SUSTAINABLE INTERMODAL FREIGHT TRANSPORTATION OPTIONS IN THE GREAT LAKES: DEVELOPMENT AND APPLICATION OF A GREAT LAKES GEOGRAPHIC INTERMODAL FREIGHT TRANSPORT (GIFT) MODEL

JAMES J. WINEBRAKE, PHD.
J. SCOTT HAWKER, PHD.
ROCHESTER INSTITUTE OF TECHNOLOGY

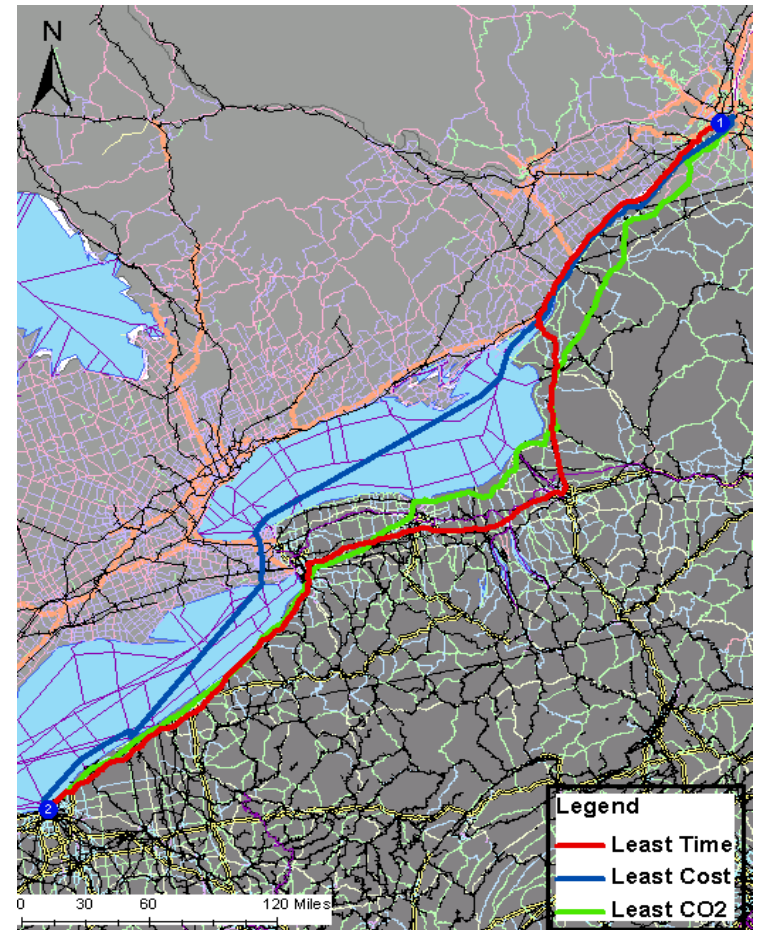GLMRI UNIVERSITY AFFILIATES MEETING
DULUTH, MN
24-25 SEPTEMBER 2009

Great Lakes Maritime Research Institute
A University of Wisconsin - Superior and University of Minnesota Duluth Consortium

Rochester Institute of Technology/University of Delaware

The UD/RIT GIFT Team

- Dr. James J. Corbett, UD
- Dr. Earl "Rusty" Lee, UD
- Dr. J. Scott Hawker, RIT
- Dr. Karl Korfmacher, RIT
- Dr. James J. Winebrake, RIT
- Dustin Briggs, UD
- Kelly Ambrose, UD
- Bryan Comer, RIT
- Chris Prokop, RIT
- Bo Li, RIT
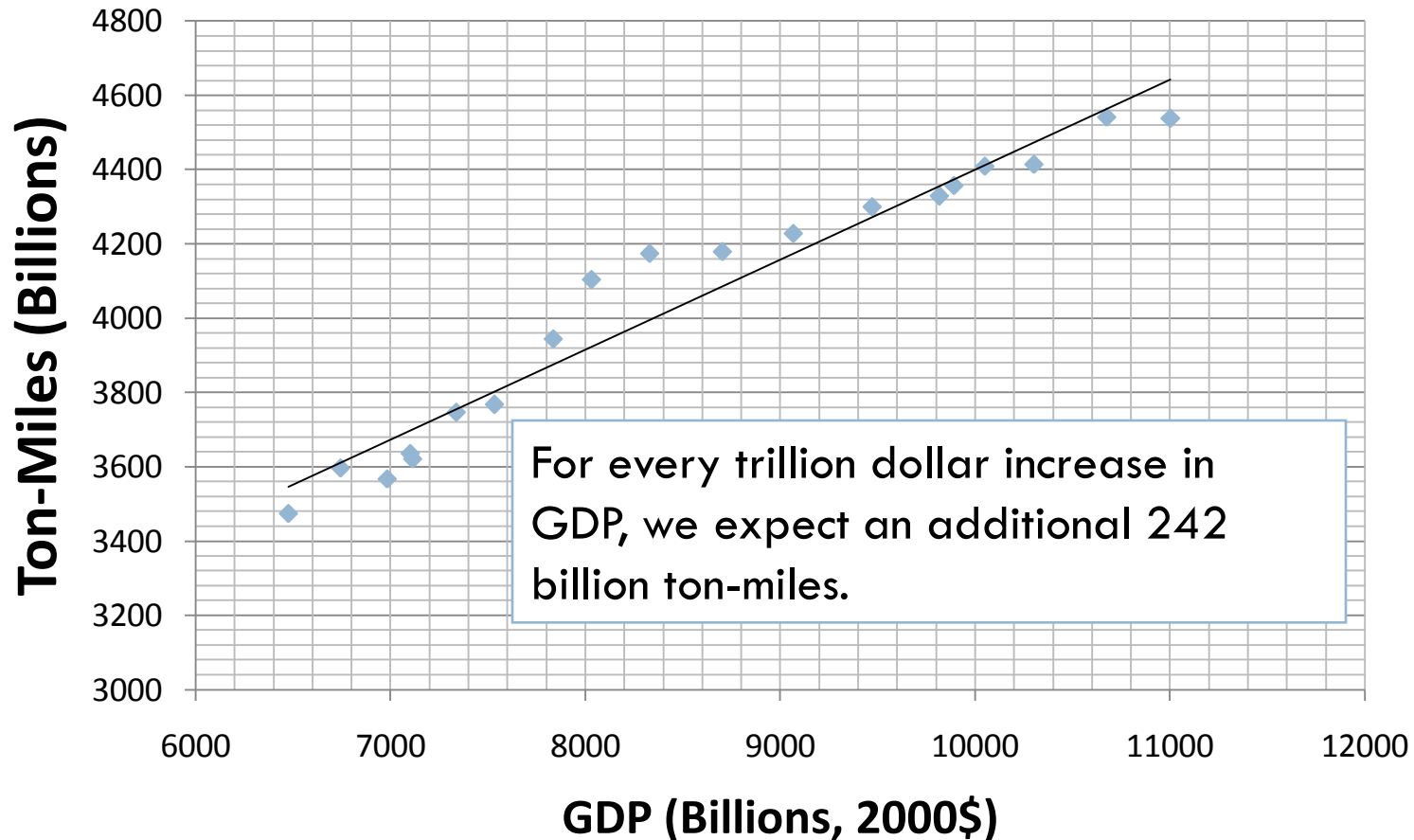- Many other students have helped as well!

