

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

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2007 CFS

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 Roles

- Funded primarily by BTS
- Actual survey carried out by the Census Bureau
- BTS is responsible for calculating the mileage, by mode, travelled by each shipment

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 and 1997 Surveys

- BTS contracted with the Oak Ridge National Laboratory (ORNL) to perform the work
- 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

Mileage Calculations in the 2002 Survey

- In 2002 CFS, mileage calculations were performed by BTS analysts at the Census Bureau using the ORNL-developed applications
- The BTS analysts quickly became aware of the limitations of a non-GIS approach to mileage calculations

Problem Records: An Example



2007 CFS: Time for a Change

- **Re-engineering the mileage calculation process was part of major performance push to:**
 - Improve overall efficiency of estimating distances in the 2007 Commodity Flow Survey
 - Improve the methods used in generating the shipment mileages
 - Improve the quality of mileage information reported in the survey

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

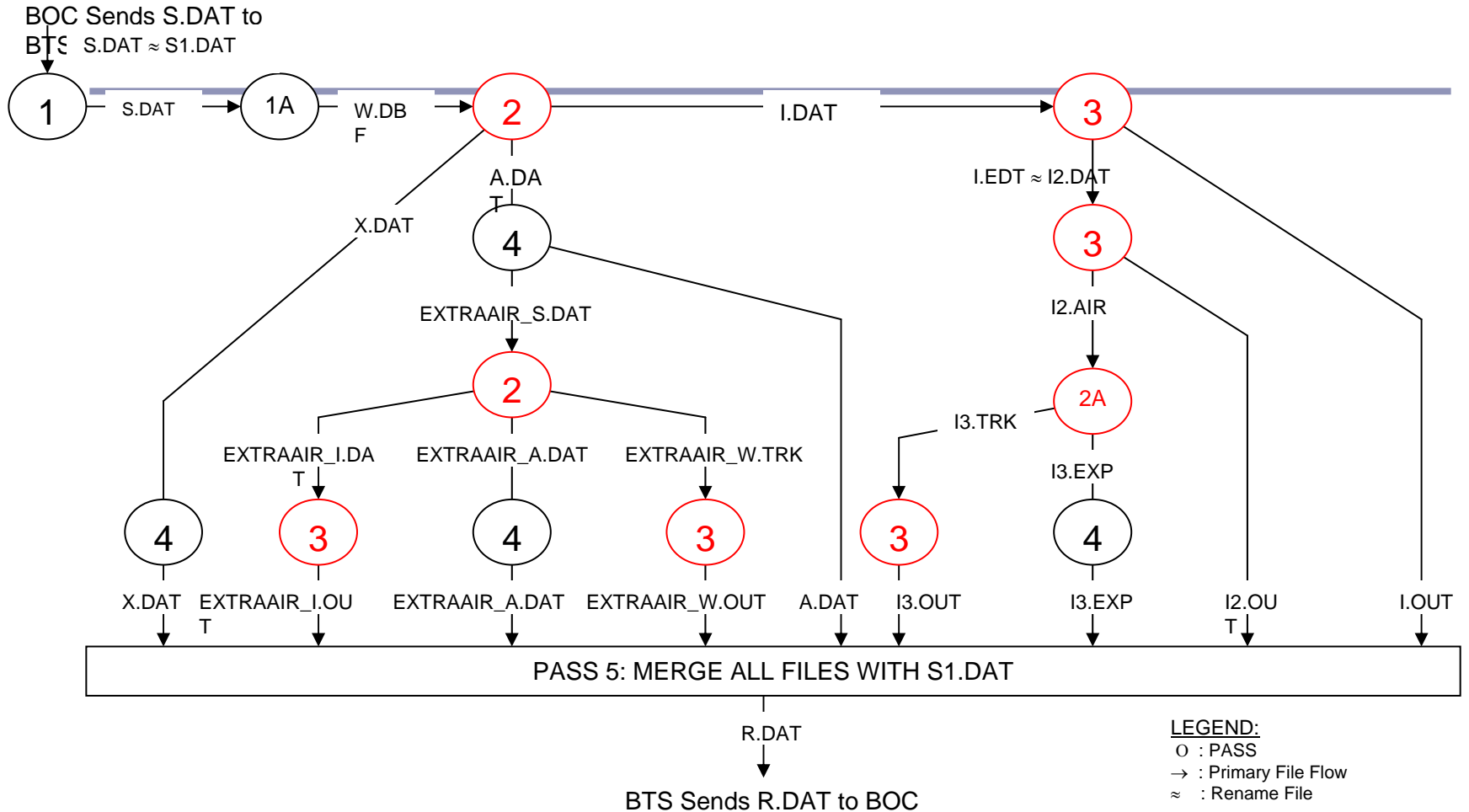
The Solution: A Geospatial Approach

Our goals:

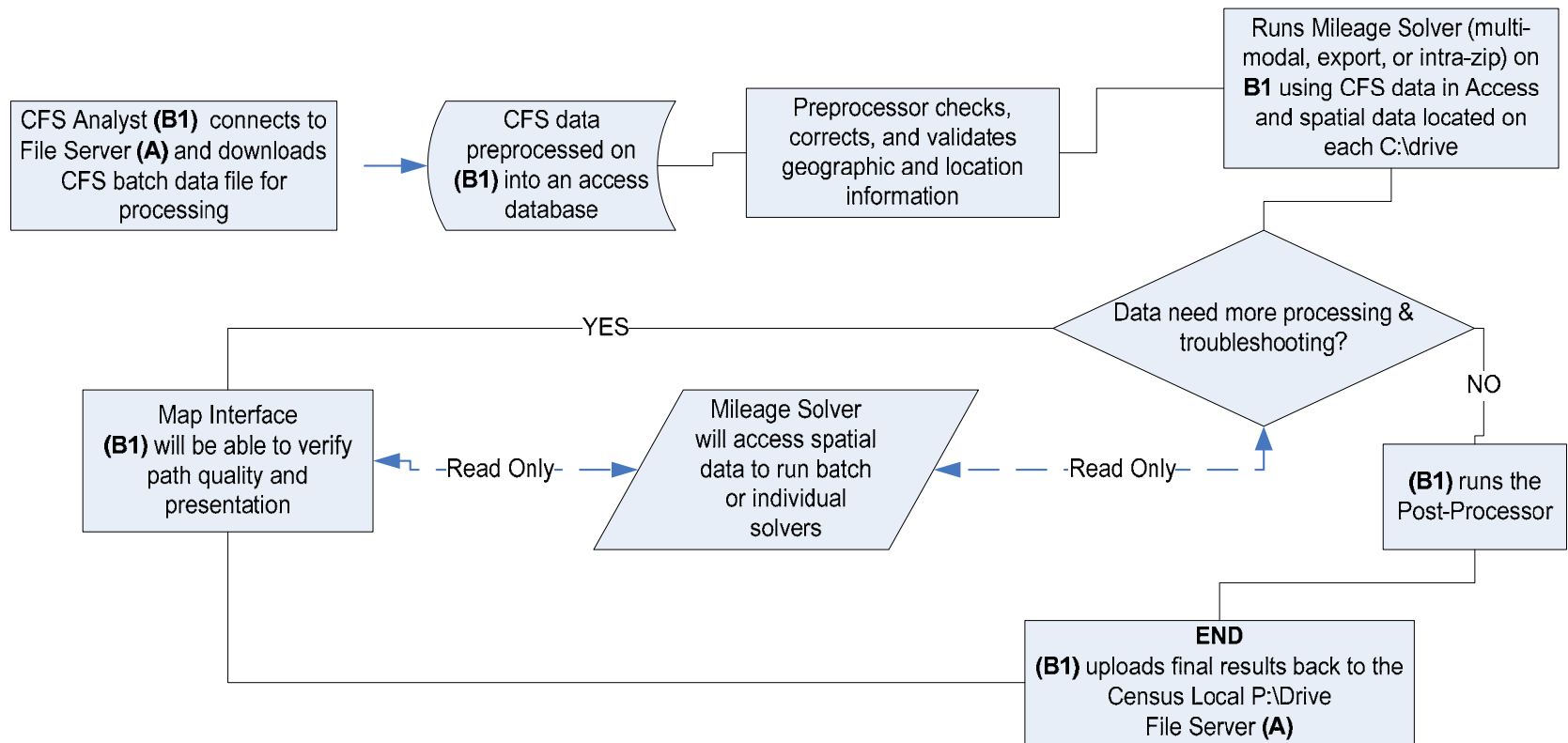
- Develop a multi-modal transportation network
- Develop core multi-modal routing models for domestic and export shipments for all modes
- Develop comprehensive pre-processing and post-processing modules that are part of the process flow
- Integrate map visualization tool to help Analysts better estimate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

