Geographic Information Systems – Applications in Transportation

For

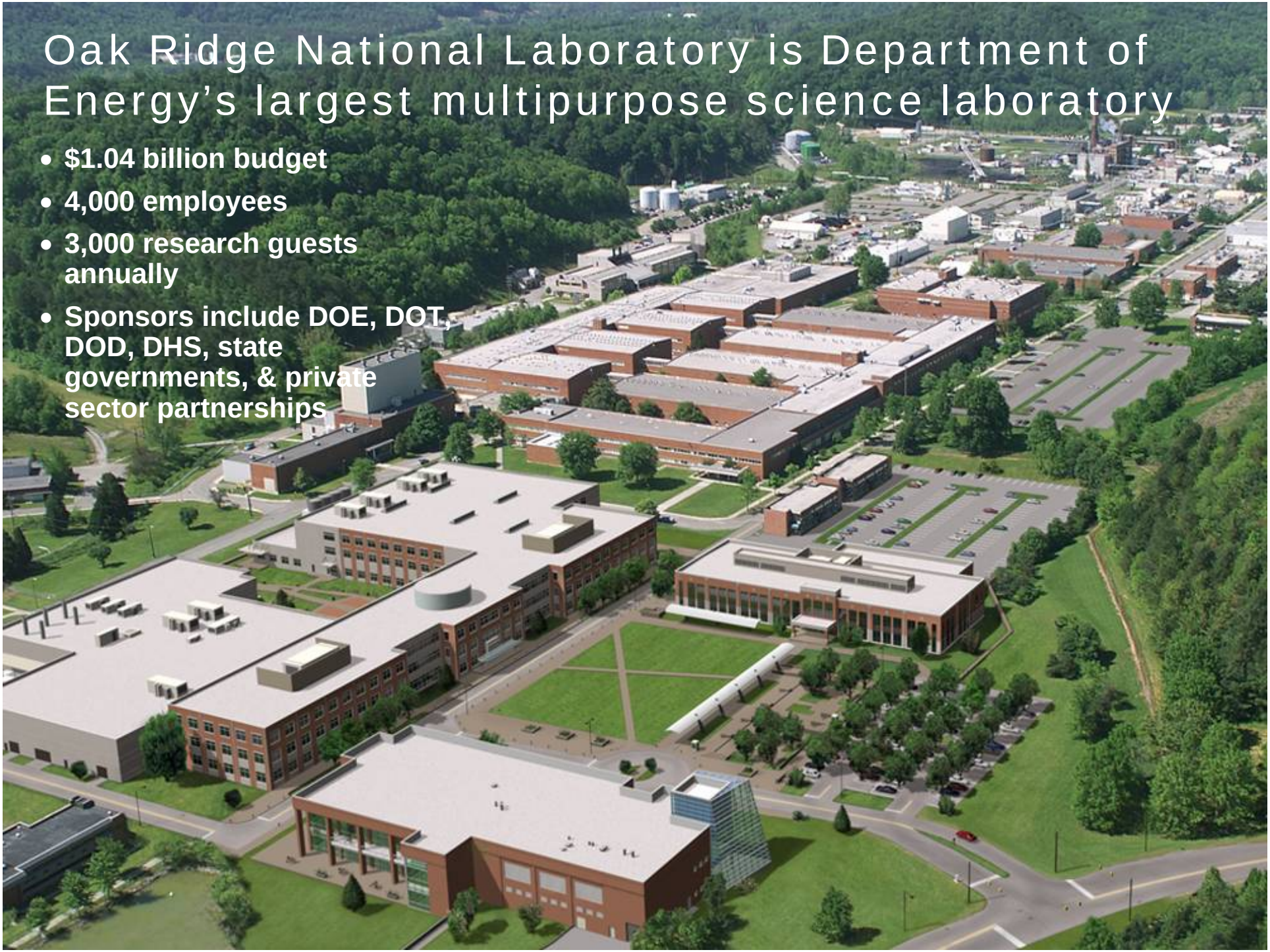
GIS Day
University of Kansas

15 November 2006

Glen Harrison, PhD
Center for Transportation Analysis
Oak Ridge National Laboratory

Oak Ridge National Laboratory is Department of Energy's largest multipurpose science laboratory

- **$1.04 billion budget**
- **4,000 employees**
- **3,000 research guests annually**
- **Sponsors include DOE, DOT, DOD, DHS, state governments, & private sector partnerships**




File Edit View Favorites Tools Help
Back Search Favorites
Address http://cta.ornl.gov/cta/
Go
CTA
Center for Transportation Analysis
Oak Ridge National Laboratory
Engineering Science and Technology Division
About CTA
Research Areas
Staff Directory
Publications
Contact
On-Line Tools
Site Map
Search
Links
NEWS
In the News: ORNL doing yearlong study on long-haul trucks.
New Report: Biomass Energy Data Book: Edition 1
More...
WebMaster
October 2006
Disclaimer
Trusted sites

Outline

- Introduction
- Commercial Applications
  - Aviation
  - Railroads
  - Waterways
  - Motor Carrier
  - Private automobile
- Government Applications
  - State and Local government
  - Federal government
- Future Trends

GIS-T Defined

- **GIS-T is interconnected system of hardware, software, data, people, organizations, and institutional arrangements for collecting, storing, analyzing, and disseminating information about areas of the earth that are used for, influenced by, or affected by transportation activity.**

Reference: David R. Fletcher, *Geographic Information Systems For Transportation: A Look Forward*, Transportation Research Board, Committee on Safety Data, Analysis, and Evaluation, Washington, DC, 2000.

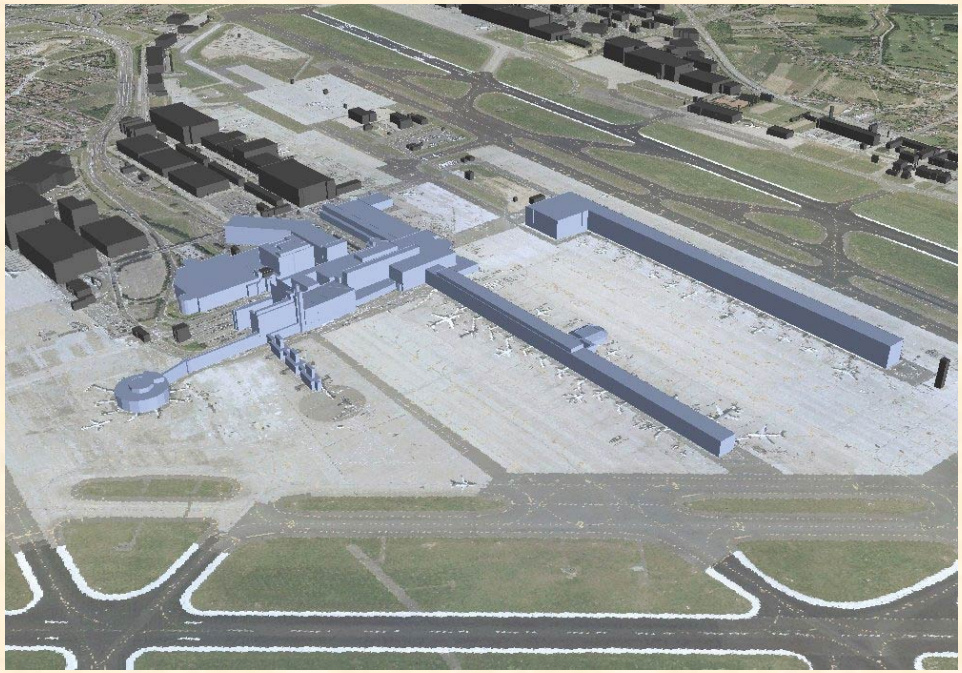
Commercial Applications

- **Aviation**
- **Railroads**
- **Waterways**
- **Motor Carrier**
- **Private automobile**

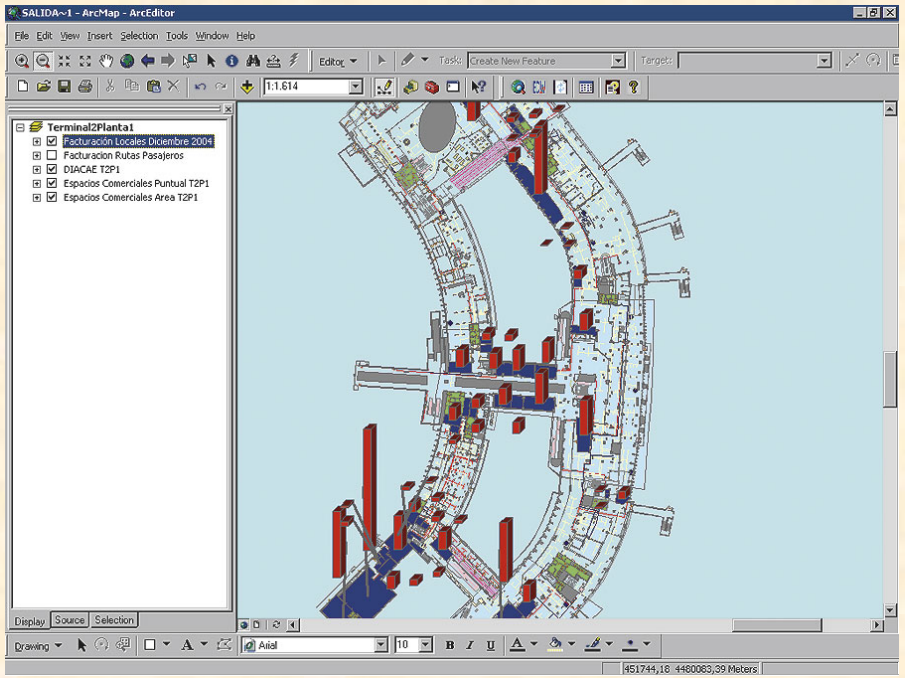
Commercial Applications - Aviation

- **Airport management**
  - **Facilities planning and management**
    - **Passenger and cargo facilities**
    - **Runway**
    - **Traffic management and parking**
    - **Land use management around the airport**
    - **Security**
    - **Air Traffic Management**
  - **Environmental compliance**
    - **Noise management**
    - **Water runoff**

Commercial Applications - Aviation

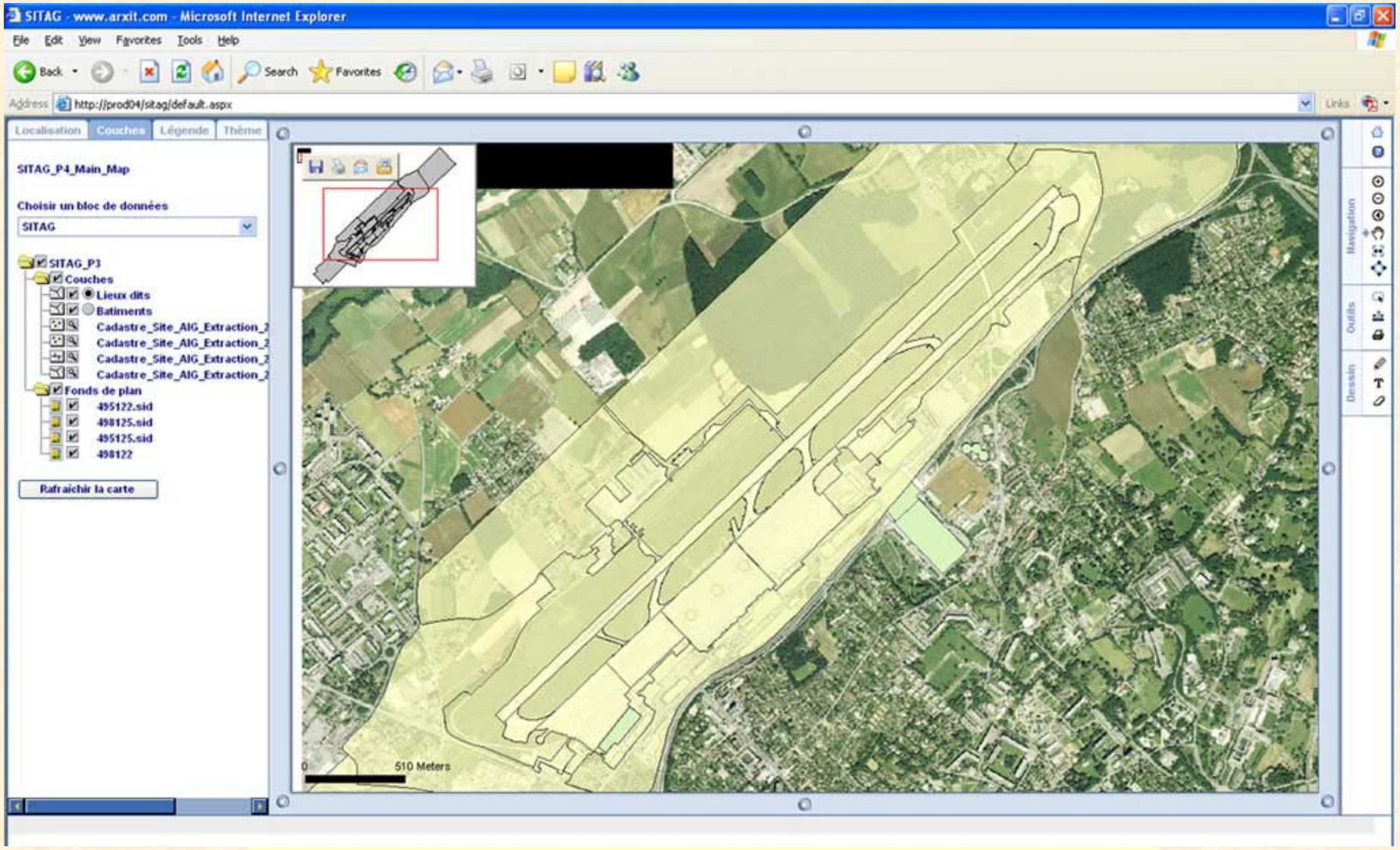


Airport Facilities Management at Brussels International Airport



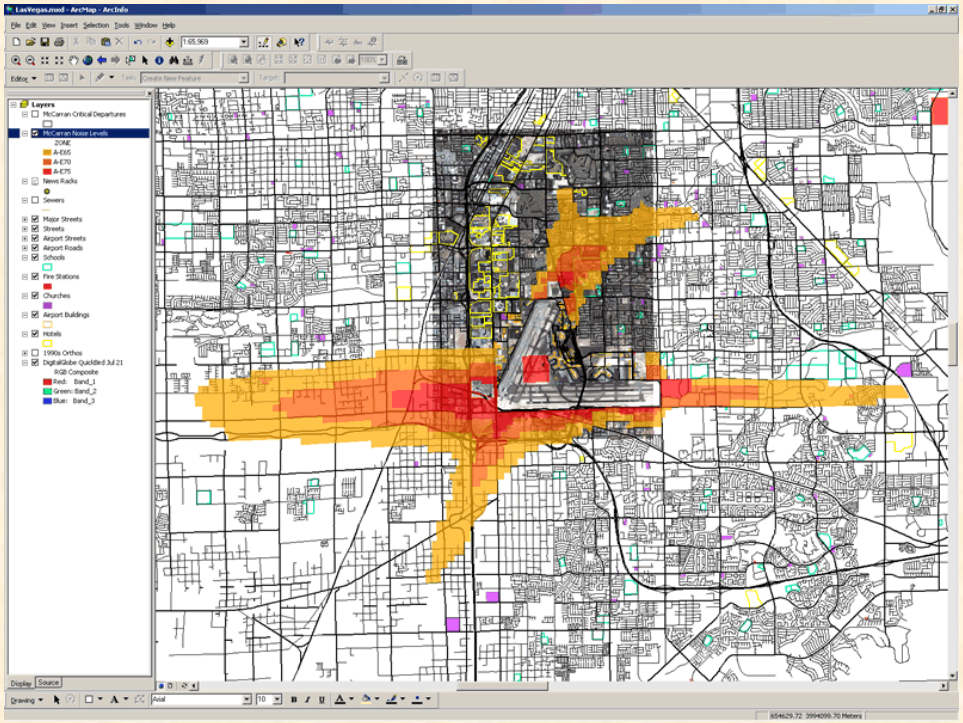
Airport Facilities Management at Madrid International Airport