Overview of Presentation

- Project Motivation

- GL-GIFT Structure
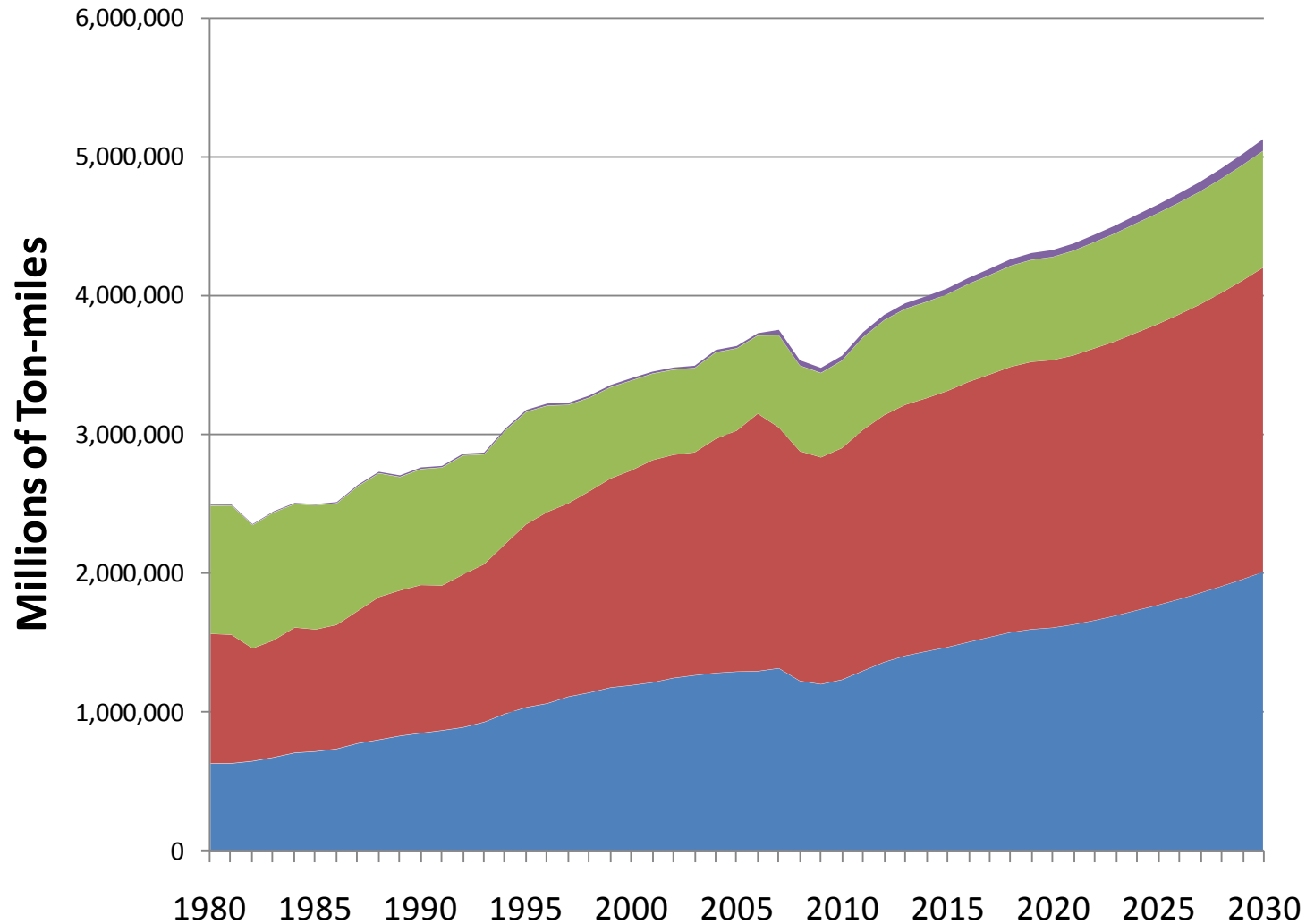
- Some Example Cases

- Demonstration

- Next Steps

Legend
- Least Time
- Least Cost
- Least CO2

GLMRI 2009

Project Motivation

Goods Movement and GDP

Ton-Miles v. GDP for the U.S. (1987-2005)

For every trillion dollar increase in GDP, we expect an additional 242 billion ton-miles.

Source: Corbett and Winebrake, 2009.

GLMRI 2009

U.S. Freight Transport by Mode, 1980-2030

Source: Bureau of Transportation Statistics Table 1-46b (1980-2006); AEO 2009 (derived, 2007-2030).

GLMRI 2009

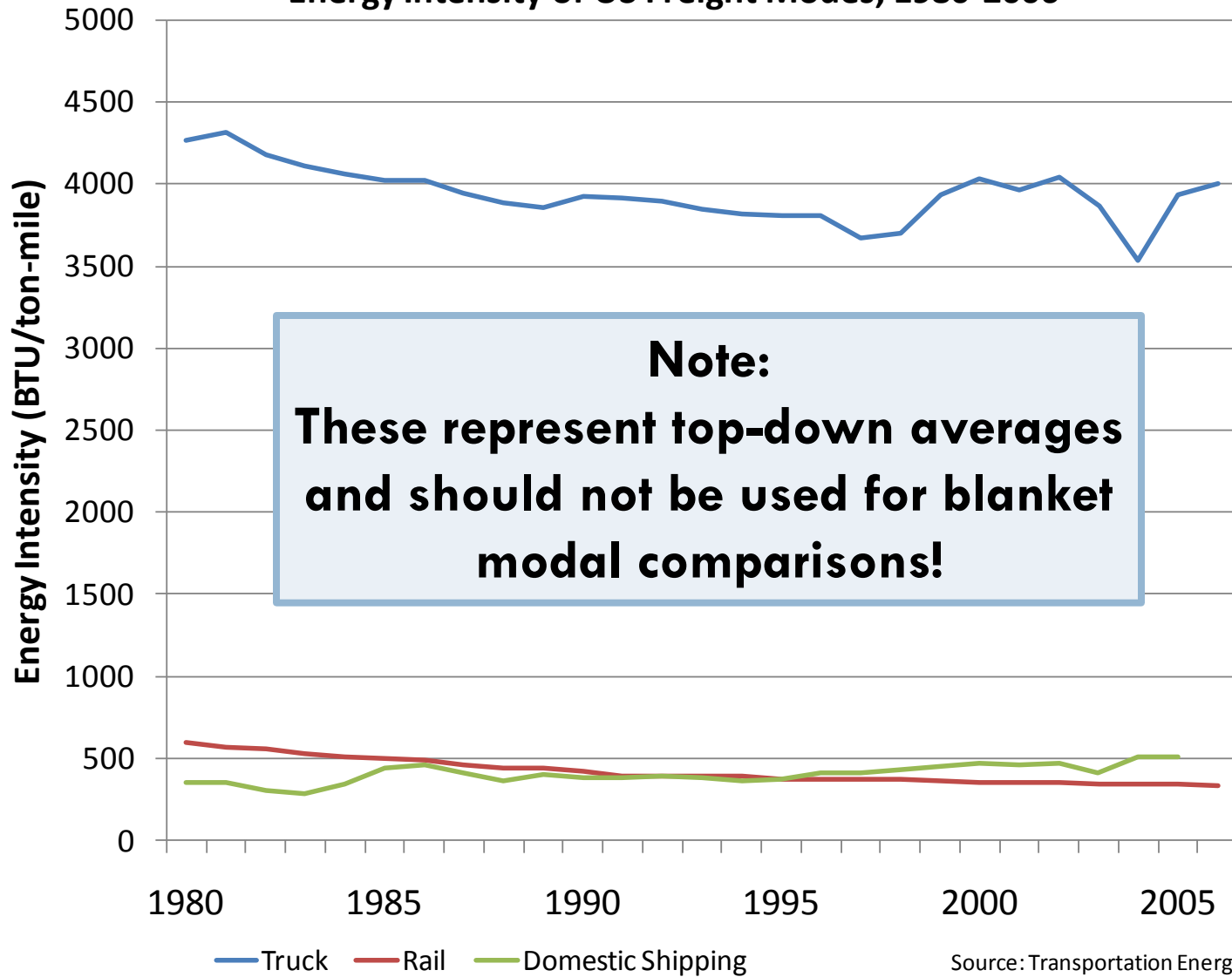# Percentage of Energy-Related Transportation CO2 Emissions by Mode, 2008