Put it all together, and you get **GeoMiler!**

2002 CFS: FLOW DIAGRAM OF DATA FILES



2007 CFS: FLOW DIAGRAM OF DATA FILES



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

Input from Survey Form

Item F SHIPMENT CHARACTERISTICS

NOTE: Each line runs across pages 4 and 5. After entering column H data on page 4 for any line, continue with column (I) on page 5 for the same line.

Line No. (A)	Your Shipment ID Number (B)	Shipment Date (C)		Shipment value (excluding shipping costs) in whole dollars. Estimates acceptable. (D)	Net Shipment Weight in pounds (E)	SCTG commodity code from accompanying booklet (F)	Commodity Description (G)	If a hazardous material, enter the "UN" or "NA" number (H)	Continue with column (I) on page 5
		Month	Day						
0	123-5	4	26	224,235	4840	34520	Mechanical machinery		→
00	402H	4	26	1,375	50,125	20222	Sulfuric acid	1830	→
1									→
2									
3									

U.S. Destination or U.S. Exit Port (Complete for all shipments.) (I)			Mode(s) of transport to U.S. destination. Enter all that apply in order used. Use codes at bottom. (J)	★ Intermodal shipment? (Y/N) (K)	Export? (Y/N) (L)	Foreign Destination (for export shipments only) Note: In column (I) enter the U.S. port, airport, or border crossing of exit. (M)		Export mode (N)	Line No. (O)
City	State	ZIP Code				City	Country		
Los Angeles	CA	90040	2, 4	Y	Y	Beijing	China	6	0
Newark	NJ	07105	4	N	N				00
									1
									2
									3

