are actual distances

• Validating LRS and GIS
  • Does asset exist within GIS?
  • Are there missing assets in LRS?
Integrate LRS Core Functions

- `get_measure_maximum` - returns the maximum measure value for geometry
- `get_measure_minimum` - returns the minimum measure value for geometry
- `is_measured_line_monotonic_increasing` - returns boolean based on how the measures change from beginning to end
Integrate LRS Core Functions

- `line_segment_from_measures` - returns the line between two measures (subset of an input line)
- `measure_from_point` - returns the measure at a point along line (could be interpolated)
- `measured_point` - create a point with x,y,m
- `point_from_measure` - returns the point along a line for a given measure (could be interpolated)
- `set_measure` - set the measure on a vertex
LBRS/LRS Conflation – The Ohio State

- **Goals**
  - Align LRS to LBRS Centerline
    - Update Linear Geometries
    - Update Mile Posts
  - Update Events to use new mile posts
    - Interpolate between mile posts

- **Challenges**
  - Varying Spatial Accuracy
  - LRS missing Mile Posts at some intersections
  - LBRS Mileage isn’t always known (-999)
  - LRS doesn’t always align with LBRS
    - Same road digitized in opposite direction
Ohio DOT LBRS/LRS Conflation – Challenges Approach

Challenge - Varying spatial accuracy across LRS

Perform Node Matching

- Identify Calibration points in LRS and LBRS that have same
  - NFD_ID
  - Measure
Ohio DOT LBRS/LRS Conflation – Challenges Approach

Challenge - LRS doesn’t contain Mile Posts at all intersections

Create missing Calibration Points

- Create a Calibration Point (in LRS) for each intersection along a route (where no Calibration points existed before)
- Interpolate the Measure by comparing the proportion along the route against the route begin and end measures
Challenge - LBRS Mileage isn’t always known (-999)

• Create LBRS routes (a single feature for the NFDOLDID)

• Identify the original begin and end Calibration points for LRS with same NFD_ID

• Copy the original MEASURE values to LBRS (end points)

• Interpolate interior MEASUREs for each intersection by taking the proportion along the LBRS Route and the calibrated length
Ohio DOT LBRS/LRS Conflation – Challenges Approach

Challenge - LRS doesn’t always align with LBRS

- Identify LRS digitized in the opposite direction as LBRS
- Switch the start and end MEASUREs
- Reverse the direction of the line geometry
- Update the MEASURE value on all the interior Calibration Points
- Update the associated Events
Questions?

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