Commercial Applications - Aviation

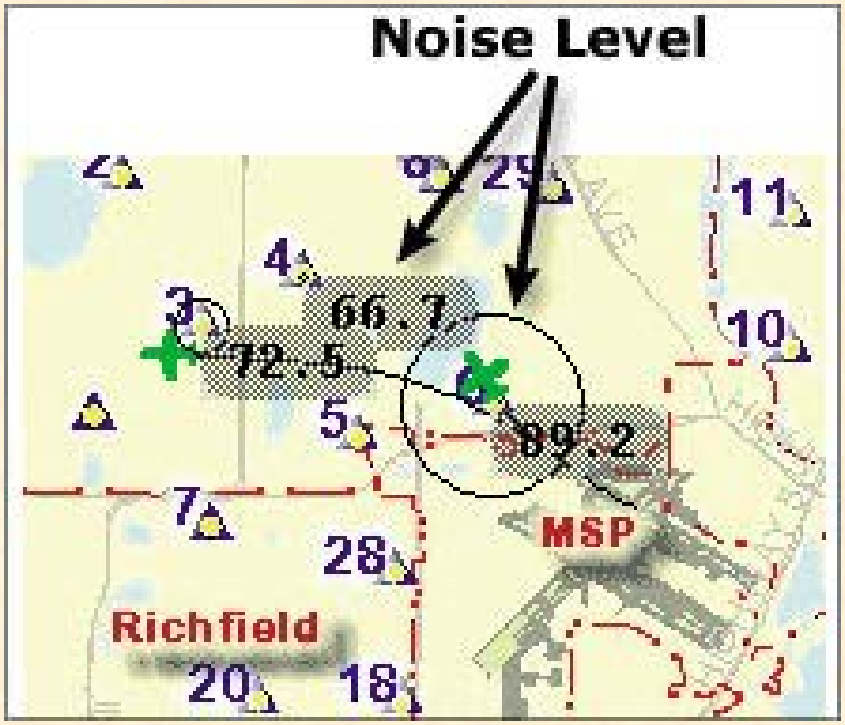


Land use around the Geneva International Airport.

Commercial Applications - Aviation



Noise contour information at McCarran Airport in Las Vegas, Nevada.



Minneapolis-St. Paul International Airport Noise Information System

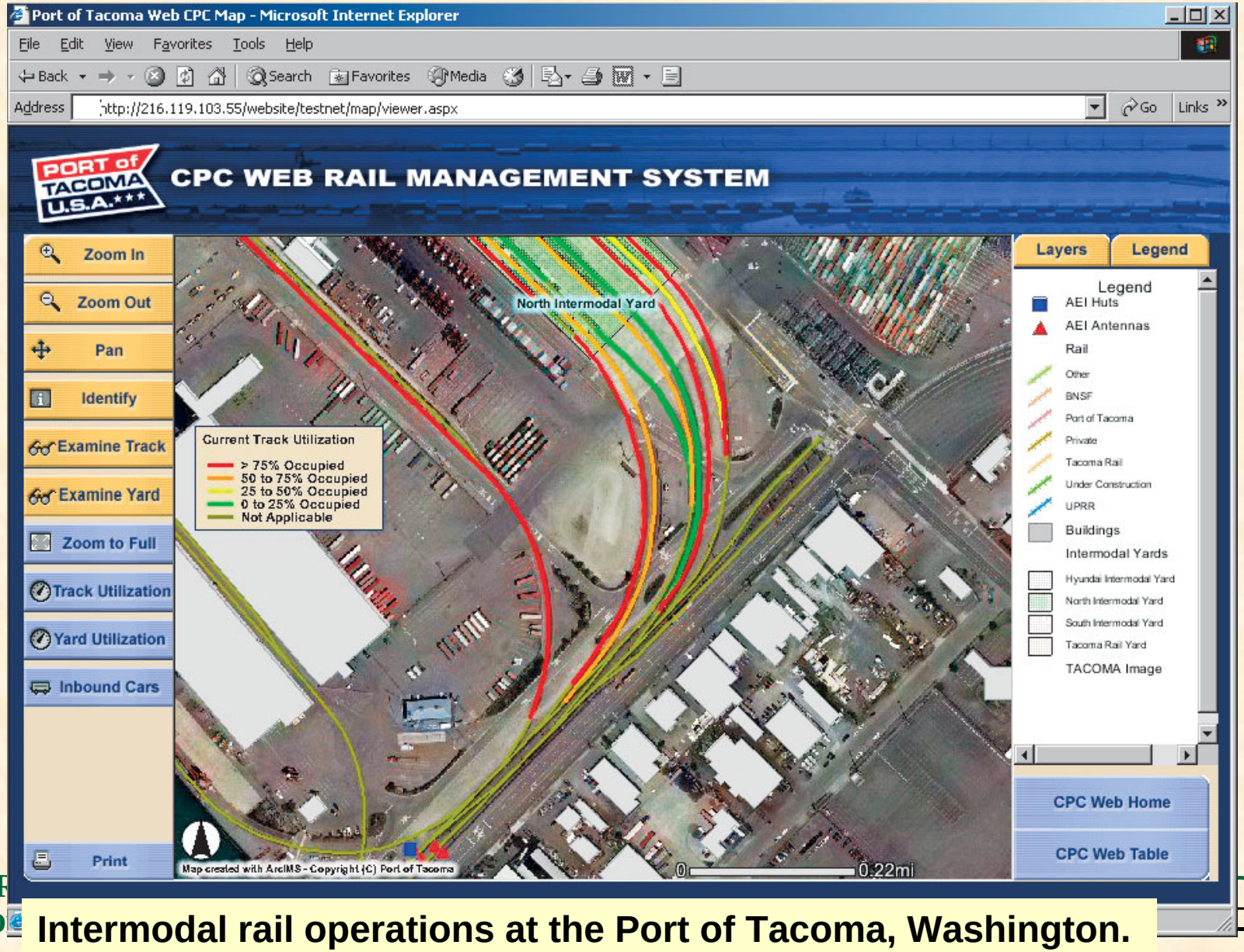
Commercial Applications - Railroads

- **Infrastructure management**
  - Bridges, tunnels, and tracks
  - Communications, signaling, and electric power networks
  - Rail yards
  - Intermodal operations (motor carrier and ports)
- **Rail Operations**
  - Rolling stock management (cars and locomotives)
- **Planning**

Commercial Applications - Railroads

Rail yard management.

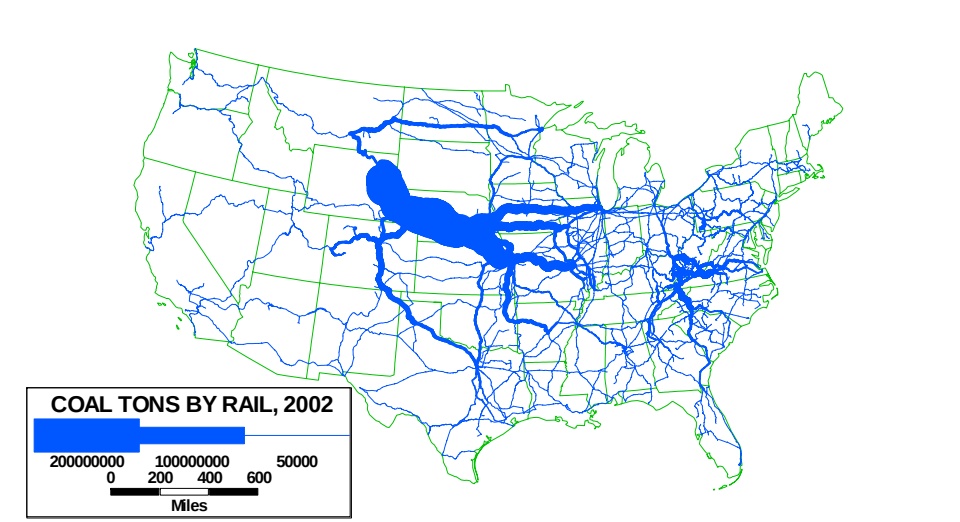
Commercial Applications - Railroads



Intermodal rail operations at the Port of Tacoma, Washington.

Commercial Applications - Railroads

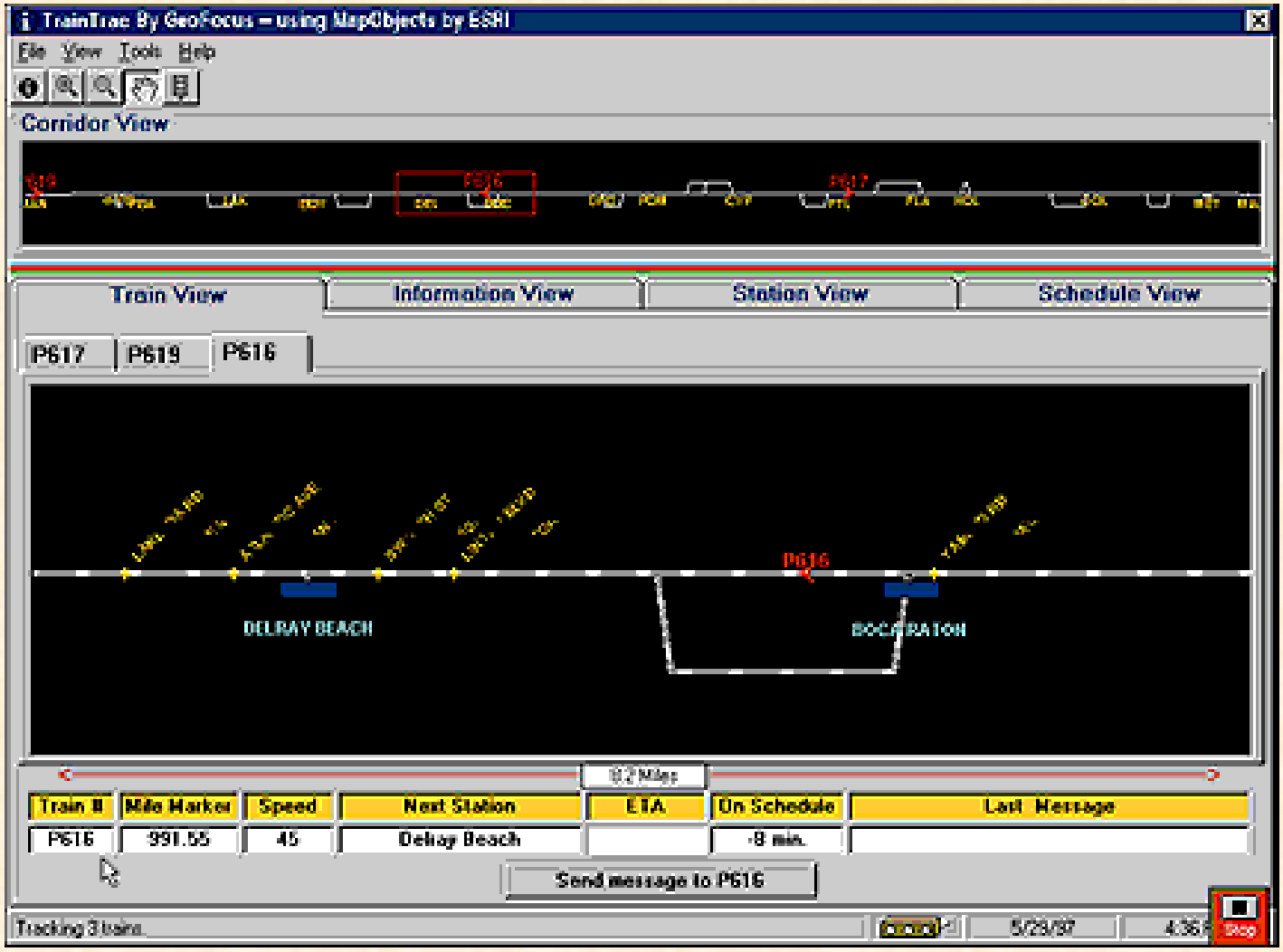
Rail Resource Planning



Coal shipments by rail

Wheat shipments by rail

Commercial Applications - Railroads

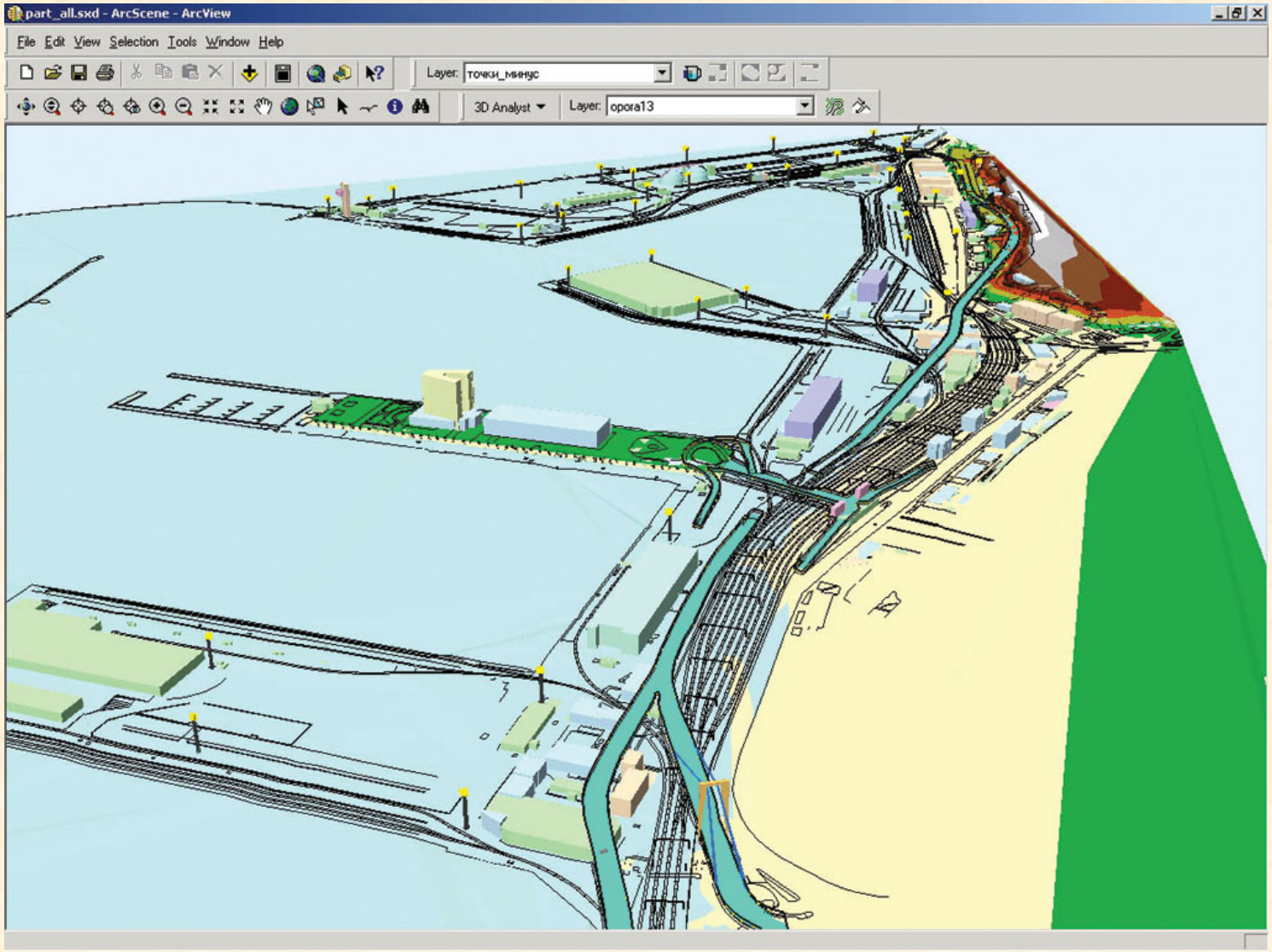


Rolling stock tracking on a line near Delray Beach, Florida.