Recreational Boats
0.9%

Air
9.8%

Military Use
2.8%

Lubricants
0.3%

Shipping,
International
3.1%

Shipping, Domestic
1.2%

Rail, Freight
2.2%

Rail, Passenger
0.3%

Freight Trucks
18.3%

Bus Transportation
1.0%

Commercial Light
Trucks
2.1%

Light-Duty Vehicles
57.8%
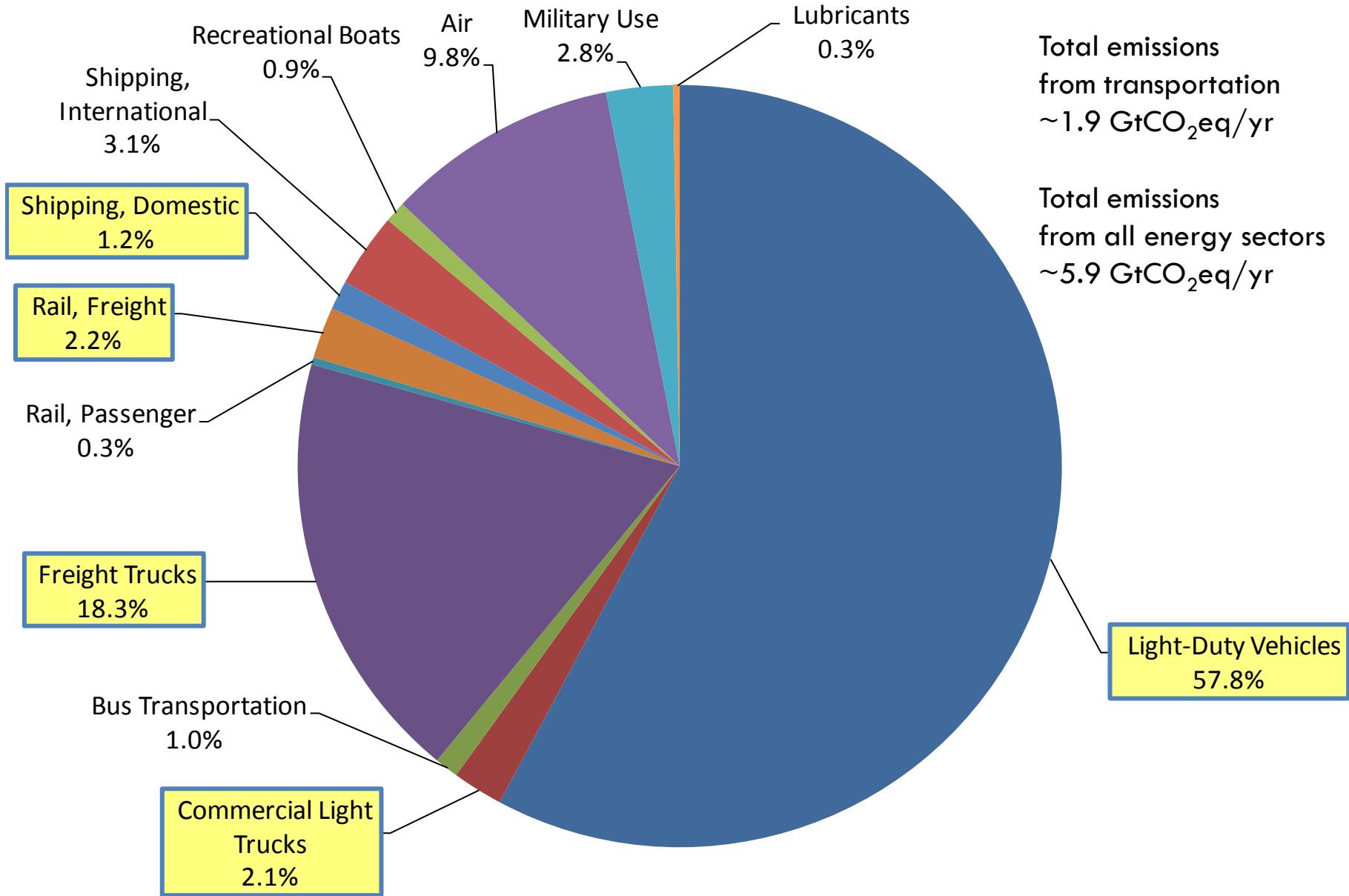
Total emissions
from transportation
~1.9 $GtCO_2eq/yr$

Total emissions
from all energy sectors
~5.9 $GtCO_2eq/yr$

Source: AEO 2009, Table 19.

GLMRI 2009

Energy Intensity of US Freight Modes, 1980-2006

Y-axis: Energy Intensity (BTU/ton-mile)

Note:
These represent top-down averages and should not be used for blanket modal comparisons!

Legend: Truck — Rail — Domestic Shipping

Source: Transportation Energy Data Book 27

GLMRI 2009

GL-GIFT Project Goals

- The goals of GL-GIFT are:
  - Examine the potential for increased use of intermodal (ship, truck, and rail) freight routes within the GLSLS region
  - Determine potential for using the Great Lakes as a corridor for intermodal freight transport
  - Illustrate how intermodal routes may affect economic and environmental costs
  - Provide a tool for policy analysis, including tradeoff analysis across competing policy objectives

- Currently operating on ArcGIS desktop with expectations for web-access in the future (2009-10)

GL-GIFT Structure

The *Geospatial Intermodal Freight Transport (GIFT)* model is a model jointly developed by the Rochester Institute of Technology and the University of Delaware, with funding support from Great Lakes Maritime Research Institute, US DOT/MARAD, California ARB, among others.

What is the GIFT model?

▸ ArcGIS based tool that helps the policy analyst do three main things:

  ▸ Evaluate the *economic, energy, and environmental* costs of freight transport

  ▸ Analyze tradeoffs across multi-modal freight transport routes

  ▸ Examine impacts of freight transport policies

▸ Policies that can be evaluated: taxes, infrastructure investment, emission reduction technologies on vehicles or fuels, etc.

Three Independent Networks

Rail Network
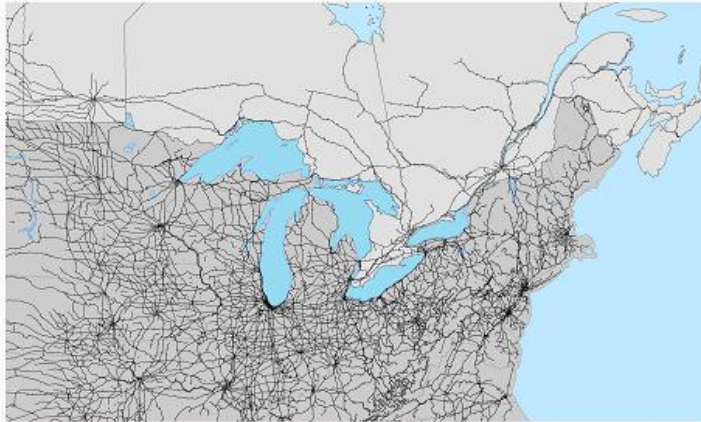
Road Network

Water Network

Hub and Spoke Construct

Road

Road Node

Railroad

Rail Node

Transportation Hub (Facility)