The GeoMiler Application

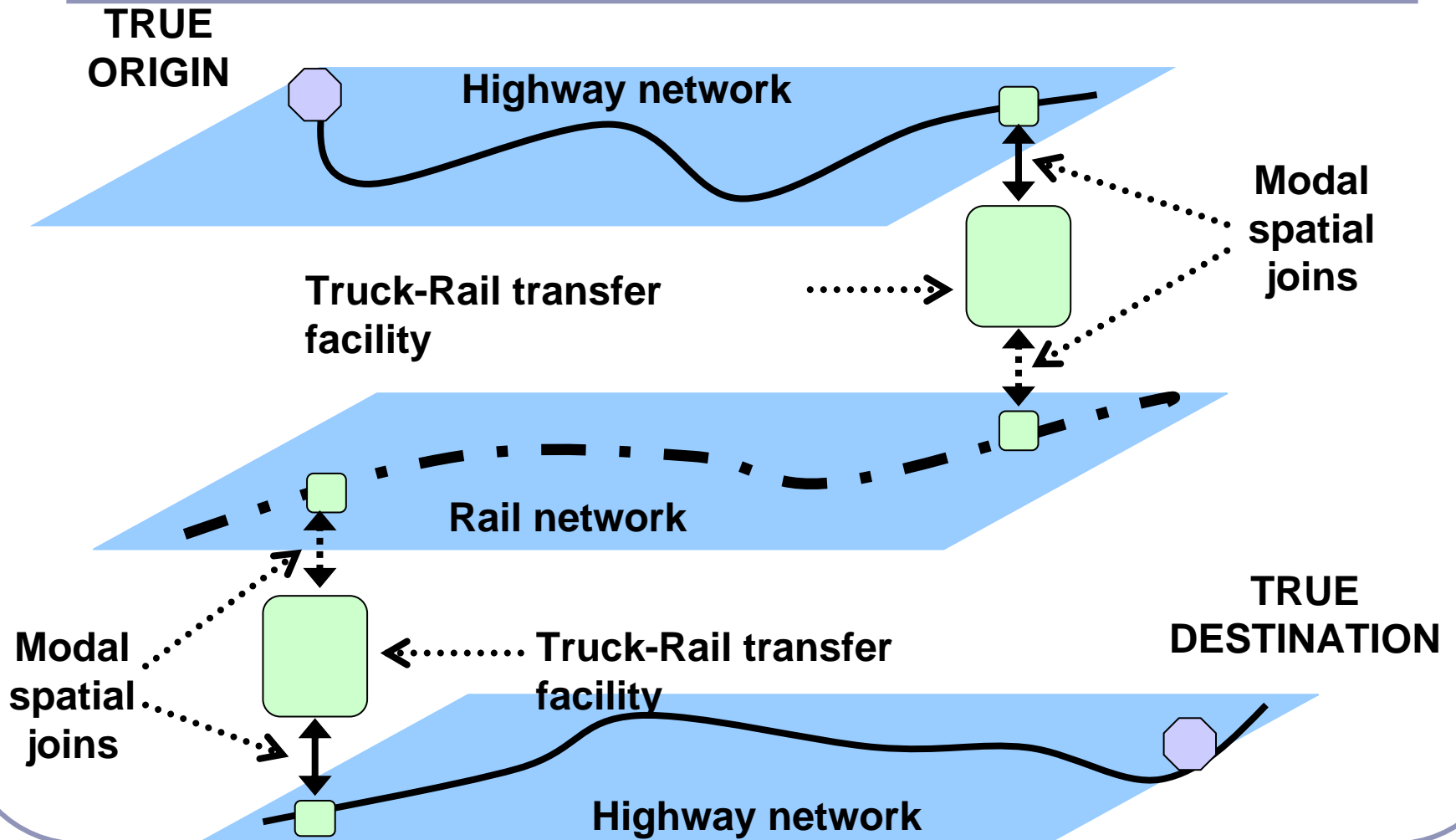
Fully integrated GIS based tool

- 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
- 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



Building GeoMiler: Summary

- Began development in Spring of 2006
- Entire application (pre-processor, solver, post-processor) and multi-model network completed in 11 months
- GeoMiler not just for the 2007 CFS!

GeoMiler in Production

- Processing began on 4/16/2007
- 5.2 million records are expected for the entire survey
- As of 2/29/08, 4.5 million records have been processed