Commercial Applications - Waterways

- **Port operations and management**
  - **Facilities management and planning**
  - **Ship traffic management**
- **Rivers and inland waterways management**
- **Barge operations and tracking**

Commercial Applications - Waterways

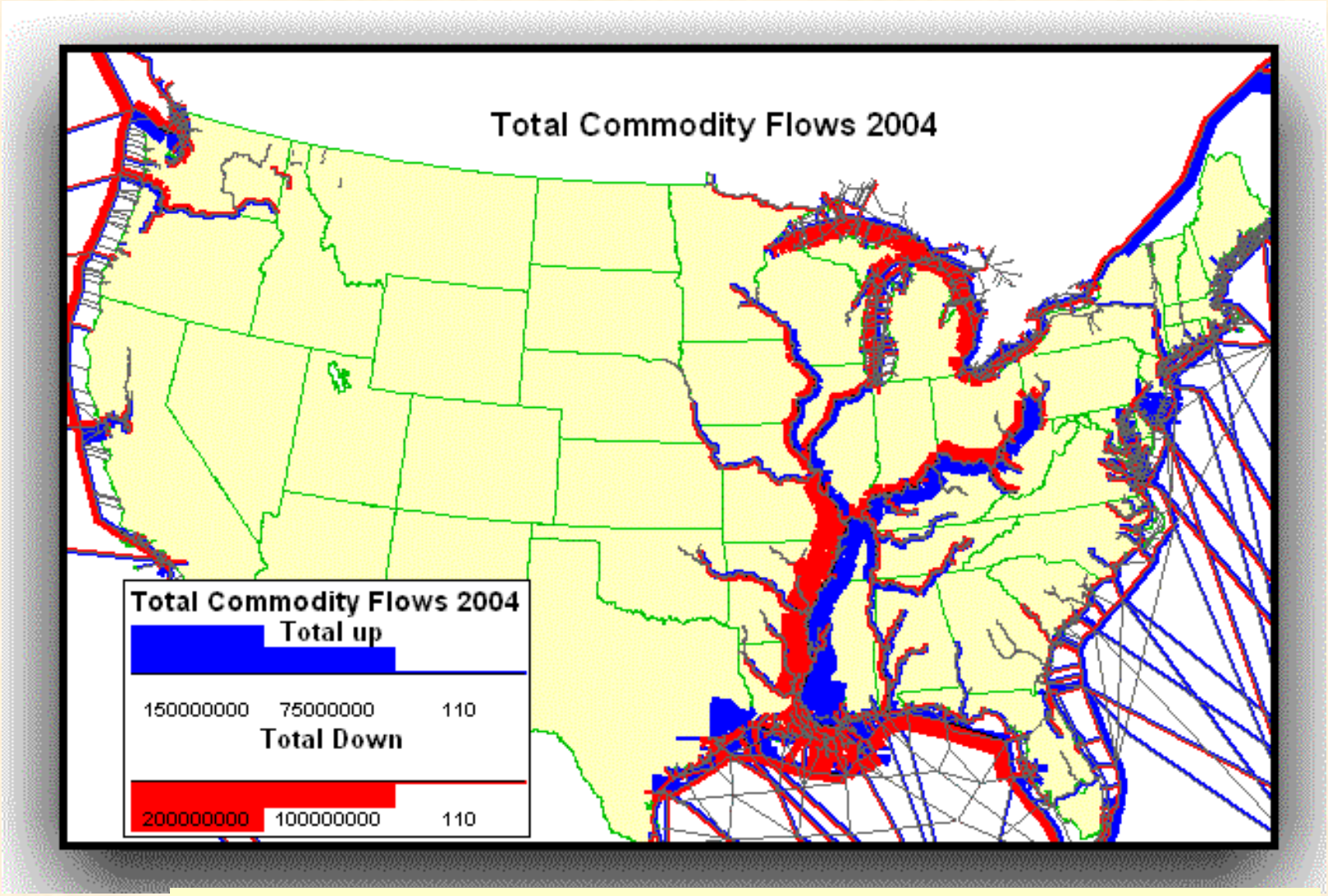


3D GIS model of the Port of Odessa, Ukraine used for facilities management and planning

Commercial Applications - Waterways

Ship navigation management in the port of Rotterdam, Netherlands

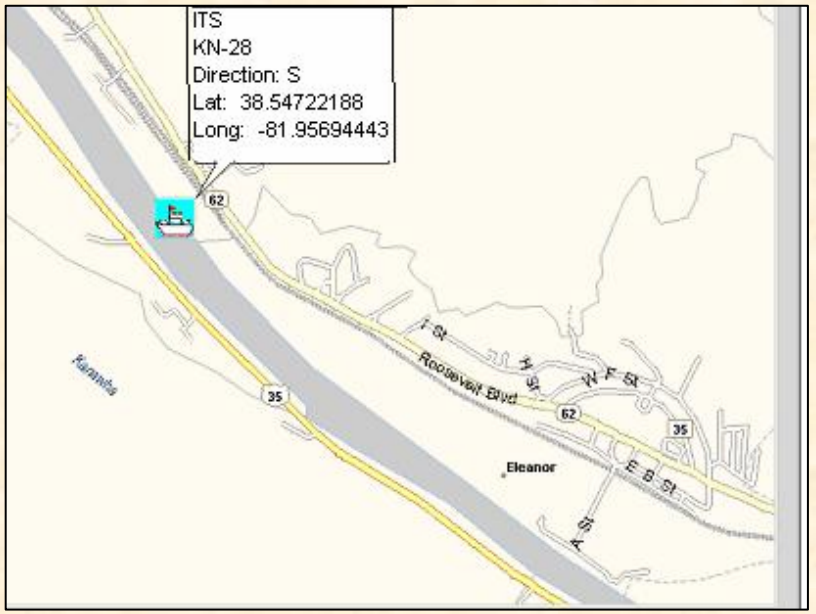
Commercial Applications - Waterways



Corps of Engineers Commodity Flow Map is used in inland waterway navigation infrastructure investment planning

Commercial Applications - Waterways

Barge Tracking on the Inland Waterways



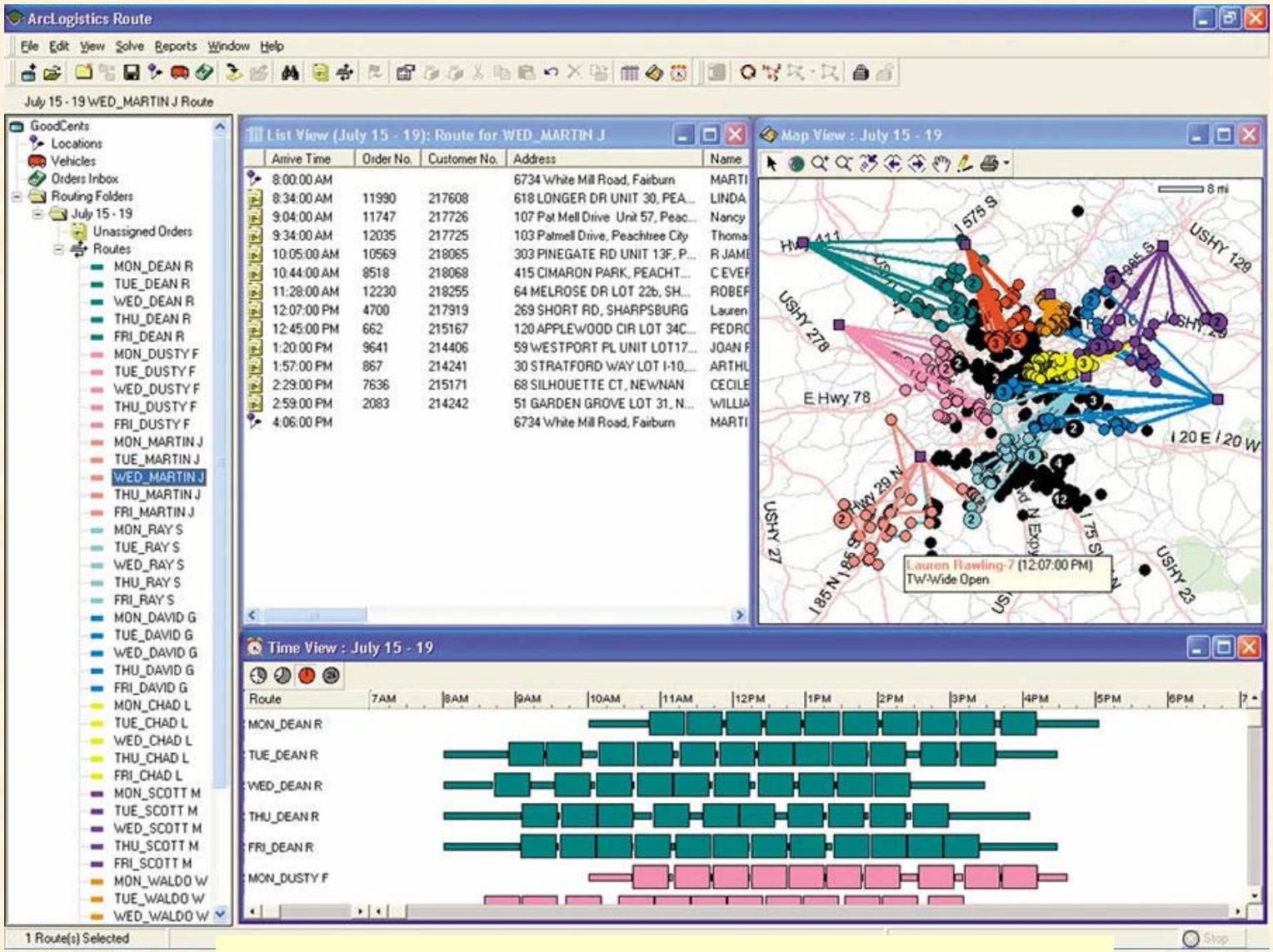
Regional Level on the Ohio River

Local Level on the Kanawha River, WV

Commercial Applications - Motor Carrier

- **Fleet management of tractors and trailers**
- **Routing and scheduling of the fleet through a sequence of delivery and pick-up stops**
- **Motor Carrier Tracking**
- **In-transit visibility for the carrier and customer**

Commercial Applications - Motor Carrier



GIS ArcLogistics Route software used for planning for multiple delivery routes.

Vehicle Location Technology using Global Positioning System

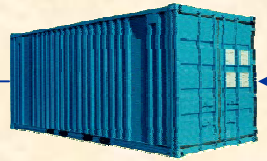
Transportation Operations Center

Download Location Information

Rail Car

Tractor

Trailer



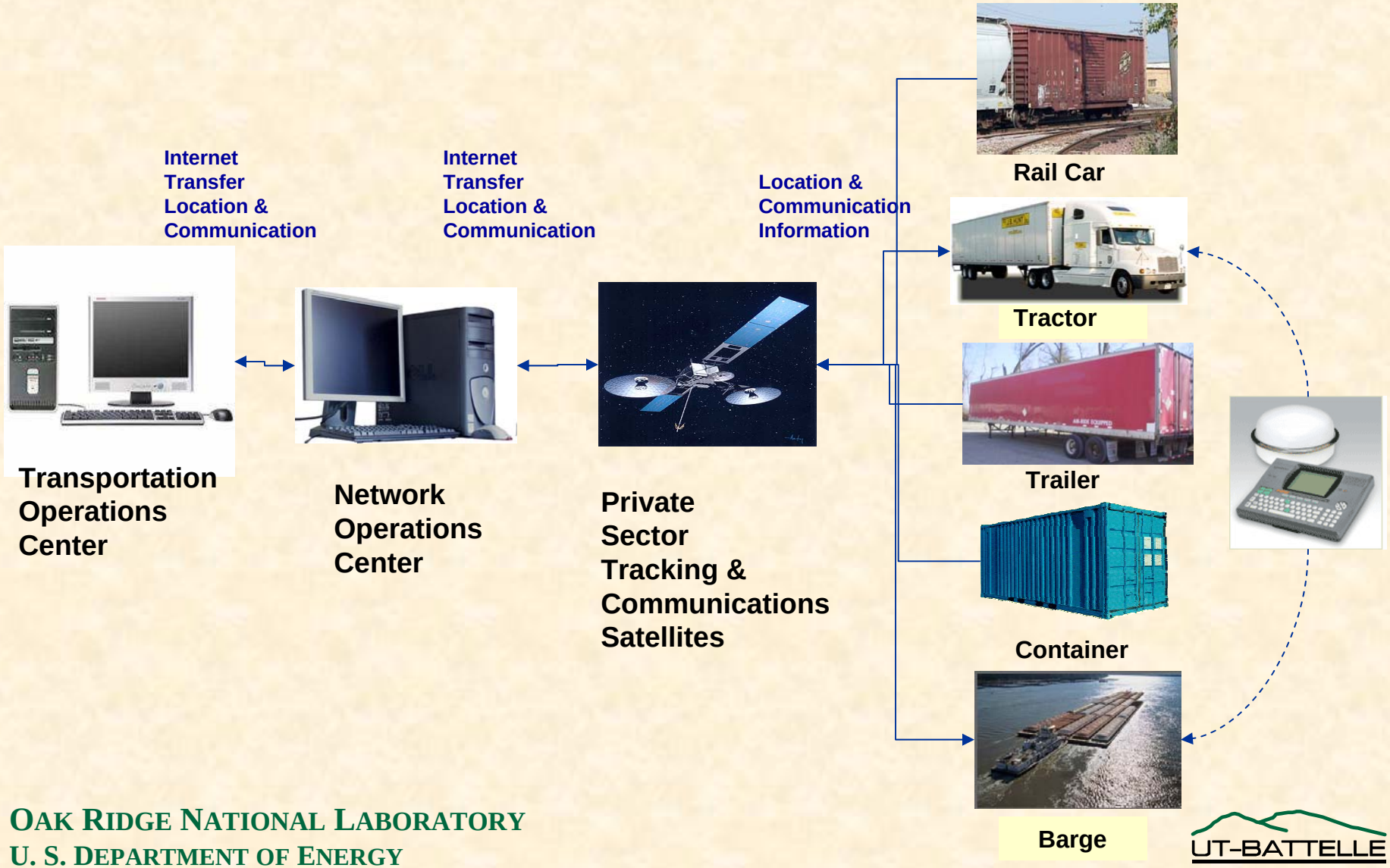
Container

Barge

Location Information

Vehicle Location Technology using Global Positioning System Satellites and Mobile Telephone System