Road Spoke

Rail Spoke

Water Spoke

Waterway

Water Node
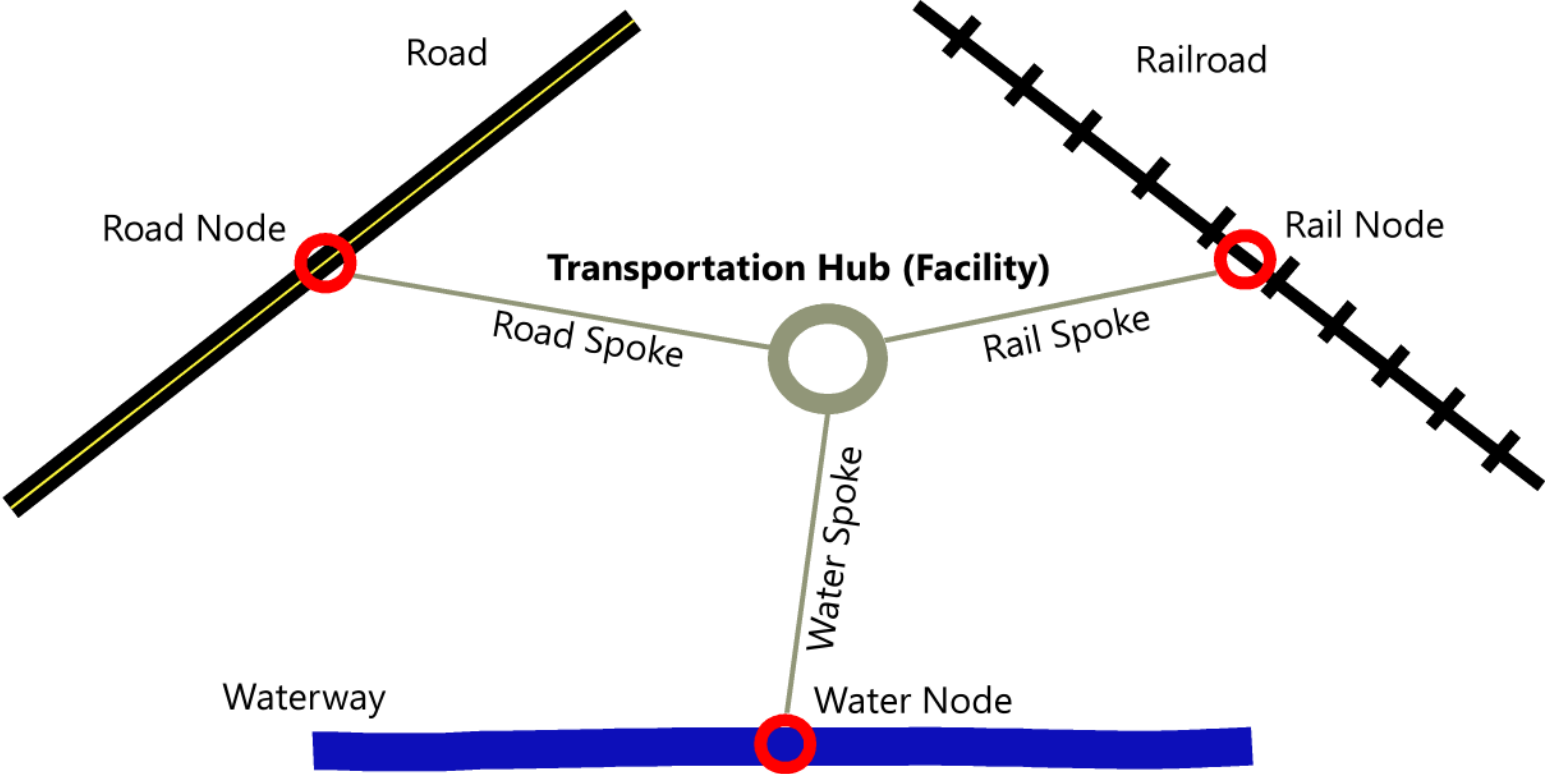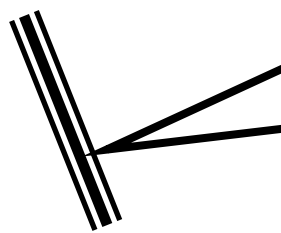
Intermodal Freight Network
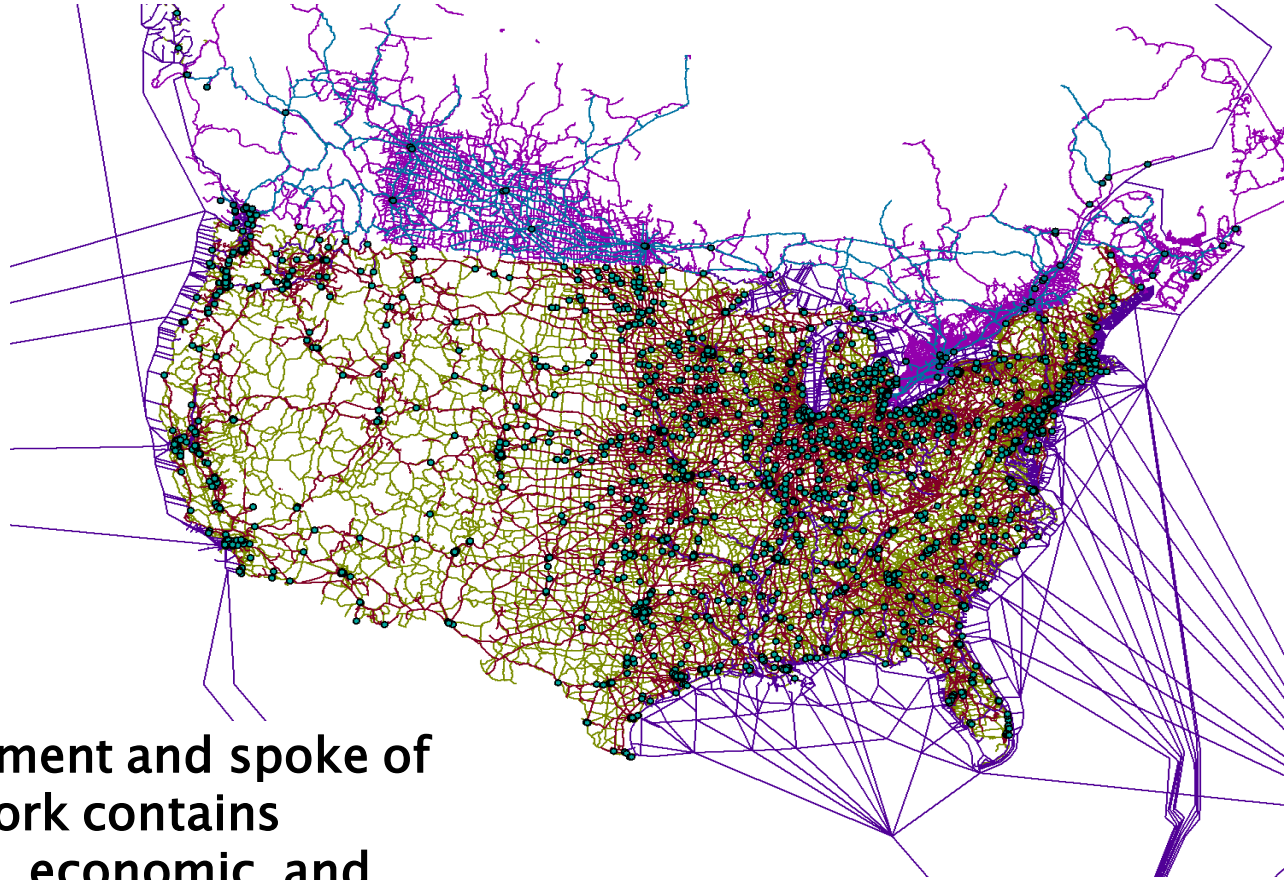
Each segment and spoke of the network contains temporal, economic, and environmental attributes.