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

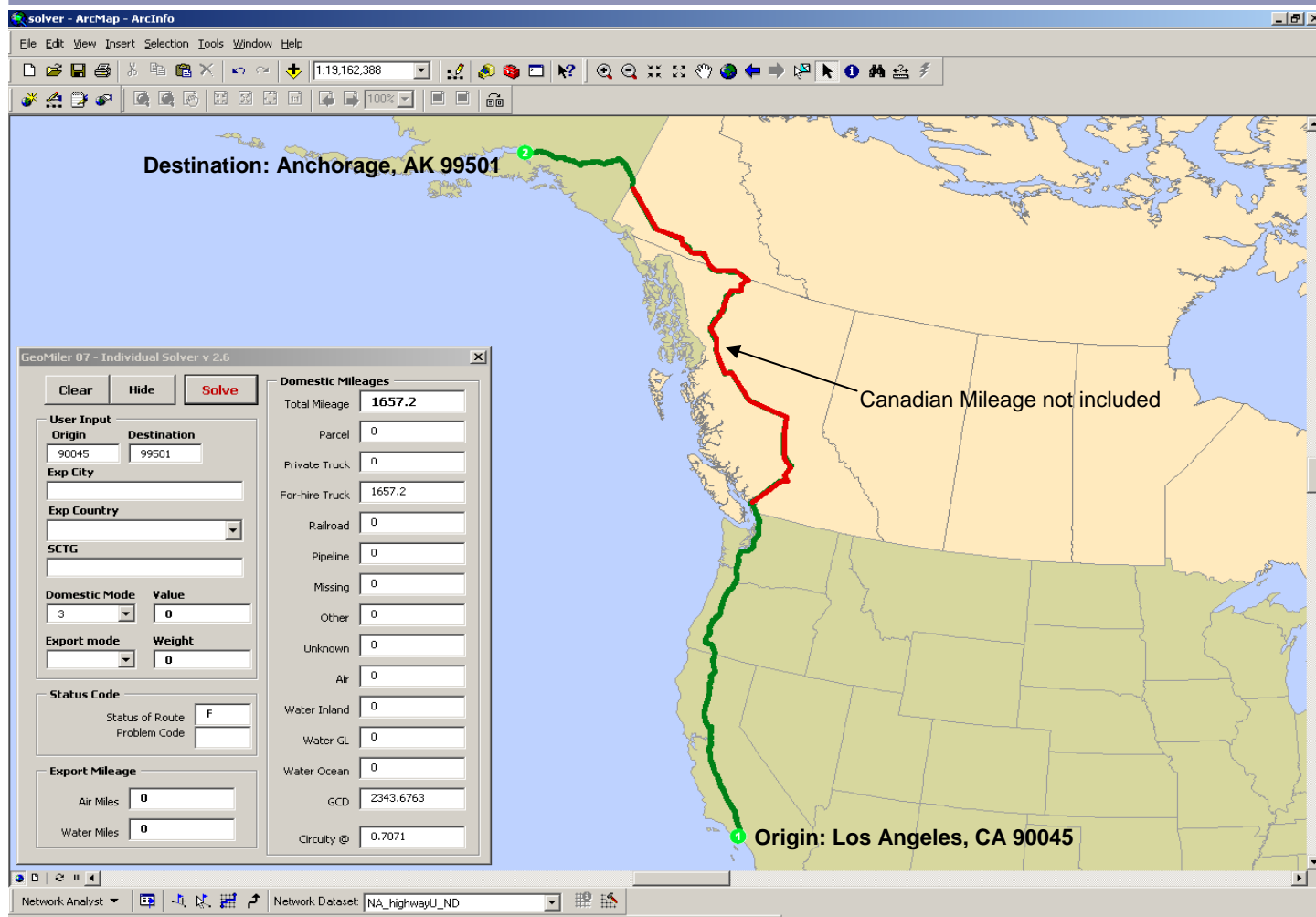
2002 CFS

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

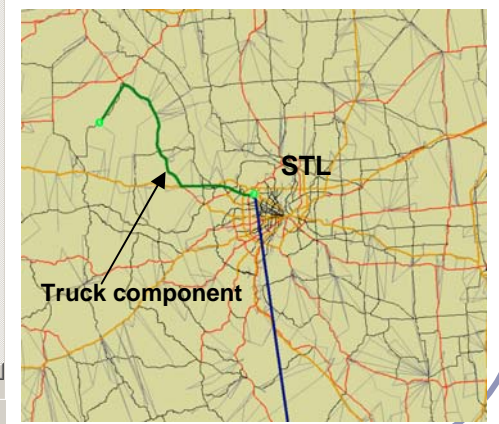