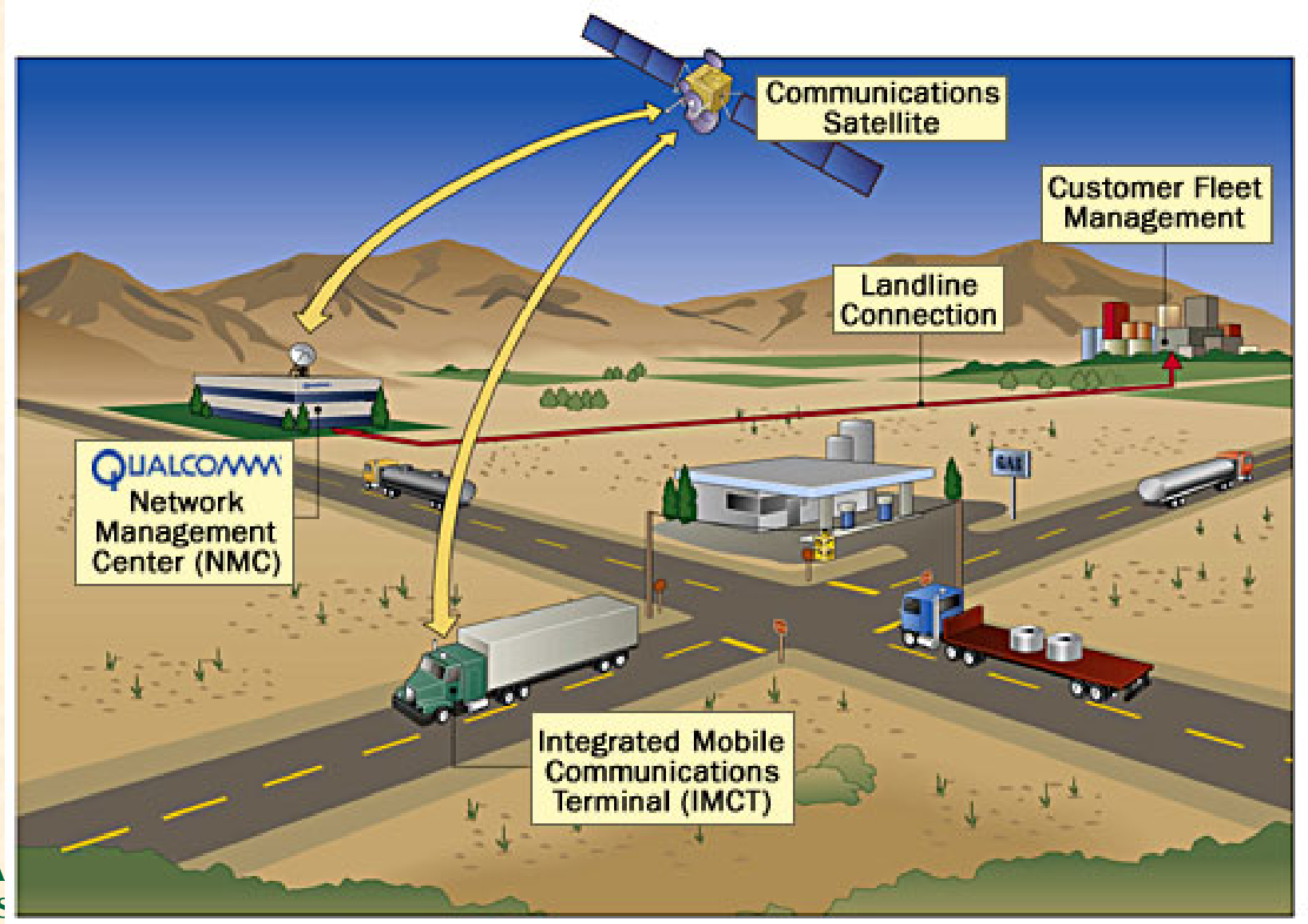
Vehicle Location Technology using Global Location and Communication Satellite



Vehicle Location Technology using Global Location and Communication Satellite

- **Qualcomm Equipment**

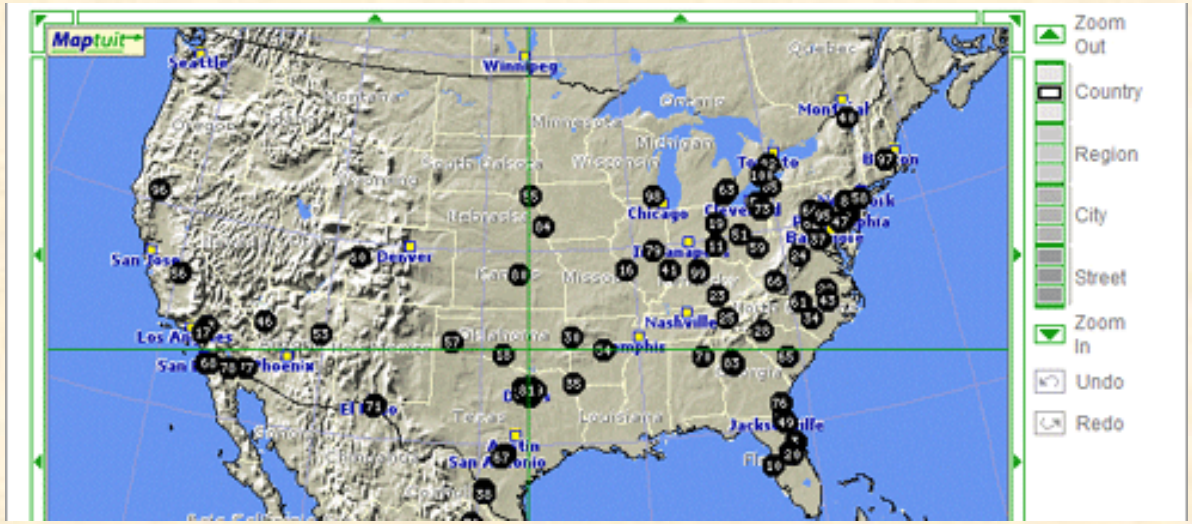
Vehicle Location Technology using Global Location and Communication Satellite



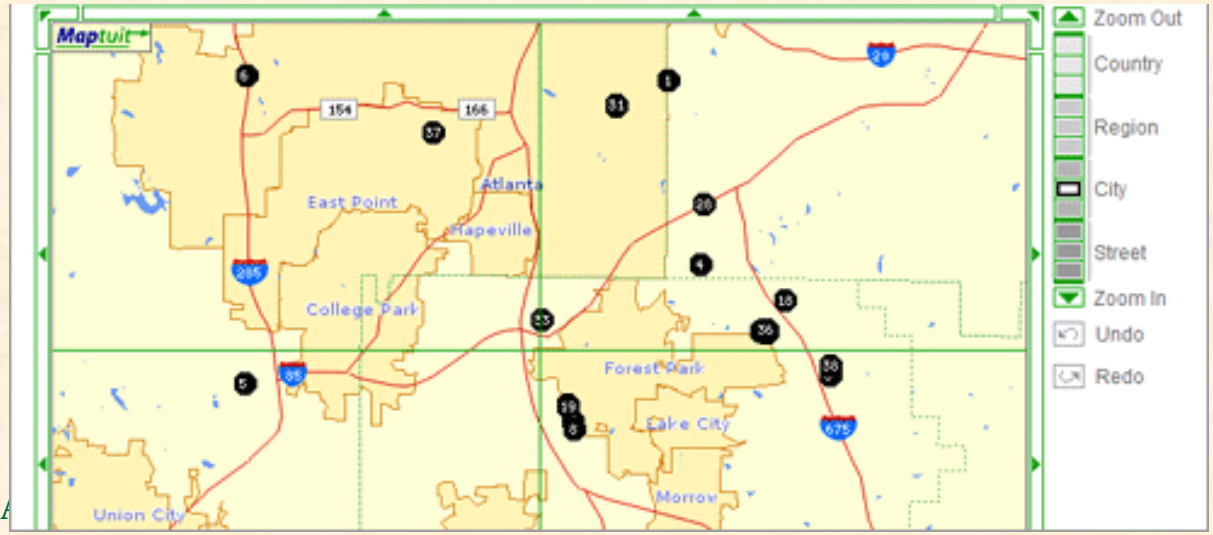
Commercial Applications - Motor Carrier

- **Information**
  - **Location – current and past**
  - **Speed and vehicle performance (tire pressure, engine performance, fuel levels) data**
  - **Direction**
  - **History**
  - **Loading and unloading times**
  - **Tractor to trailer matching**
  - **Trailer door opening tracking**
  - **Next step is video of load in the trailer or container**

Motor Carrier Tracking

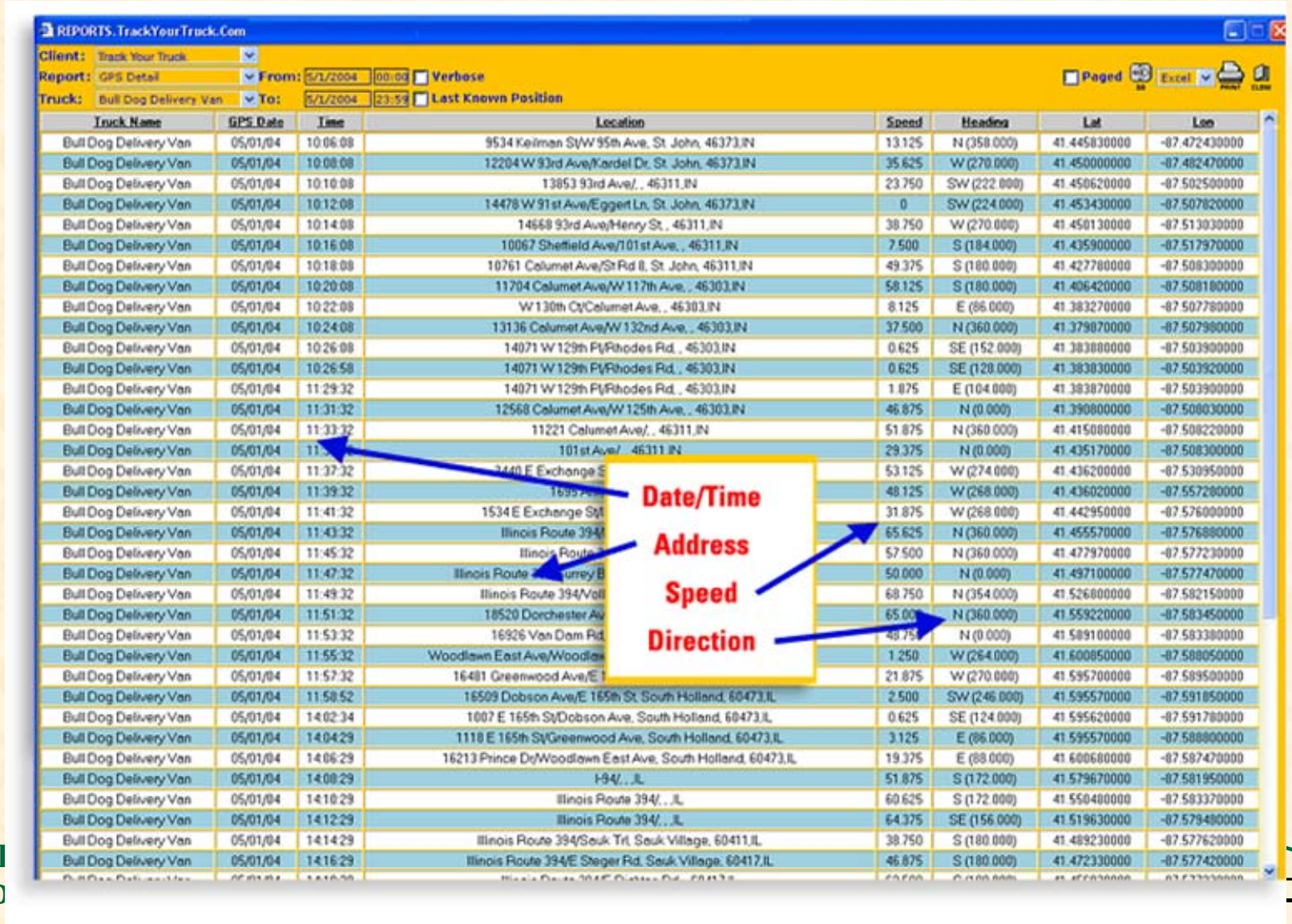


National Level



Local Level

Details on Motor Carrier Activity



Private automobile – In vehicle navigation

Systems such as Magellan provide in car location using GPS, combined with digital road maps, geocoded addresses, vehicle routing algorithms, and voice assisted directions to a destination.

Government Applications

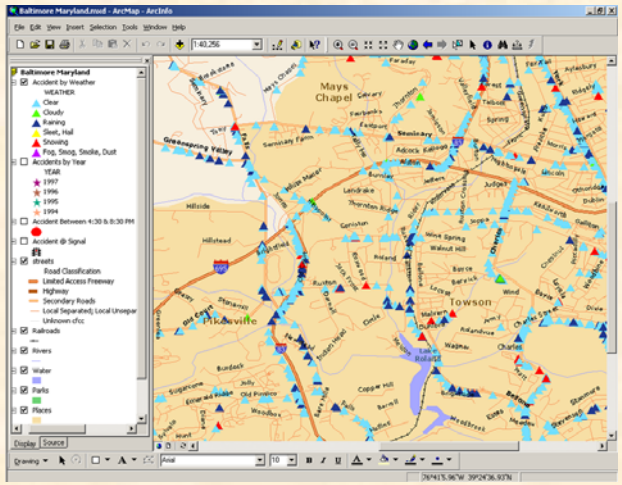
- State and Local government
- Federal government

Government Applications – State and Local Government

- **Roadway Management**
  - **Accident analysis**
  - **Maintenance management**
  - **Work Zones**
- **Planning and design for future transportation systems**
  - **Highway**
  - **Transit**
- **Operations**
  - **Driver information**
  - **Incident management**

State and Local Government - Roadway Management

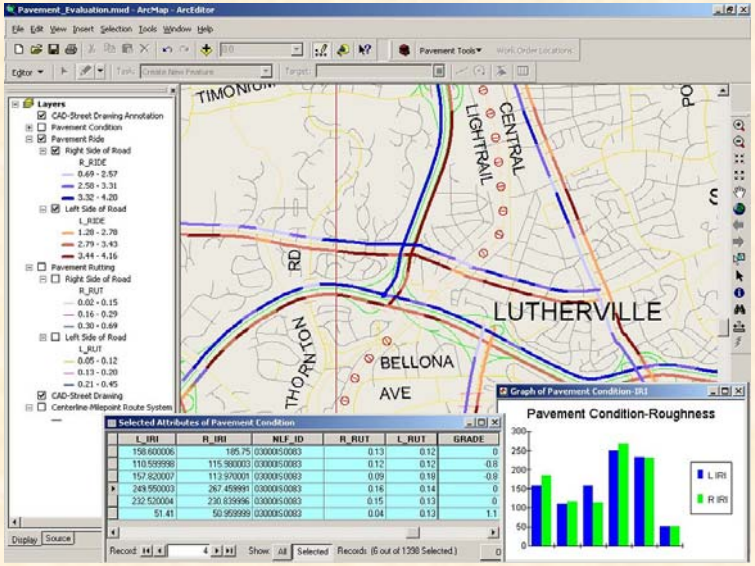
Highway accident location and report.