GLMRI 2009

Methodology: Network Attributes Define "Costs"

Truck Segment "Costs"						
Distance	Time	Operating Cost	Energy	CO_2	NOx	…

- Add attributes to network segments
- Uses attribute values to search for routes that minimize the total route costs of a selected attribute
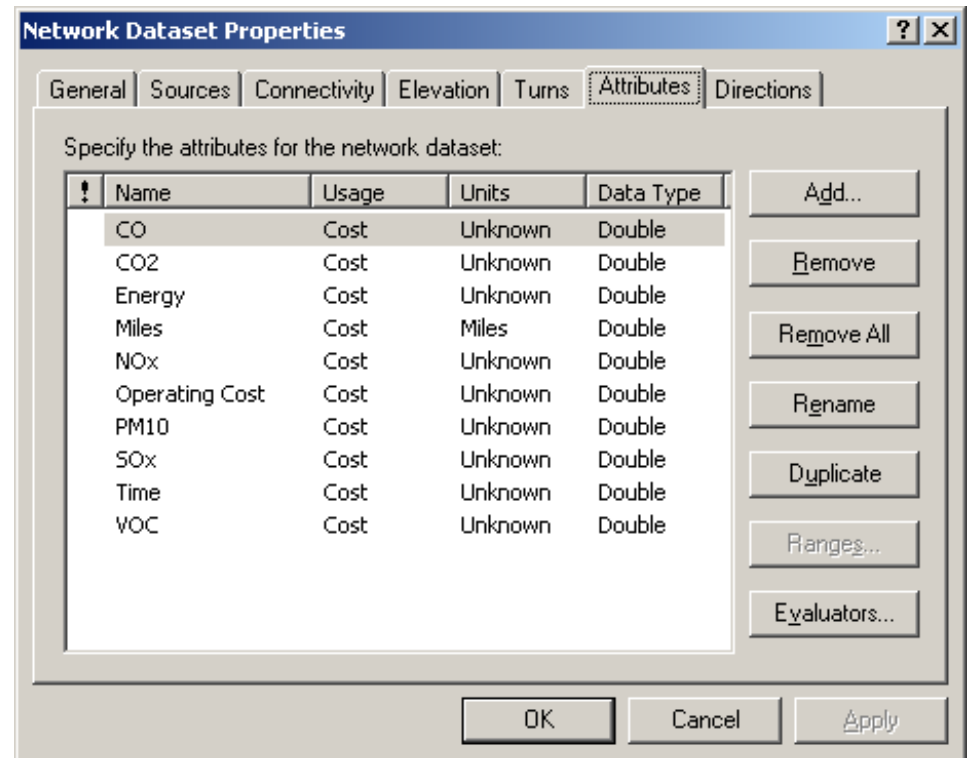
Methodology: Custom Evaluators

Rail Segment "Costs"

Distance	Time	Operating Cost	Energy	CO$_2$	NOx	…
14.3 mi.						

… Rail_Cost_Evaluator … … Rail_NOx_Evaluator …

Truck-Rail Segment "Costs"

Time	Operating Cost	Energy	CO$_2$	NOx	…

… Truck-Rail_Cost_Evaluator … … Truck-Rail_NOx_Evaluator …

Truck Segment "Costs"

Distance	Time	Operating Cost	Energy	CO$_2$	NOx	…
5.2 mi.						