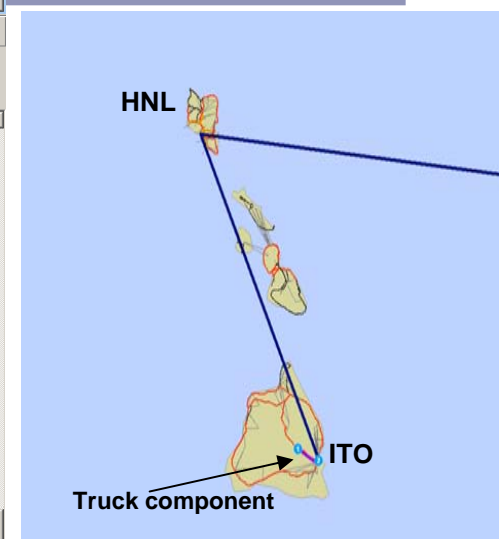
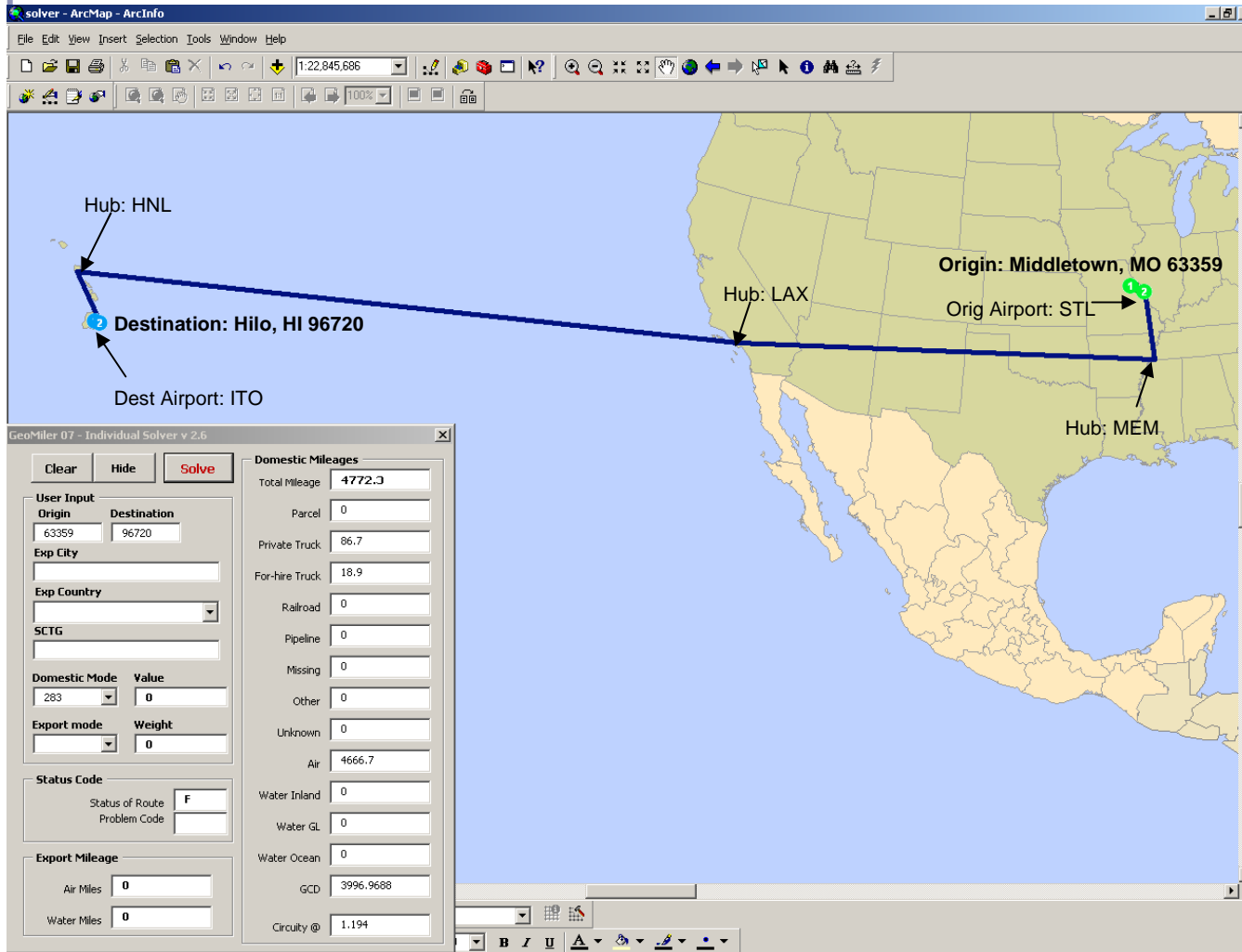
2007 CFS

- 3 analysts
- Processed 4.5 million records in 10 months
- 150,000 records per analyst per month