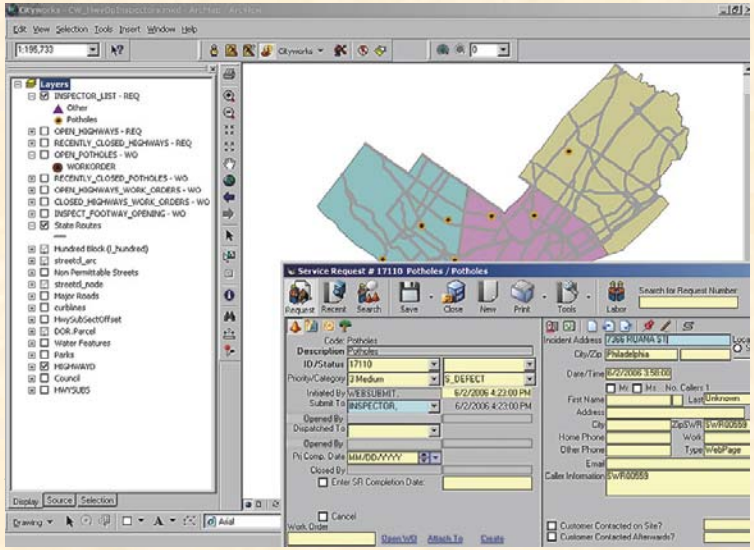
Work Zone Locations.

State and Local Government - Roadway Management

Pavement, bridge, and other infrastructure management and maintenance.

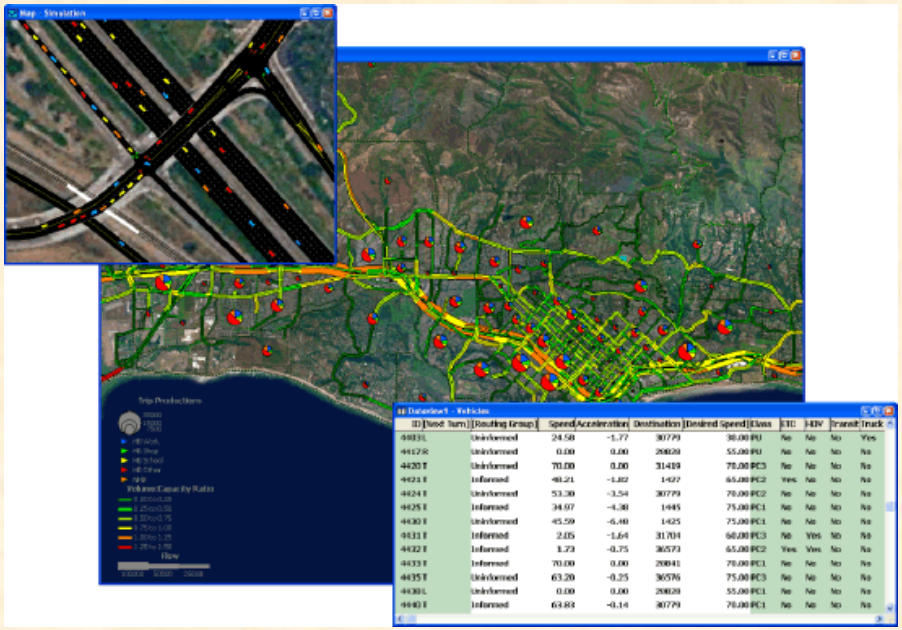


Work Order Management System for **Potholes.**

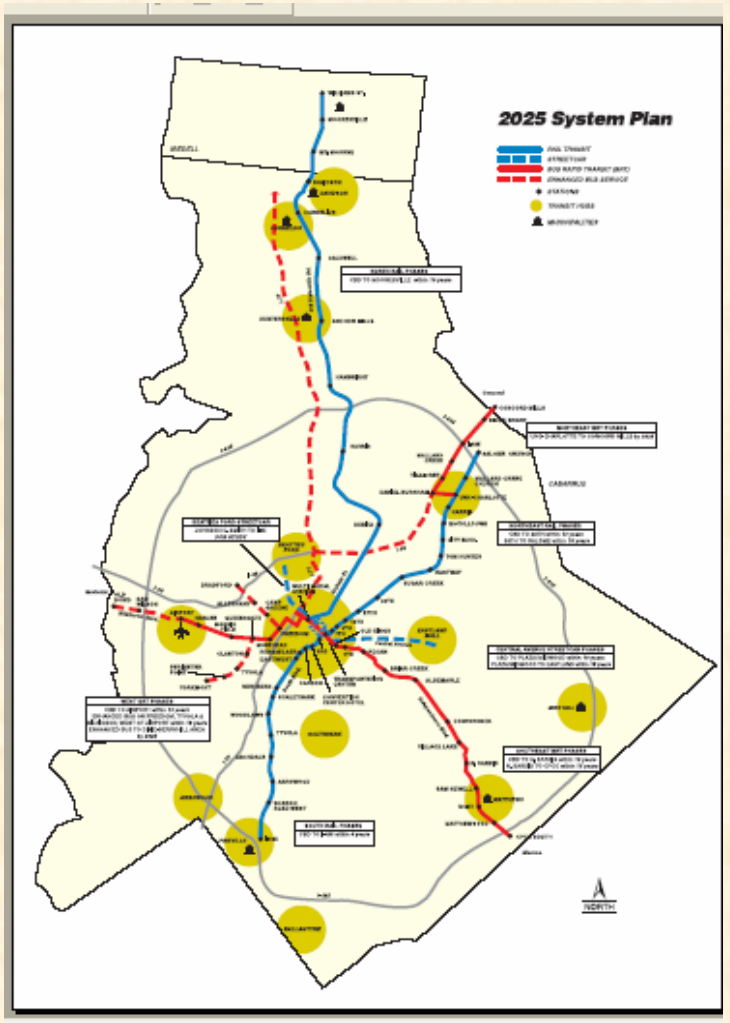


UT-BATTELLE

State and Local Government - Planning and design for future transportation systems



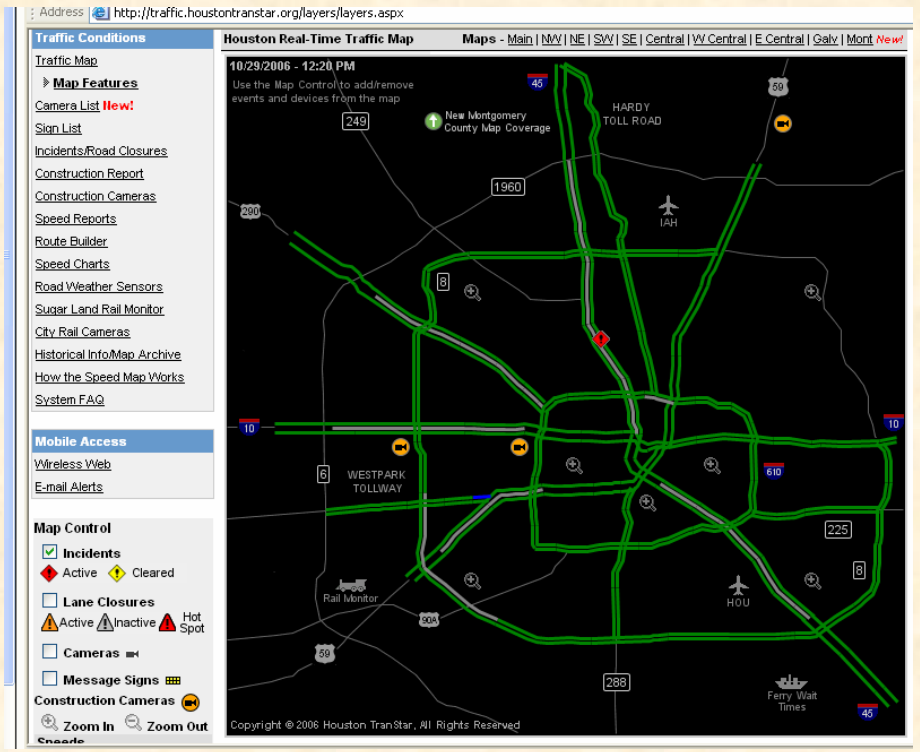
TransModeler used for travel demand forecasting for evaluating the traffic impacts of future planning.



Transit system planning for the Charlotte, NC region.