… Truck_Cost_Evaluator … … Truck_NOx_Evaluator …
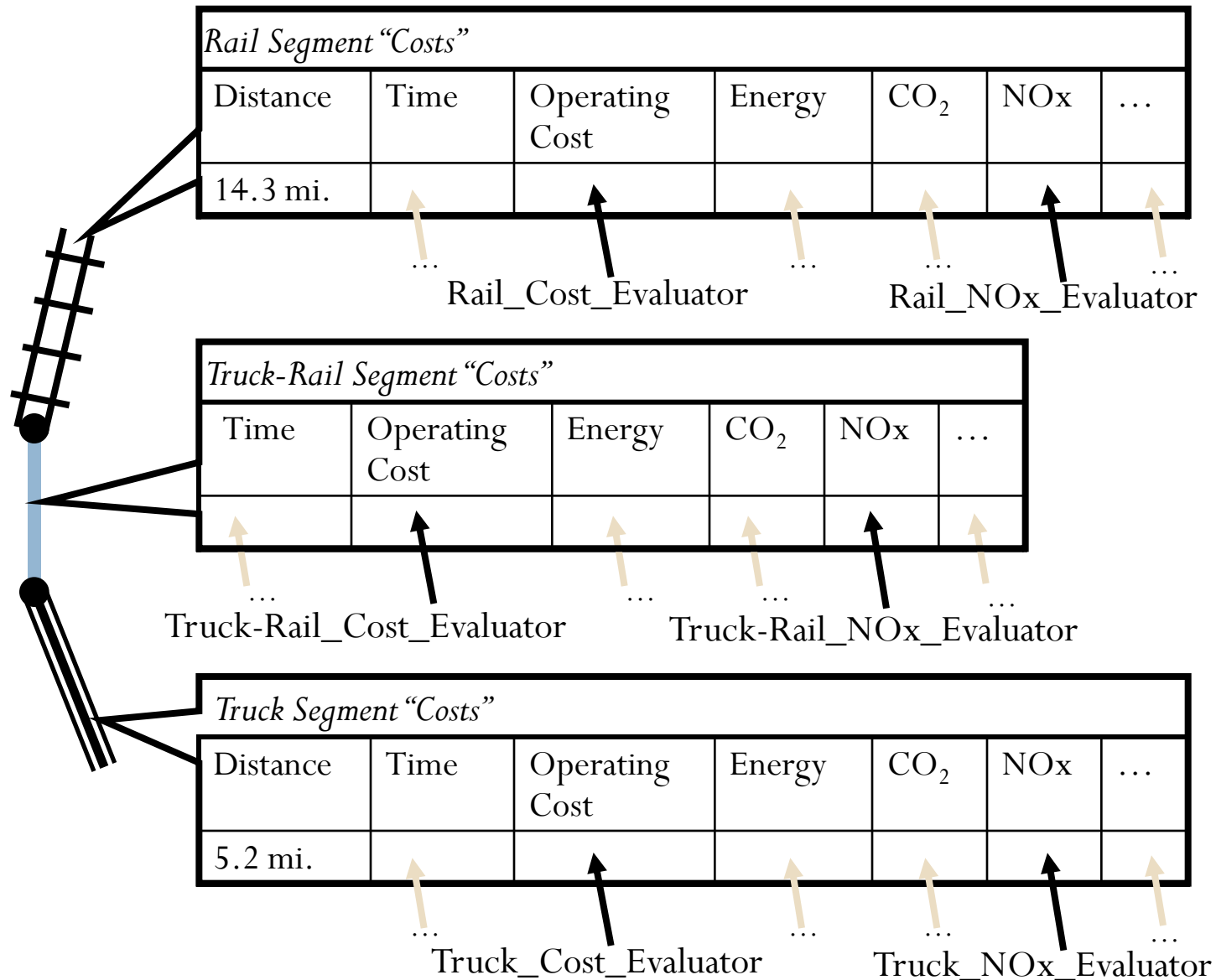
Evaluators Use Novel Calculator Interface
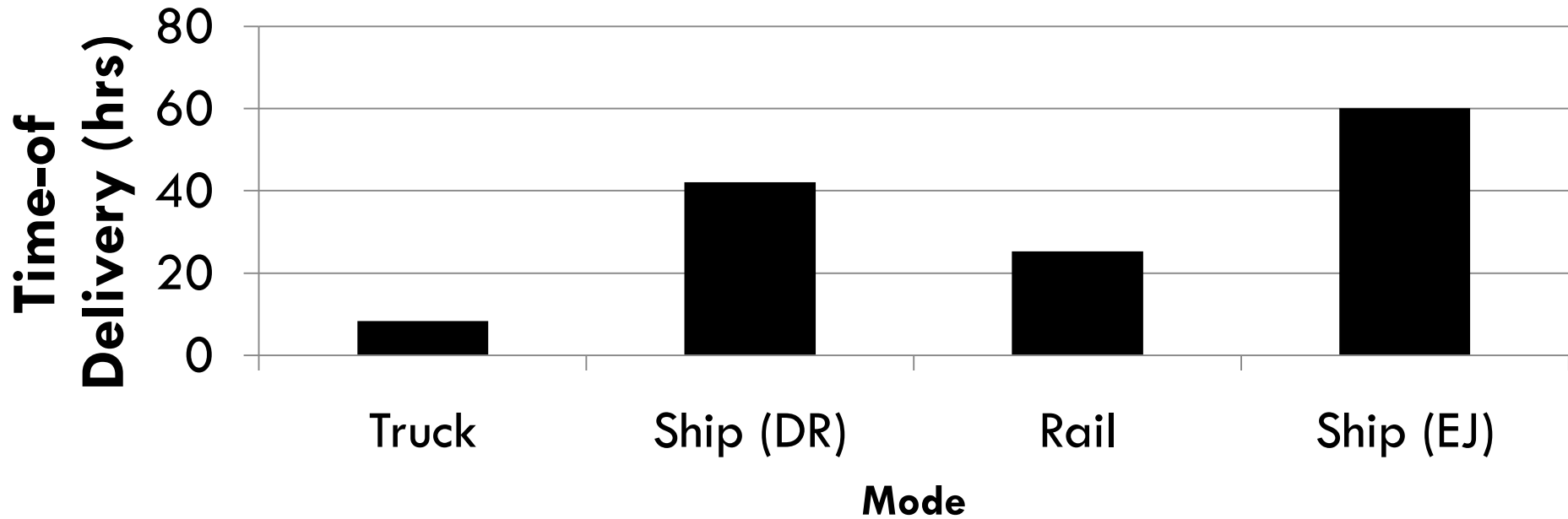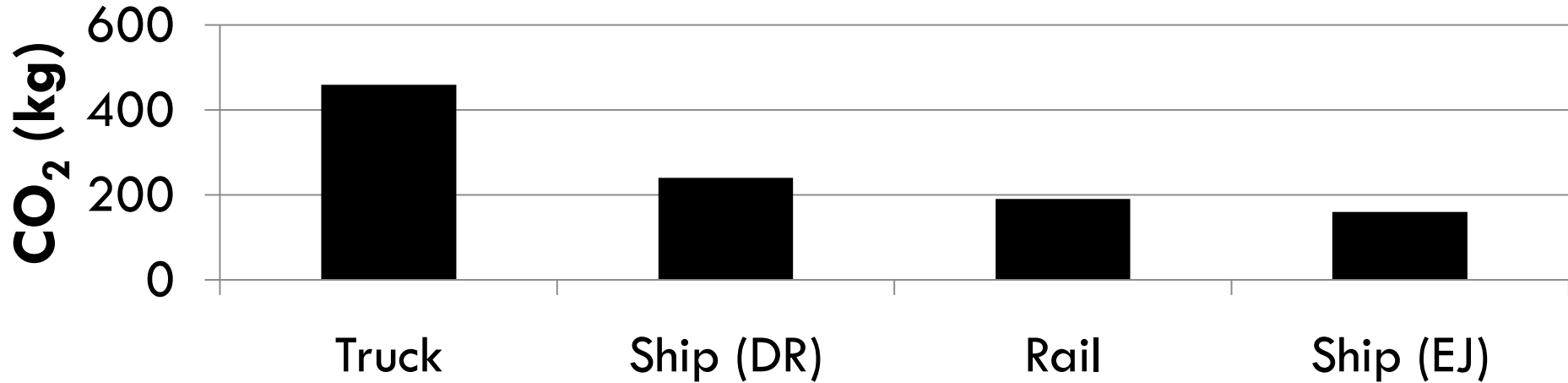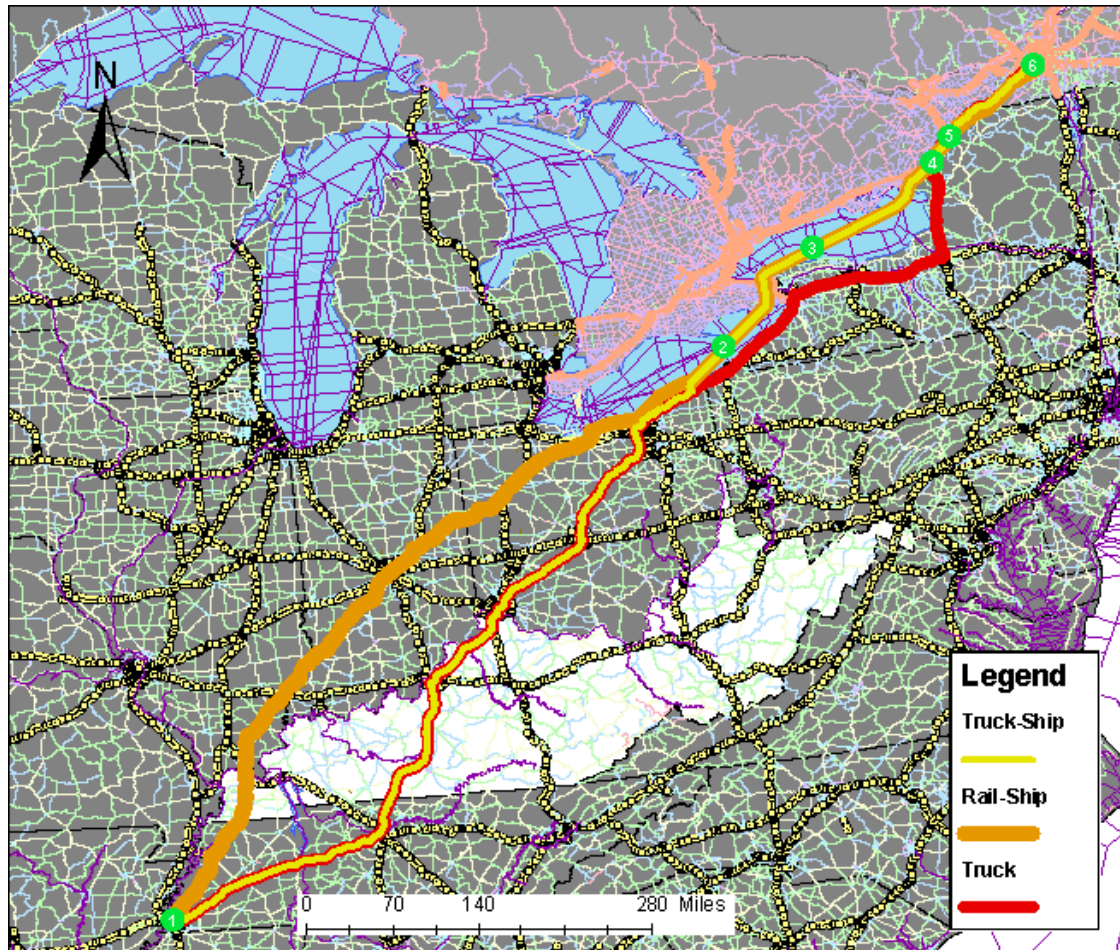
Some Example Cases