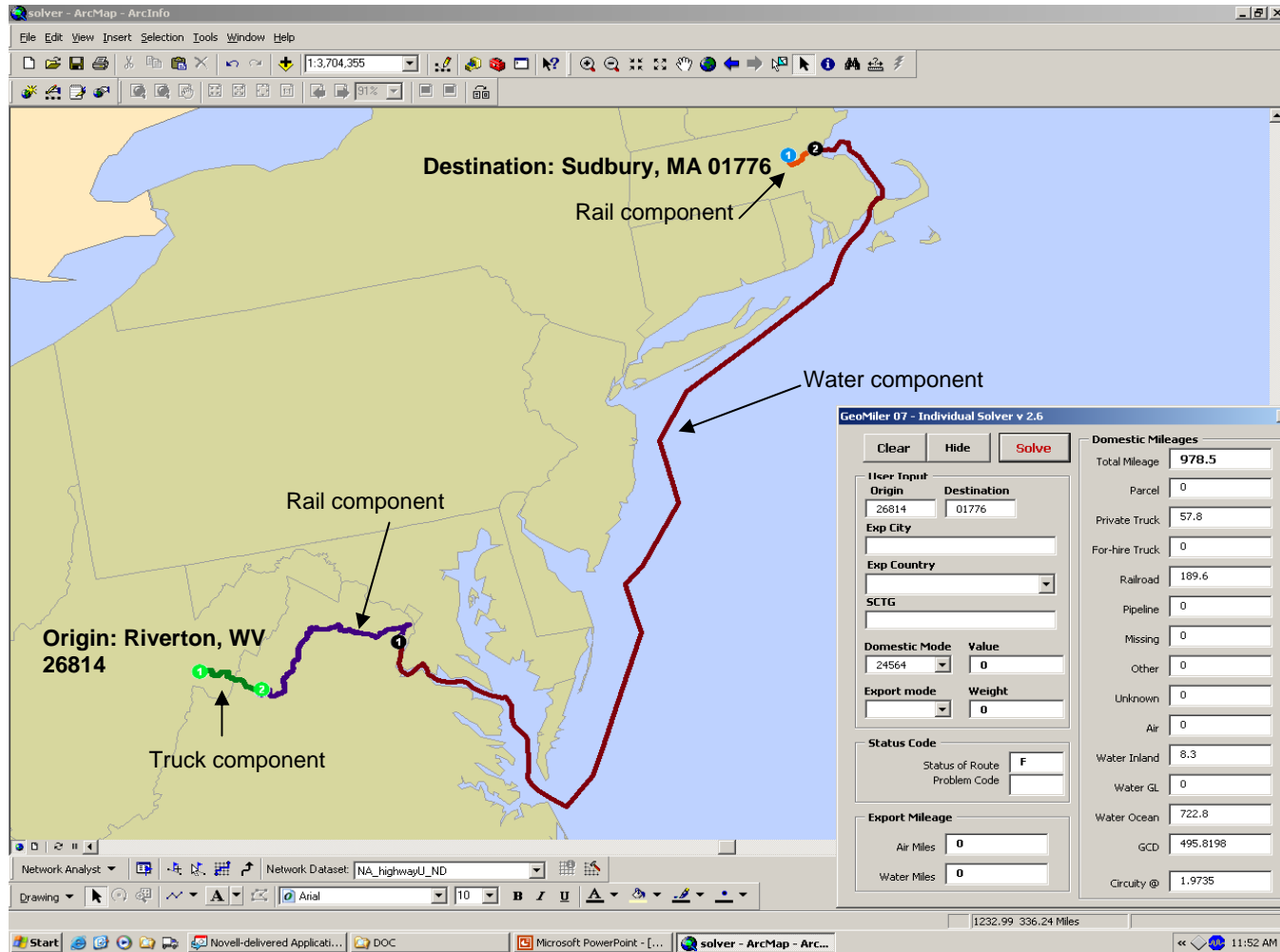
Truck Shipment Los Angeles, CA → Anchorage, AK