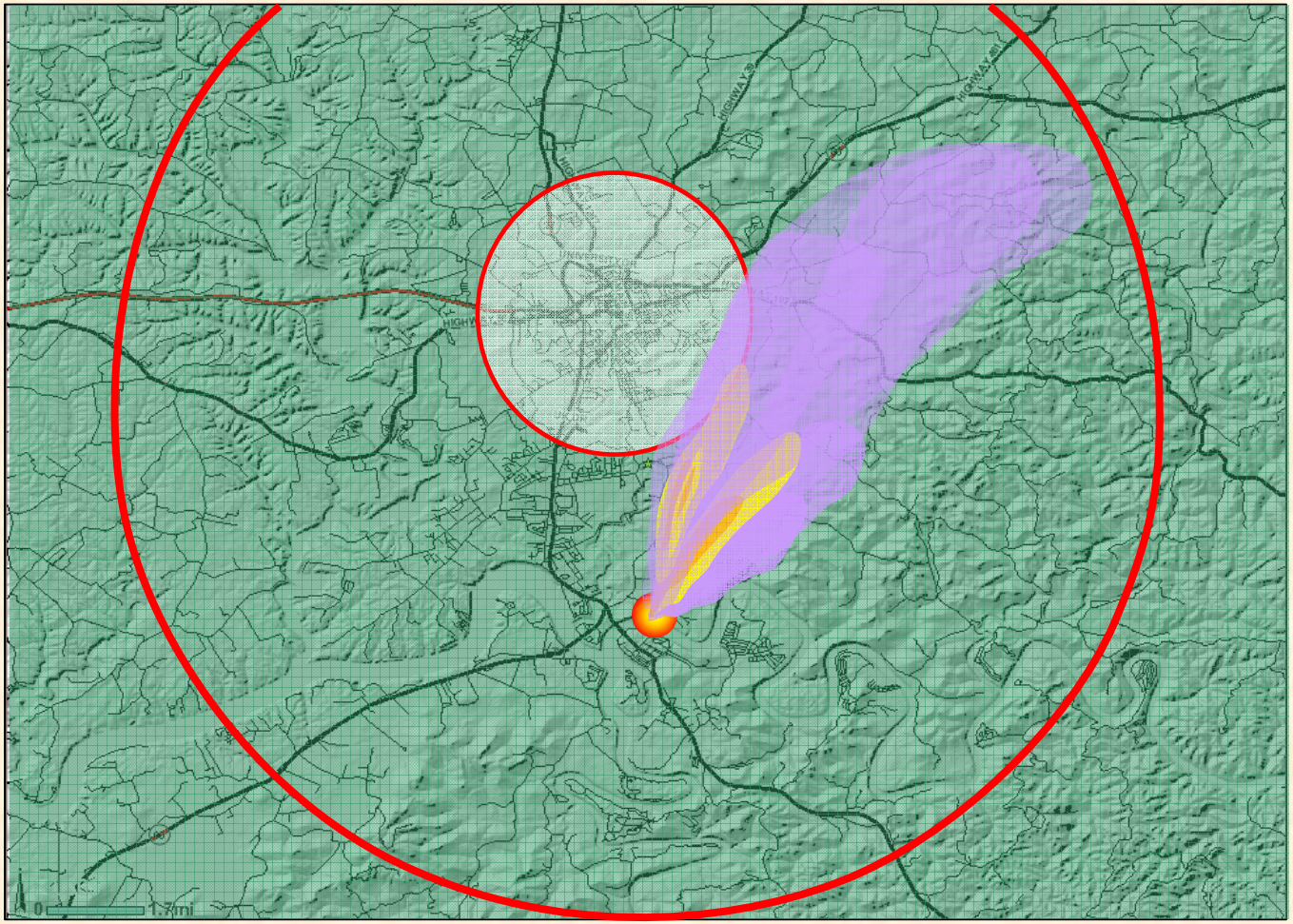
State and Local Government – Operations

Traffic conditions map in Kentucky

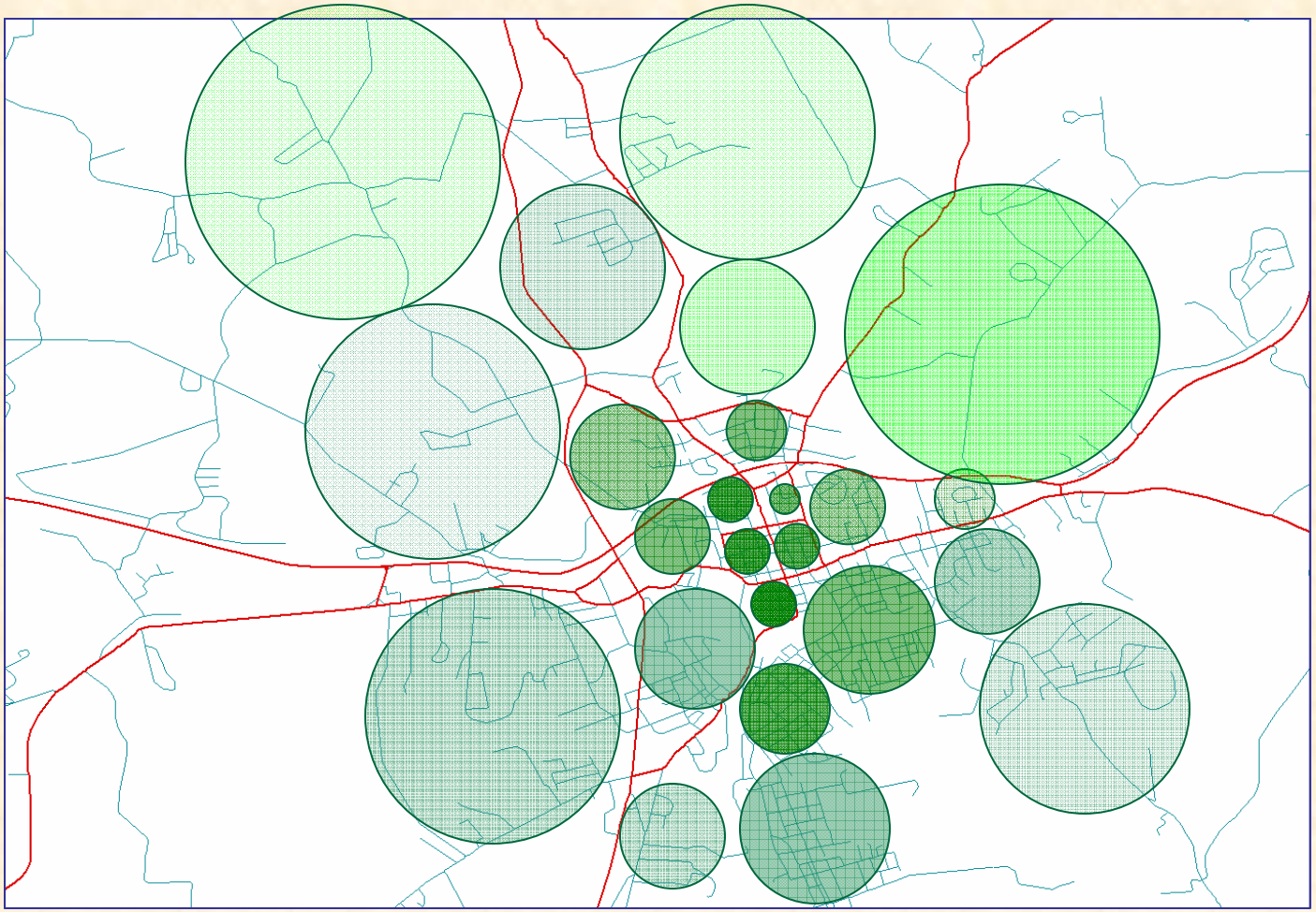


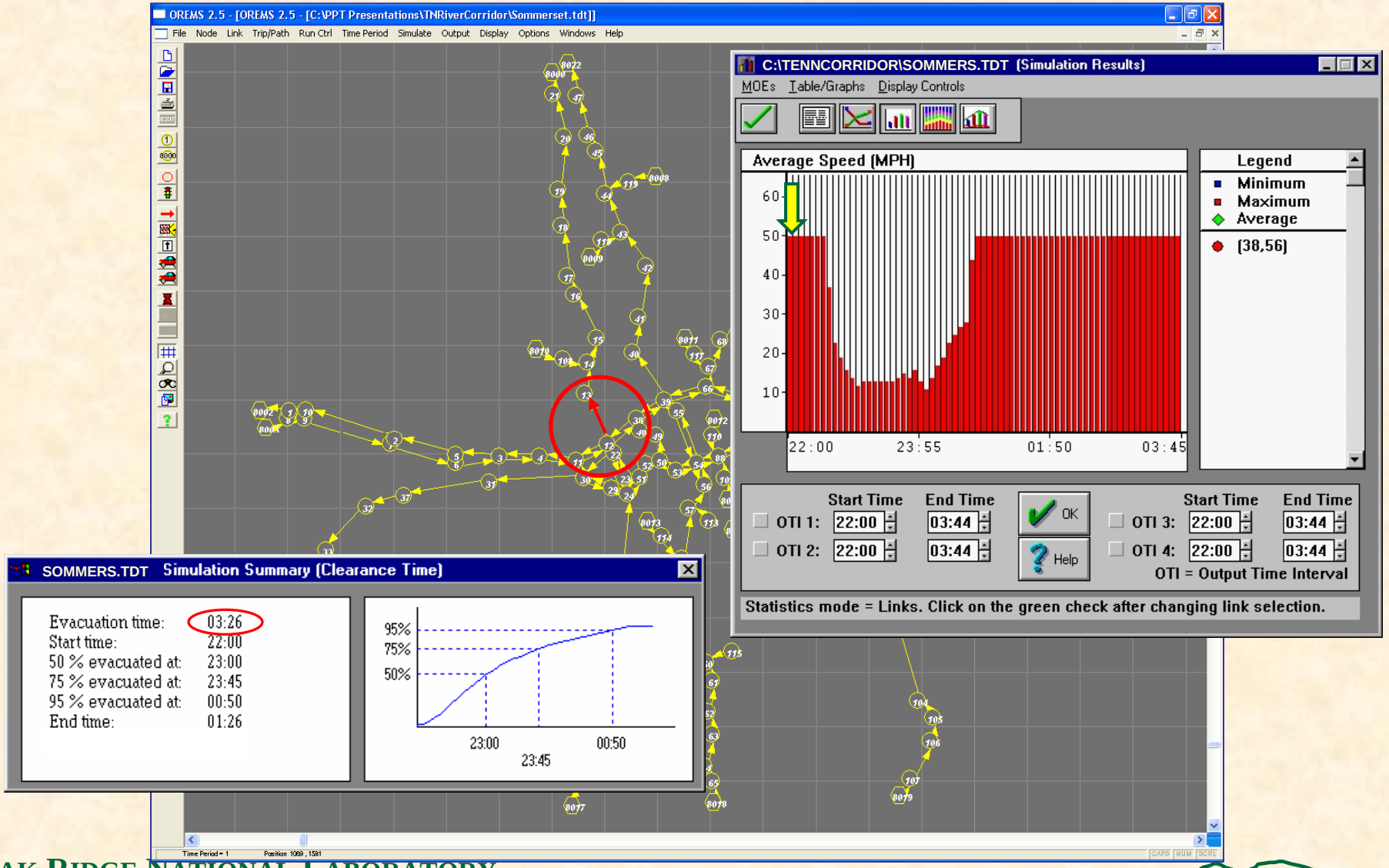
Traffic conditions map in Houston

State and Local Government - Evacuation Modeling

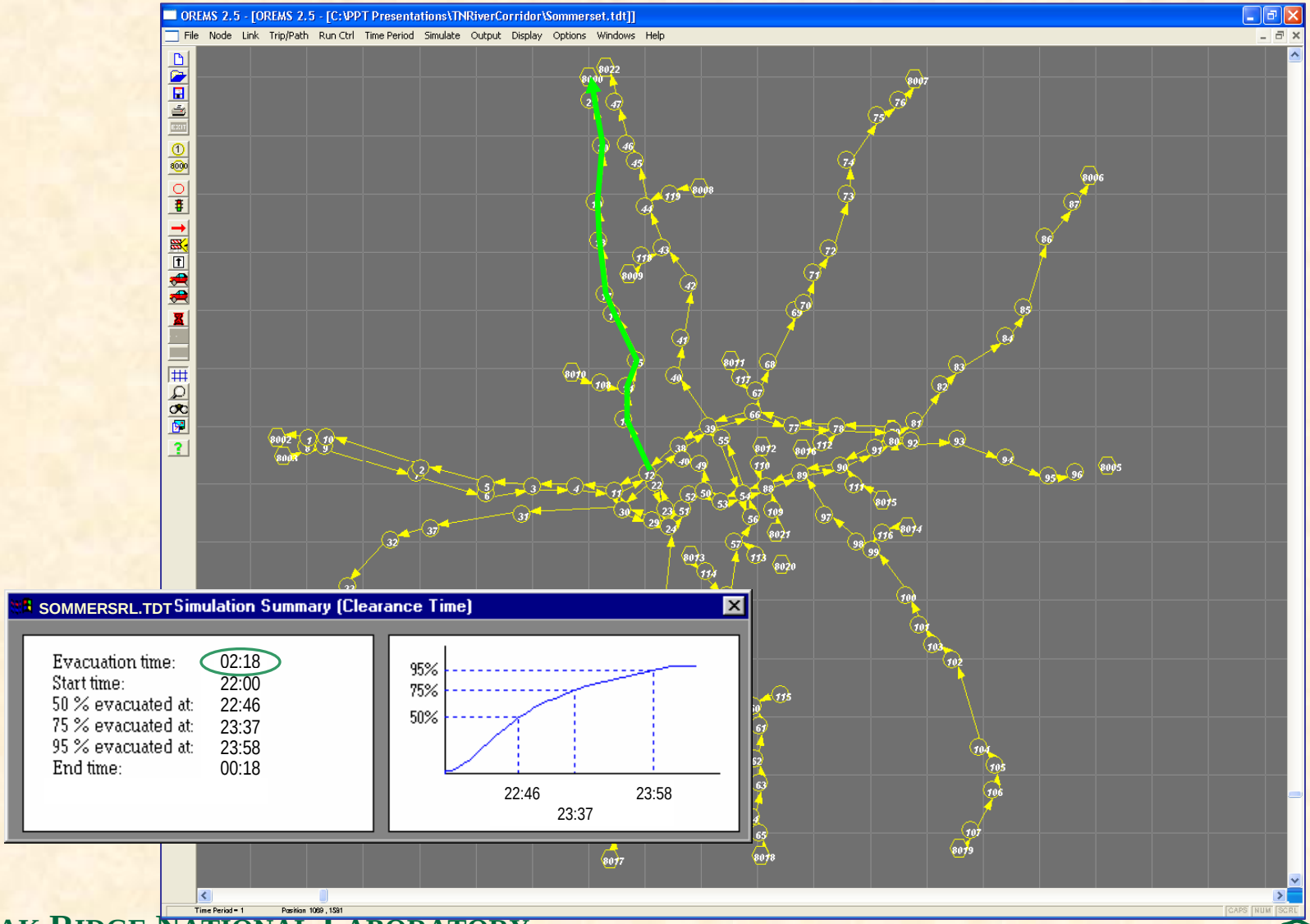


Evacuation Model Inputs




OREMS 2.5 - [OREMS 2.5 - [C:\PPT Presentations\TNRiverCorridor\Sommerset.tdt]]
File Node Link Trip/Path Run Ctrl Time Period Simulate Output Display Options Windows Help
C:\TENNCORRIDOR\SOMMERS.TDT (Simulation Results)
MOEs Table/Graphs Display Controls
Average Speed (MPH)
60
50
40
30
20
10
22:00
23:55
01:50
03:45
Legend
Minimum
Maximum
Average
(38,56)
Start Time
End Time
OTI 1: 22:00 03:44
OTI 2: 22:00 03:44
OTI 3: 22:00 03:44
OTI 4: 22:00 03:44
OK
Help
OTI = Output Time Interval
Statistics mode = Links. Click on the green check after changing link selection.
SOMMERS.TDT Simulation Summary (Clearance Time)
Evacuation time: 03:26
Start time: 22:00
50 % evacuated at: 23:00
75 % evacuated at: 23:45
95 % evacuated at: 00:50
End time: 01:26
95%
75%
50%
23:00
23:45
00:50

Traffic Management Strategy

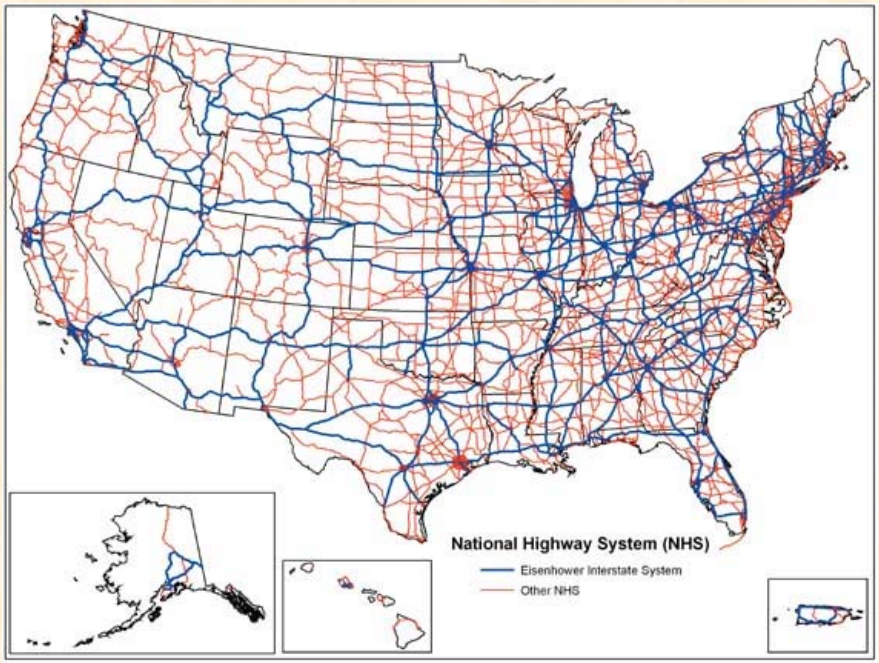


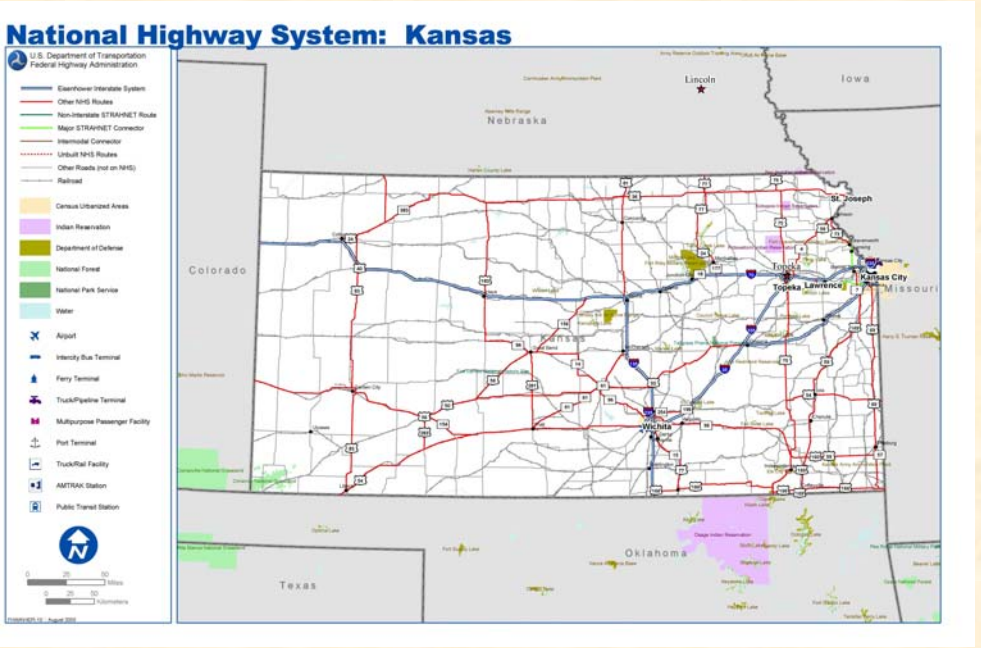
Government Applications – Federal Government

- **Examples from the:**
  - **Department of Transportation**
  - **Department of Defense**
  - **Department of Energy**
  - **Department of Homeland Security**