Example #1: Modal Comparisons
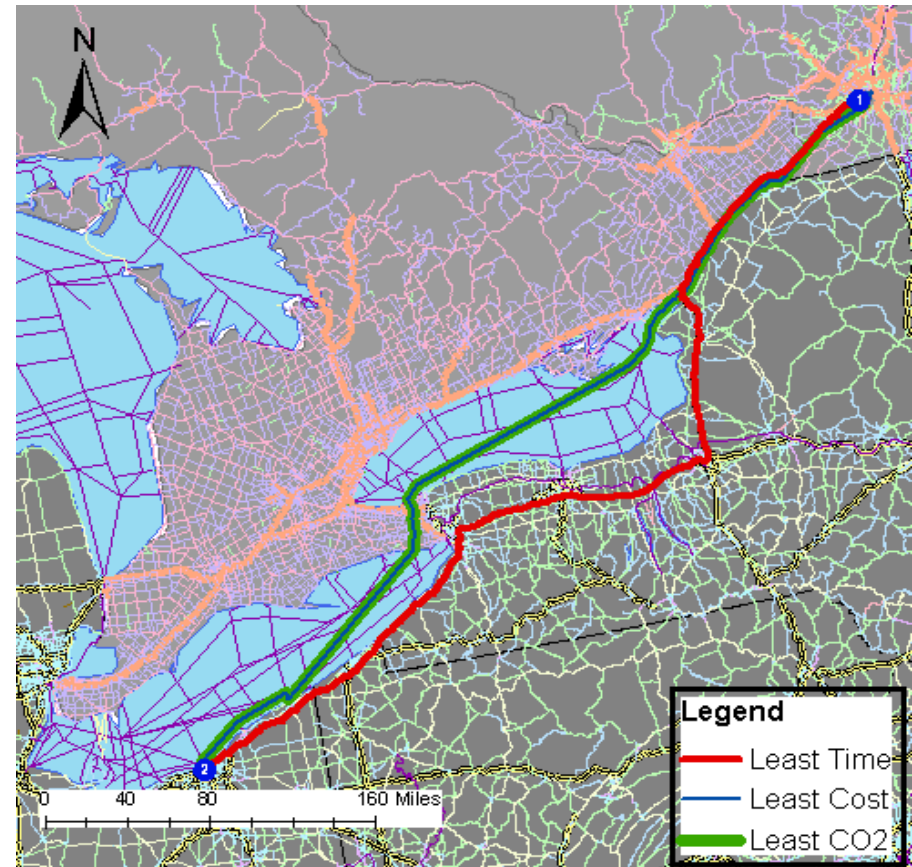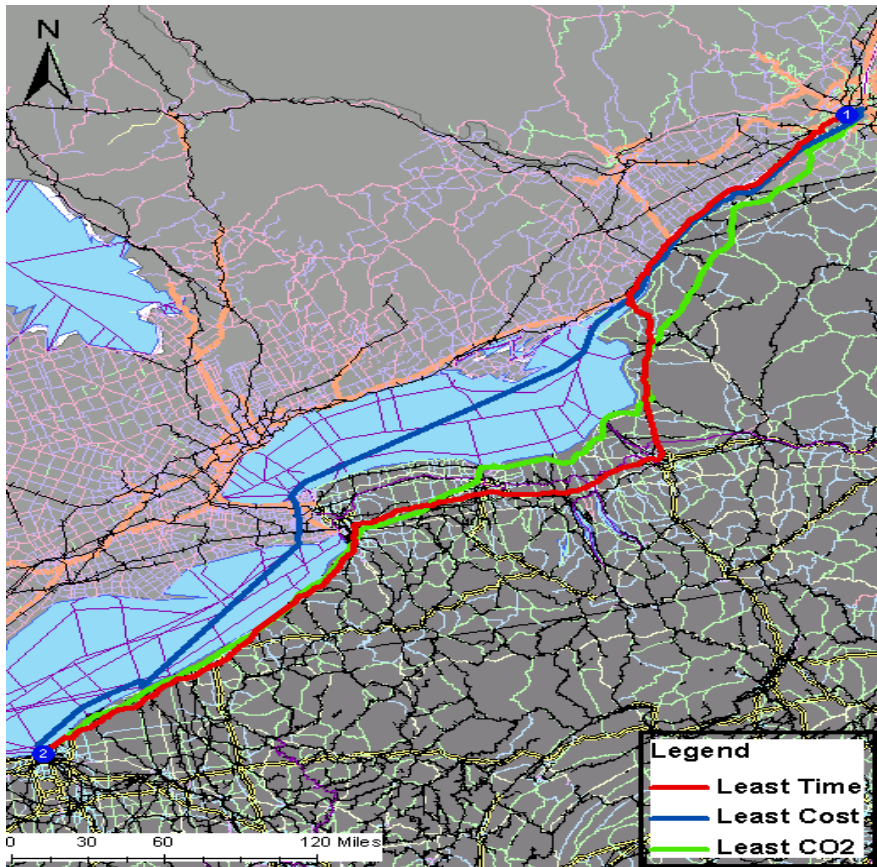
Montreal to Cleveland (Ship 1)   **Montreal to Cleveland (Ship 2)**

GLMRI 2009

**Emissions and Time of Delivery Tradeoffs
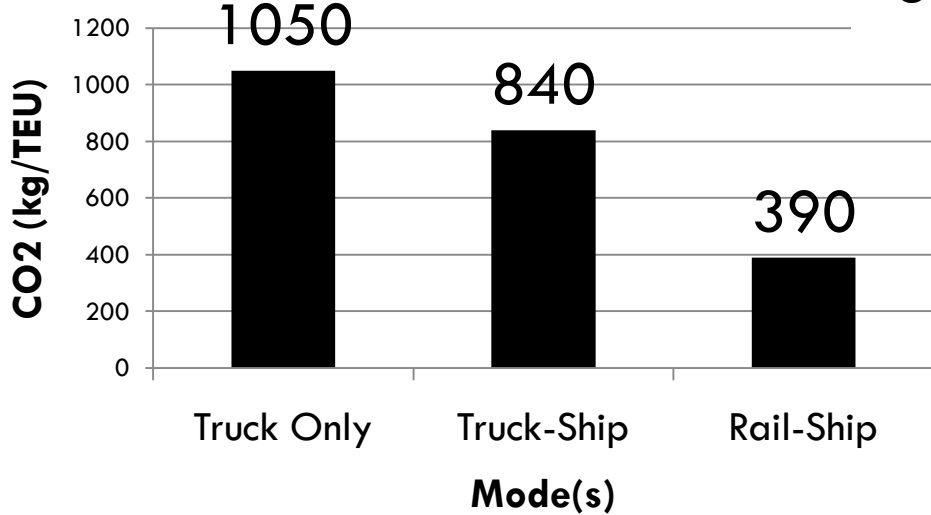Montreal to Cleveland**
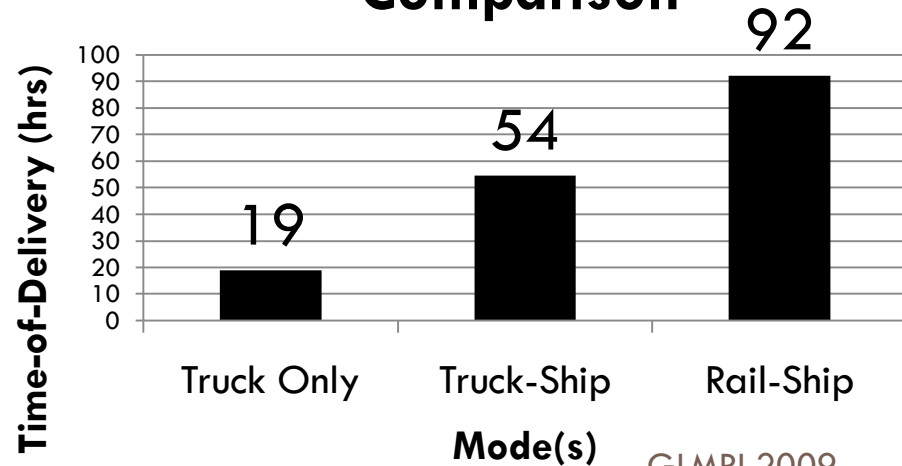
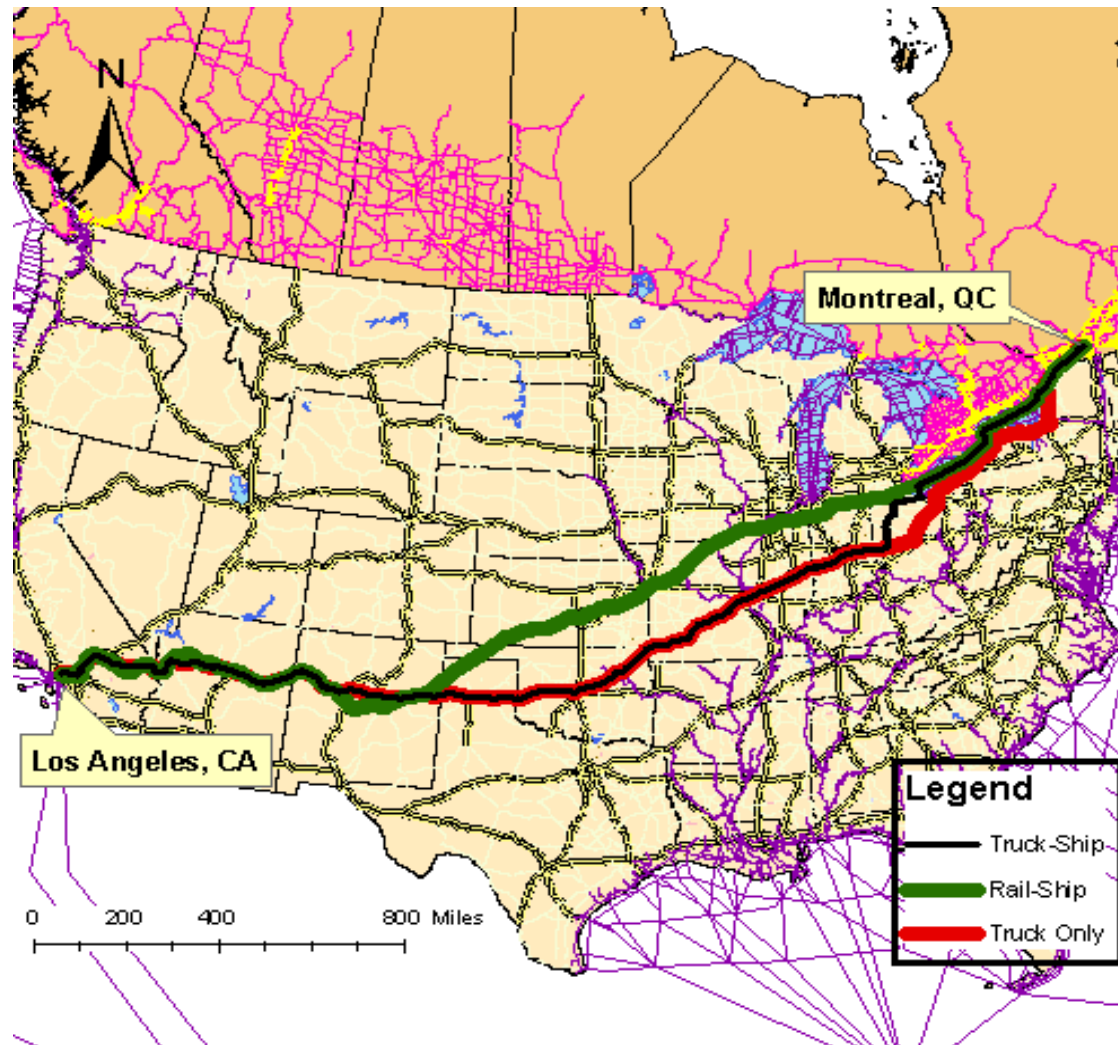# Example #2: Unimodal vs. Intermodal