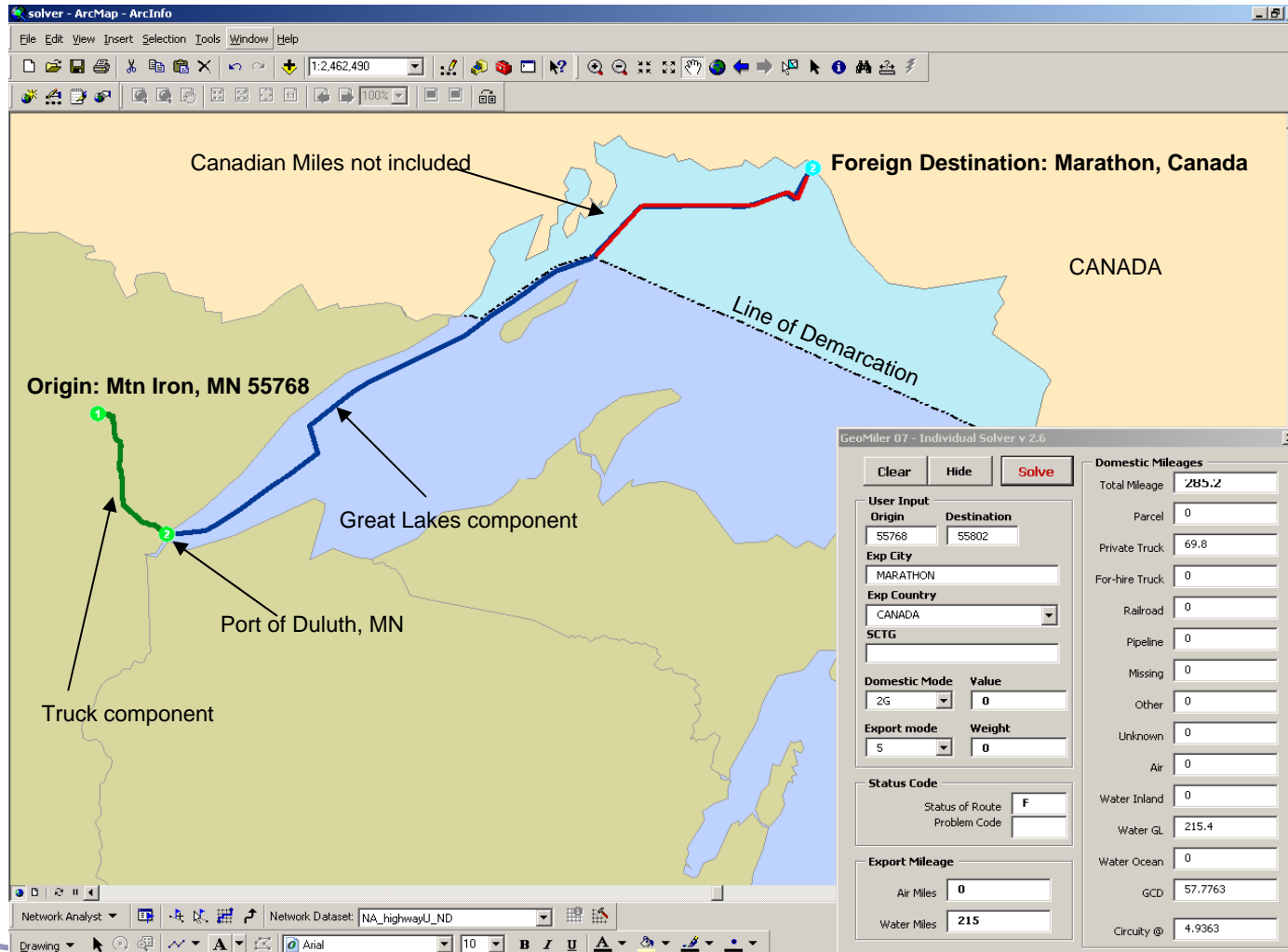
Air Shipment Middletown, MO → Hilo, HI



Truck-Rail-Water Shipment Riverton, WV → Sudbury, MA



Export Shipment via Great Lakes Mtn Iron, MN → Marathon, CANADA



Questions?

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