Federal Government – US Department of Transportation

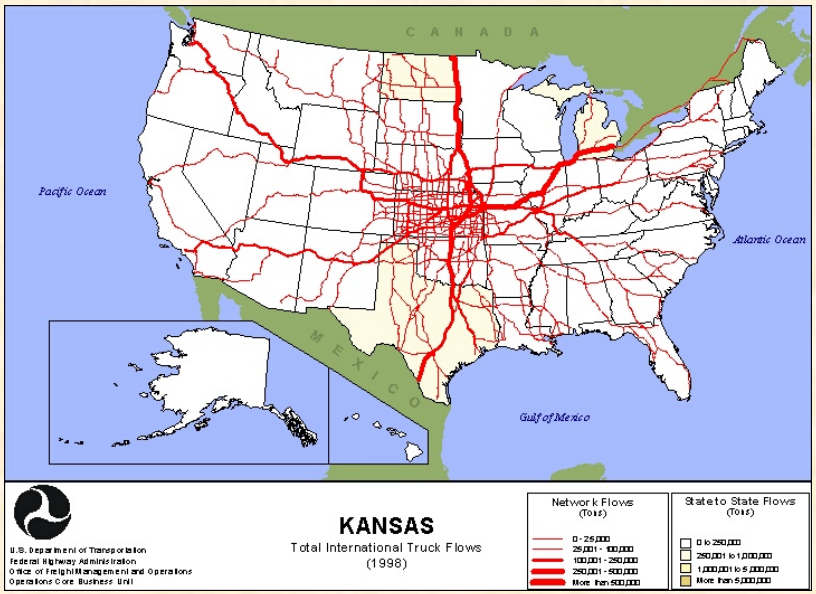
National Highway Planning Network

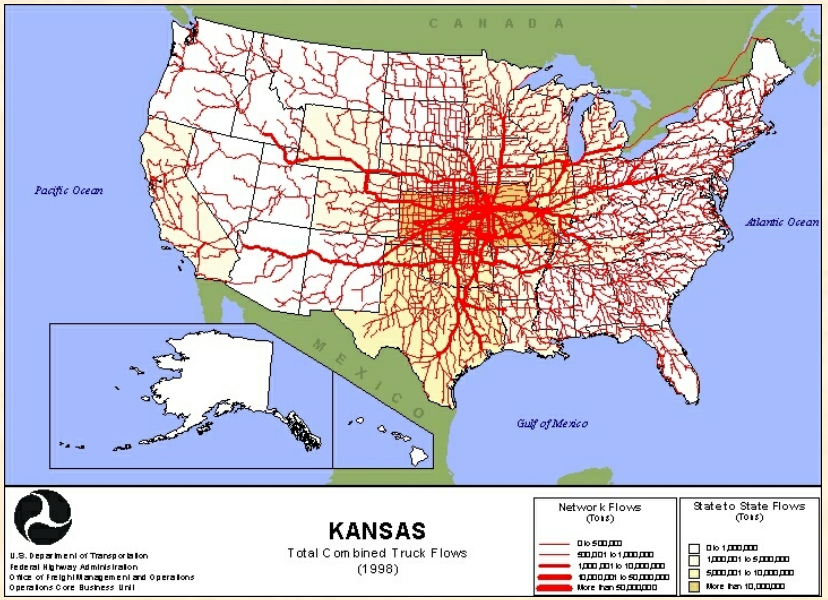


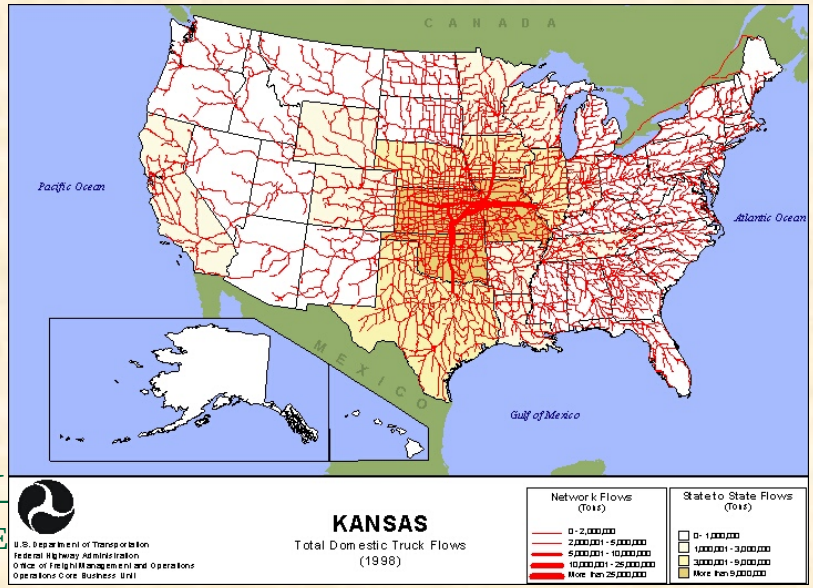


Federal Government – US Department of Transportation

Freight Analysis Framework



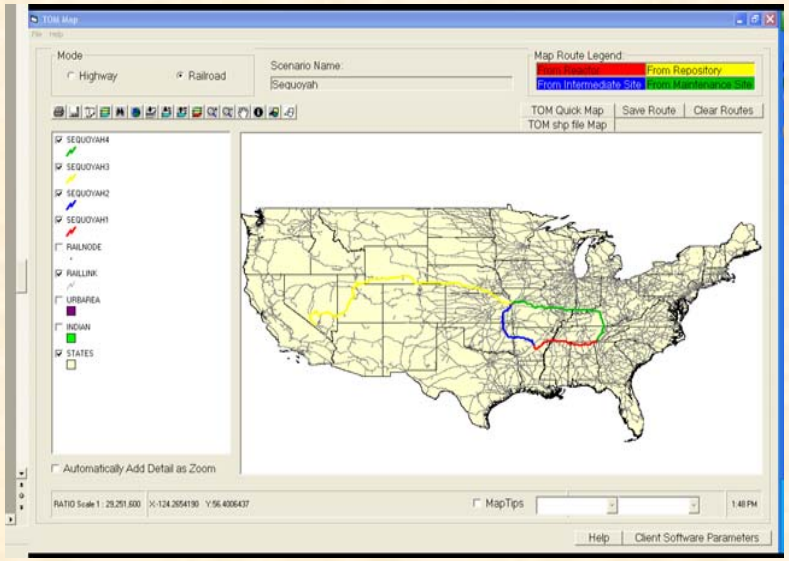




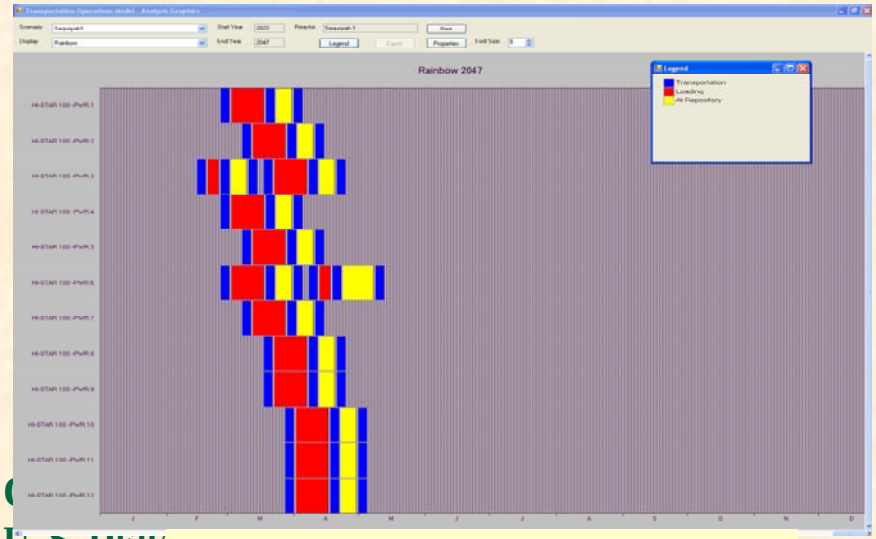
Federal Government – Department of Energy

Route and Logistics Planning for Spent Nuclear Fuel Movements

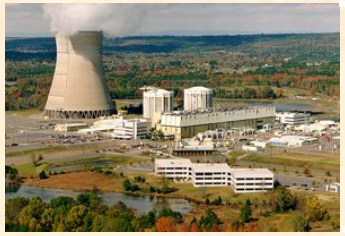
National Transportation Network

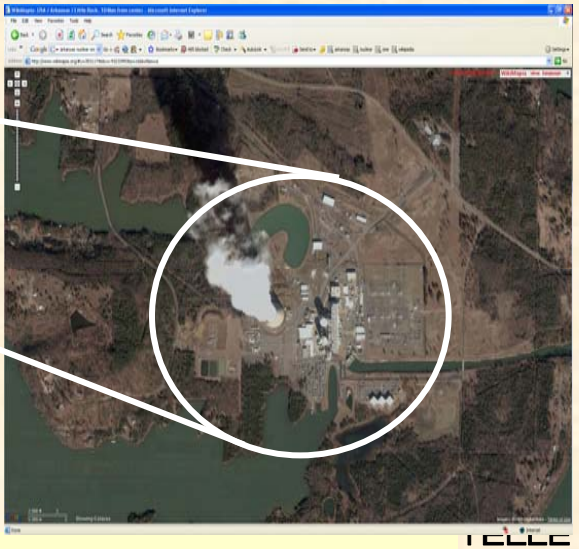


Individual Reactor Campaigns



Cask Movement Schedule

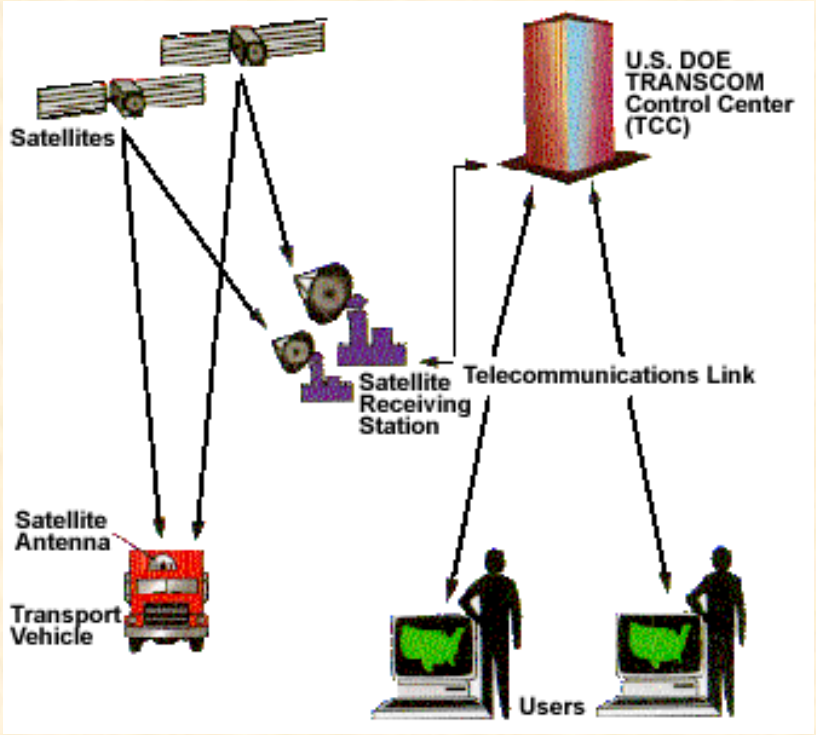


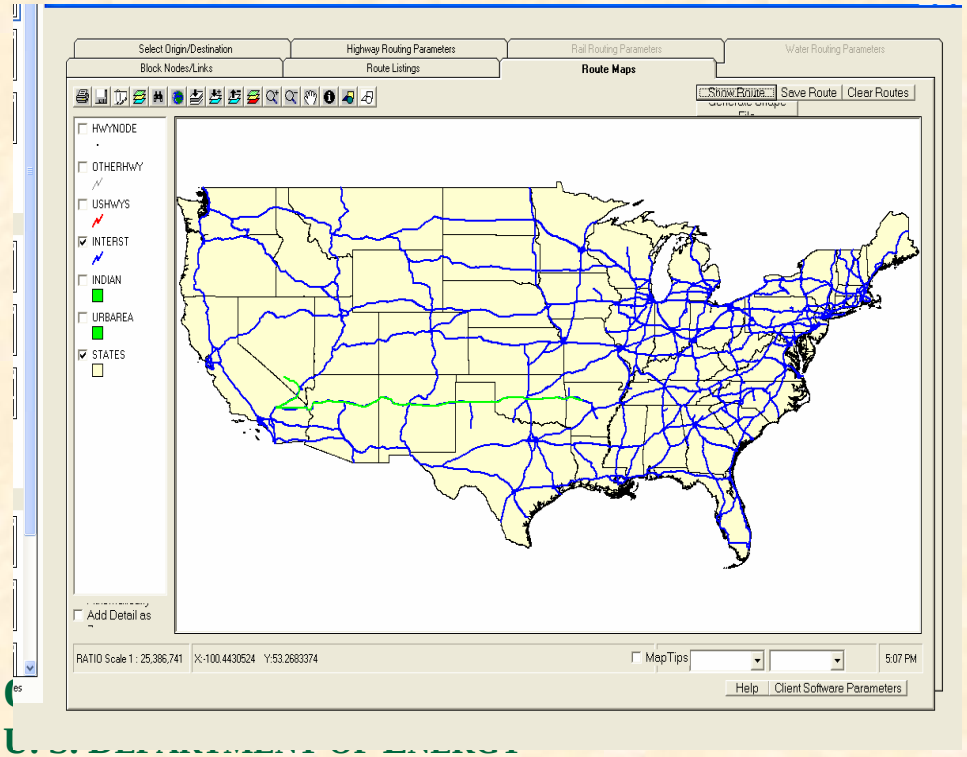


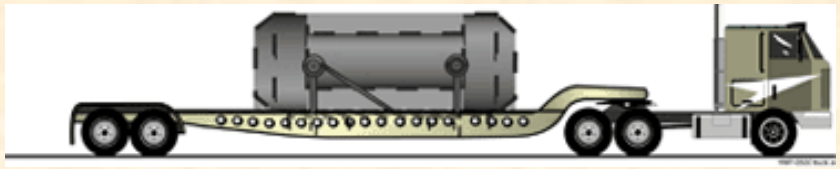
Logistics at the Reactor Site

Federal Government – Department of Energy

- **A real-time tracking system was developed for use by DOE to track spent nuclear fuel shipments**