Memphis to Montreal

GLMRI 2009

Results

Operating Cost Comparison
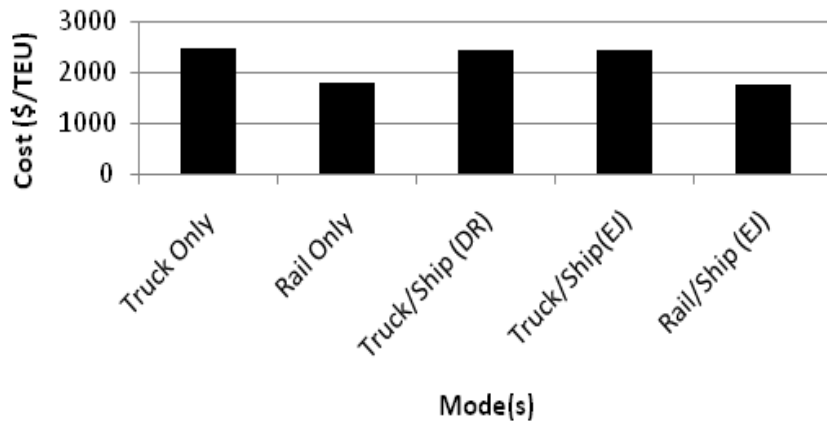
CO2 Emission Comparison
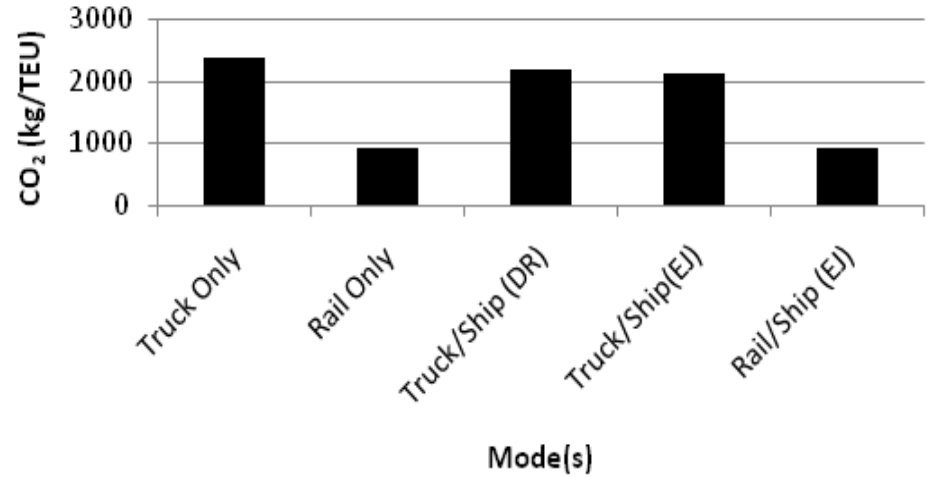
Time-of-Delivery Comparison

GLMRI 2009

Example #3: Long-haul Intermodal

GLMRI 2009

Results

GL-GIFT Demonstration

Great Lakes Maritime Research Institute
A University of Wisconsin - Superior and
University of Minnesota Duluth Consortium

R·I·T

UNIVERSITY OF DELAWARE
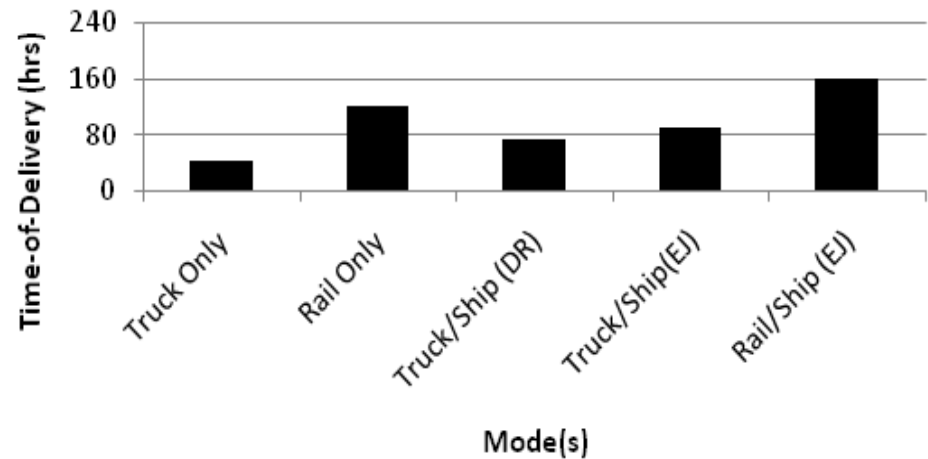
Summary and Next Steps

Summary of Advancements

- Expansion and validation of Great Lakes Region intermodal ports and network

- Integration of emissions and energy use calculator

- Movement to dedicated GIFT server

- Development of multi-objective optimization functions

- Workshop to obtain feedback from users

Summary of Advancements

- Case study exploration
  - Findings
    - Opportunities exist for GLSLS water routes to be competitive and to provide energy and environmental benefits;
    - Benefits depend on modal characteristics and tradeoff sets;
    - Intermodalism potential exists, but infrastructure needed
  - Recommendations:
    - Policies/programs should be supported that are aimed at developing or expanding these routes;
    - Policies/programs may include reducing economic disincentives, expanding intermodal and port facilities, incorporating appropriate costs for alternative modes.

Future Activities

- Extending GL-GIFT to the web (WebGIFT-GL)
- Developing approaches for conducting system-wide analyses
- Looking carefully at some particular routes, including freight ferry opportunities (www.greatlakesports.org):
    - Detroit, MI - Windsor, ON (existing)
    - Cleveland, OH - Port Stanley, ON
    - Erie, PA - Nanticoke, ON
    - Oswego, NY - Hamilton, ON
- Further case study evaluation
- Further model fidelity (canal locks, more sophisticated emissions models, capacity studies, etc.)

WebGIFT-GL Prototype

Conclusion