How Freight Moves: Estimating Mileage and Routes Using an Innovative GIS Tool

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Background: What is the CFS?

- Freight survey of U.S. businesses (shippers)
- Performed by RITA/BTS in partnership with the Census Bureau
- Previous surveys in 1993, 1997, and 2002 as part of the U.S. Economic Census
- Provides data on actual shipments by mode of transportation
CFS Mileage Calculation: Why and How?

Why?
- Shippers generally do not know travel distance of shipments
- Modal-mileages are critical for calculating ton-miles

How?
- Survey asks for origin and destination ZIP codes
- Survey asks for mode sequence (e.g. road-rail-road)
- Using this info, mileages are calculated for each shipment by mode (highway, rail, water, air, parcel and pipeline)
Mileage Calculations in the 1993, 1997, and 2002 Surveys

- BTS contracted with the Oak Ridge National Laboratory (ORNL) to develop the mileage calculation procedures.
- ORNL created a multi-modal surface transportation network (air separate).
- ORNL created routing applications using a variety of software (primarily FORTRAN and FOXPRO).
- Performed by ORNL staff in 1993 and 1997 and by BTS staff in 2002.
The Mileage Calculation Problem

- Large proportion of shipments are multi-modal
- Few national level, multi-modal GIS networks available
- Few (if any) commercial routing routines with mode-change logic
The Solution: A Geospatial Approach

What we did:

• Develop a multi-modal transportation network
• Develop core multi-modal routing models for domestic and export shipments for all modes
• Develop comprehensive pre-processing and post-processing modules that are part of the process flow
• Integrate map visualization tool to help Analysts better estimate mileages for problematic records

Put it all together, and you get GeoMiler!
CFS Data Items Uses as Input to GeoMiler

- Valid Origin ZIP Code
- Valid Destination ZIP Code; if an export, valid Country Name (valid City Name for Canada and Mexico)
- Mode or Mode Sequence
- Commodity Type, particularly hazmat
- Commodity Weight
- Commodity Value
The GeoMiler Application

Fully integrated GIS based tool
• Seamless functionality with fully mechanized geographic info correction
• Multimodal pathfinder and distance solver
• Based on ArcGIS 9.1 and Network Analyst
• ArcMap used for visualization of routes
The GeoMiler Networks

- Roads – Tele Atlas DynaMap Transportation (this is about to change! More later.)
- Rail – FRA Rail Network
- Water – USACE Navigable Waterway Network
- Air – Based on BTS Office of Airline Information and Official Airline Guide
- Pipelines – Great Circle Distance
- “Spatial Joins” created to link the networks through intermodal facilities
Modeling Multimodal Transfer

TRUE ORIGIN

Highway network

Truck-Rail transfer facility

Rail network

Modal spatial joins

TRUE DESTINATION

Highway network

Modal spatial joins

Truck-Rail transfer facility
Building GeoMiler: Summary

- False starts prior to 1997 and 2002 surveys
- Began development in Spring of 2006
- Entire application (pre-processor, solver, post-processor) and multi-model network completed in 11 months
Old vs. New: Process

2002 CFS
- FORTRAN, Foxpro, no GIS component
- Separate components for pre-processor, solvers, and post processor
- ASCII representation of networks

2007 CFS
- VB, ArcGIS
- Seamless process flow
- GIS networks
Old vs. New: Results

2002 CFS
- 2 analysts
- Processed 2.7 million records in first 12 months
- 112,500 records per analyst per month

2007 CFS
- 3 analysts
- Processed 4.5 million records in first 10 months
- 150,000 records per analyst per month
Truck-Rail-Water Shipment
Riverton, WV → Sudbury, MA
Export Shipment via Great Lakes
Mtn Iron, MN → Marathon, CANADA

Origin: Mtn Iron, MN 55768

Port of Duluth, MN

Great Lakes component

Canadian Miles not included

Line of Demarcation

Foreign Destination: Marathon, Canada

Truck component
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NAVTEQ Integration Into GeoMiler

- F1-F4 Classification Roads
- Add “Virtual Links” from zip centroid to closest street link
- Add “Virtual Links” from each airport, seaport (dock), intermodal facility (boat or rail to truck transfer point) and point-of-entry (border crossings) to the closest street link
  - Allows for accurate travel distance calculation rather than calculating straight distances from zip centroids as it uses actual grounded street network
Challenges

- In the first incarnation of GeoMiler DOT went through the issue of the old distances (zip centroids to zip centroids) matching the actually road mile values already.
- New version will improve mileage numbers to reflect more accurate number of road miles from each facility to the nearest point on the street network (rather than straight line links).
- Will impact five-year surveys as miles travel will be different
- Technologically do-able
- Politically challenging
What’s Next?

- Testing and revisions
  - Integration to be completed by November 2011
- Internal DOT Analyst will perform modifications to Network using ArcGIS Network Analyst to take advantage of enhancements to GeoMiler Model

Questions?
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