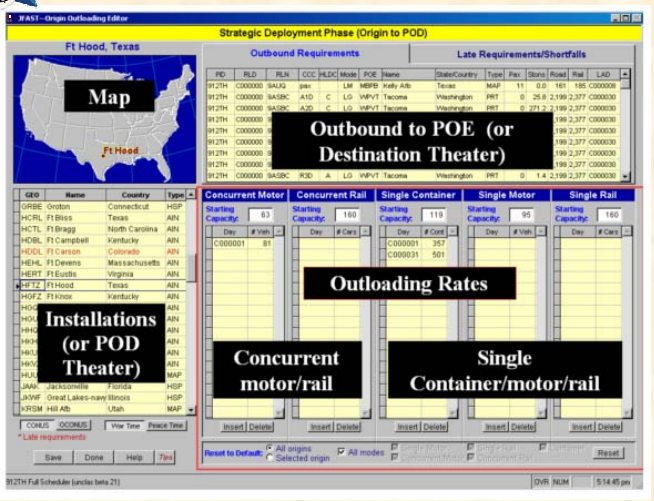




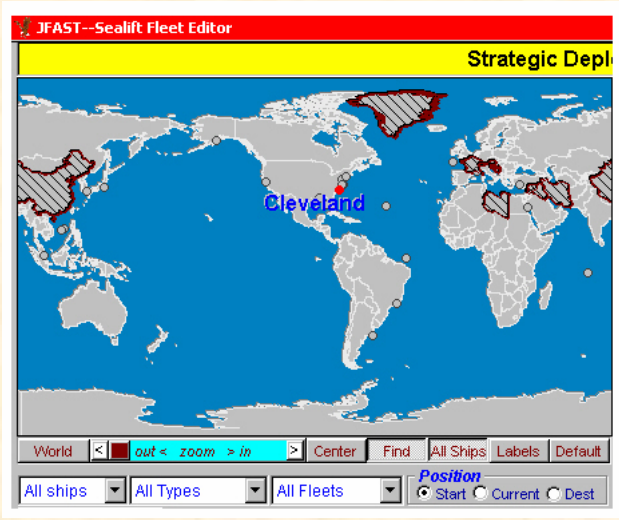


Federal Government – Department of Defense

Joint Flow and Analysis System for Transportation

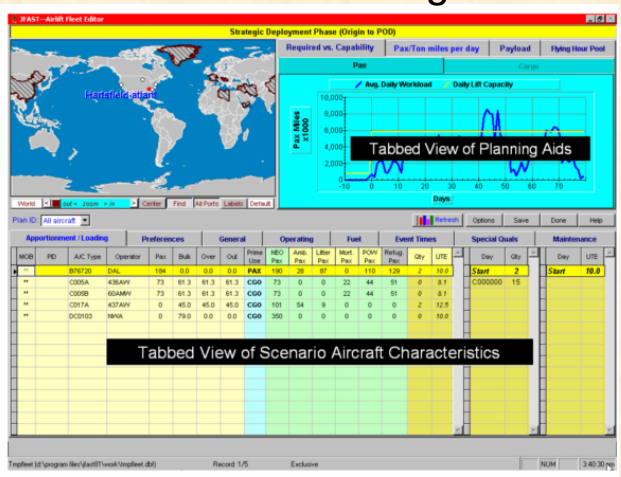


Deployment Planning



Sealift Planning

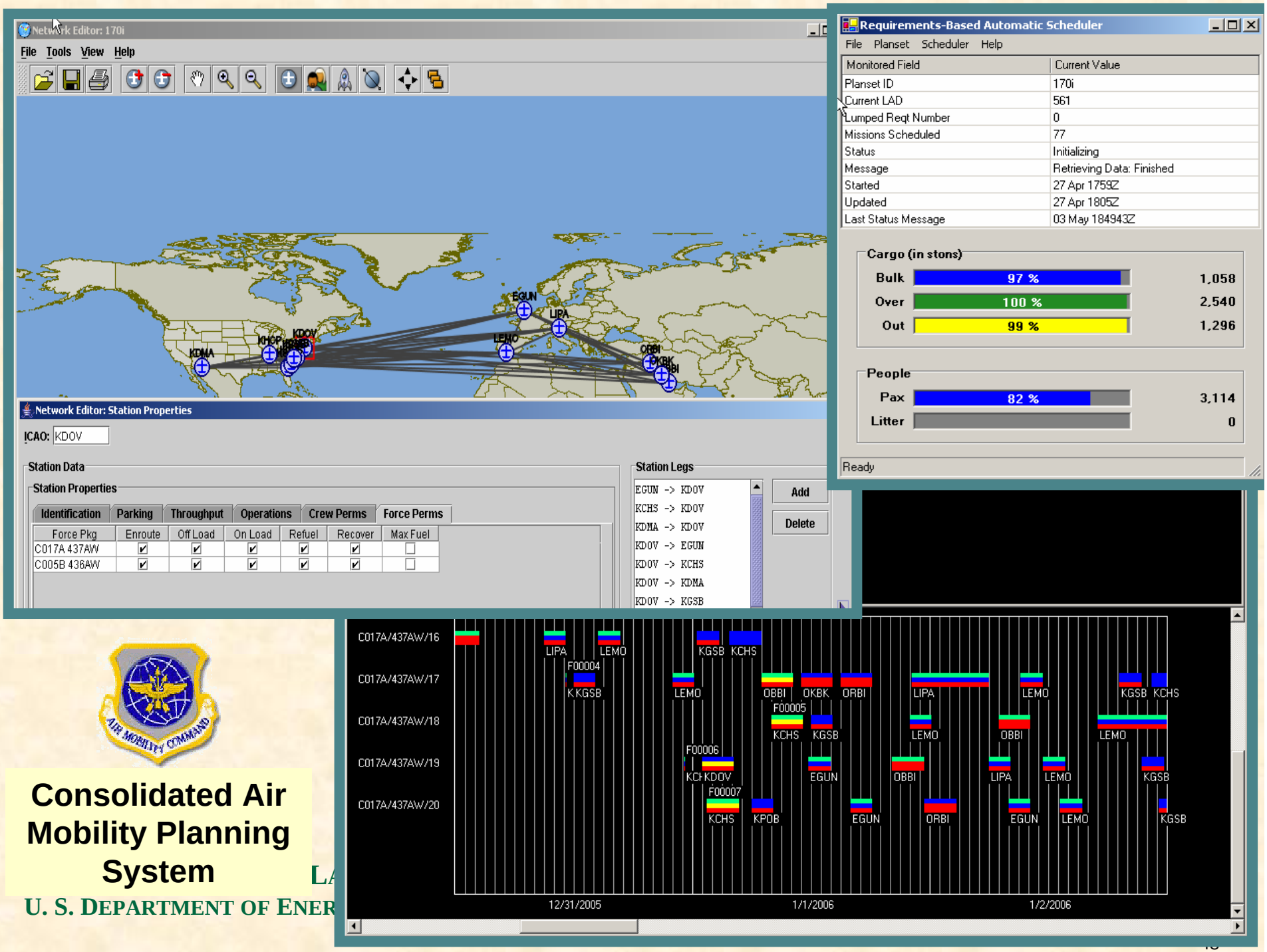
Highway and Rail Planning



Airlift Planning

OAK RIDGE NATIONAL LABORATORY
U. S. DEPARTMENT OF ENERGY

UT-BATTELLE



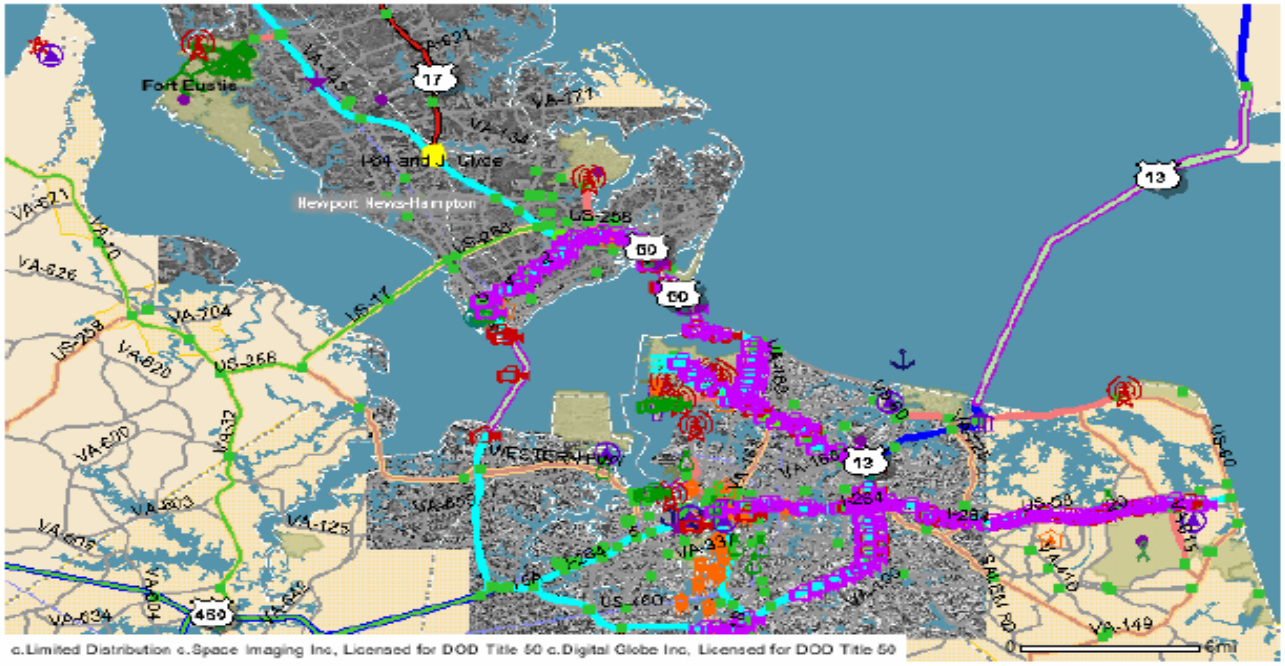
Consolidated Air Mobility Planning System

U. S. DEPARTMENT OF ENER

Federal Government – Department of Defense

Intelligent Road/Rail Information Server

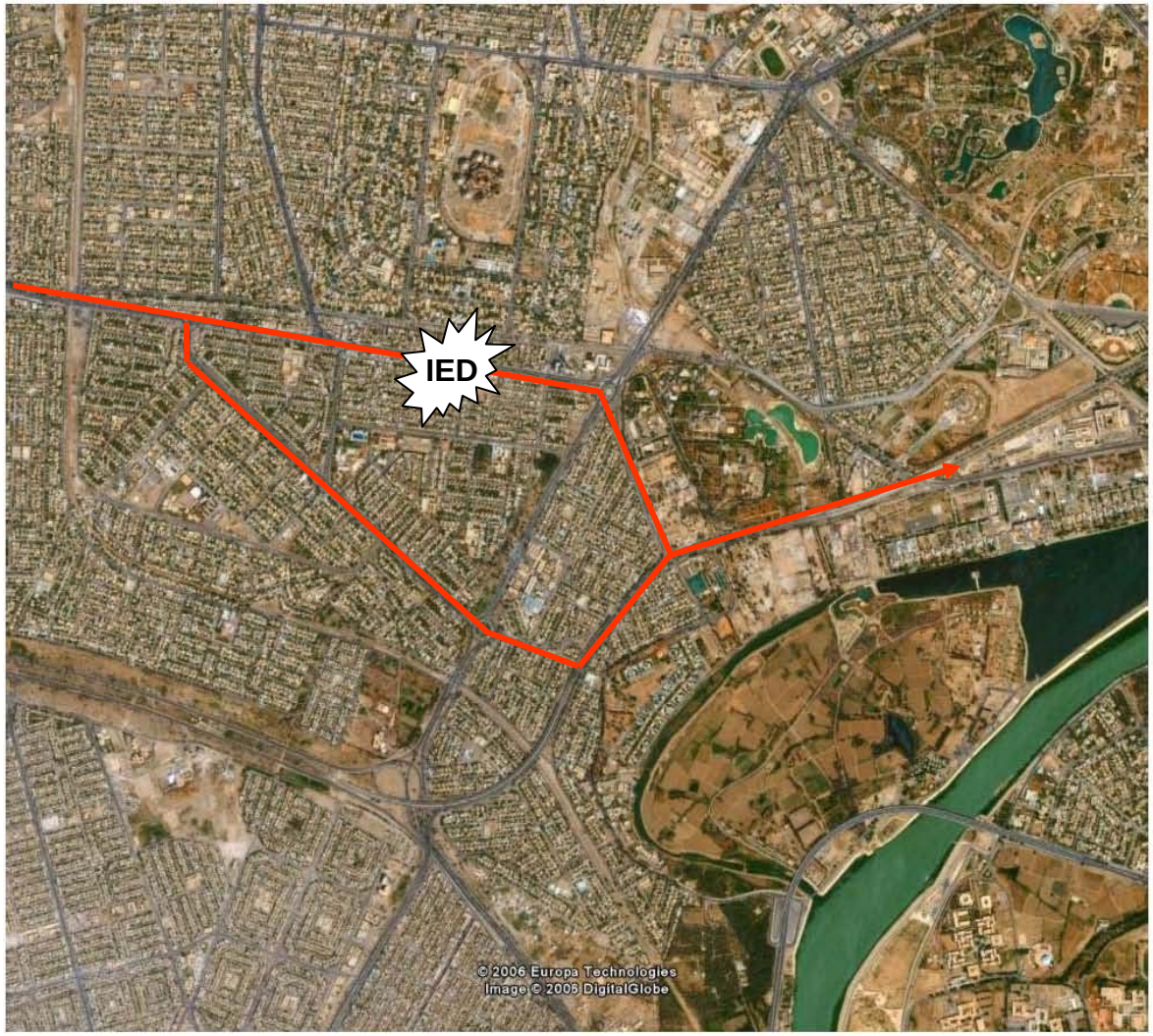
IRRIS has over 150 infrastructure data layers that are spatially accurate and can be used to create very detailed and data rich GIS maps throughout the world.



IRRIS' GIS data layers include:

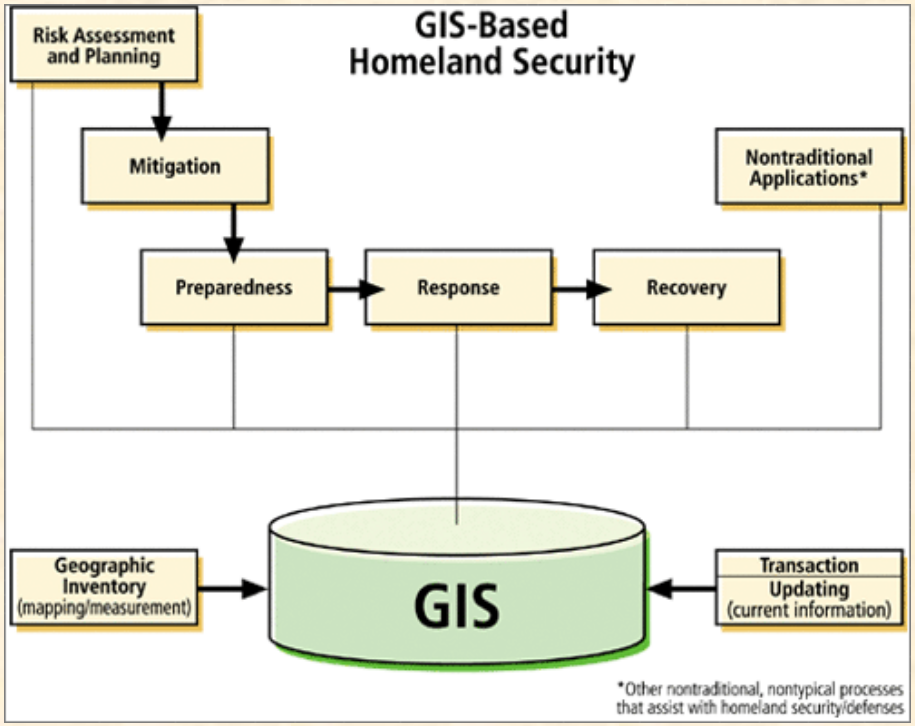
1. Transportation networks (road, rail & bridges)
2. Tracking data
3. Deployment infrastructure
4. Imagery & topographic layers
5. Real-time data (cameras, weather & traffic)
6. Critical energy nodes
7. Emergency response
8. Law enforcement
9. Military installations
10. Government agencies

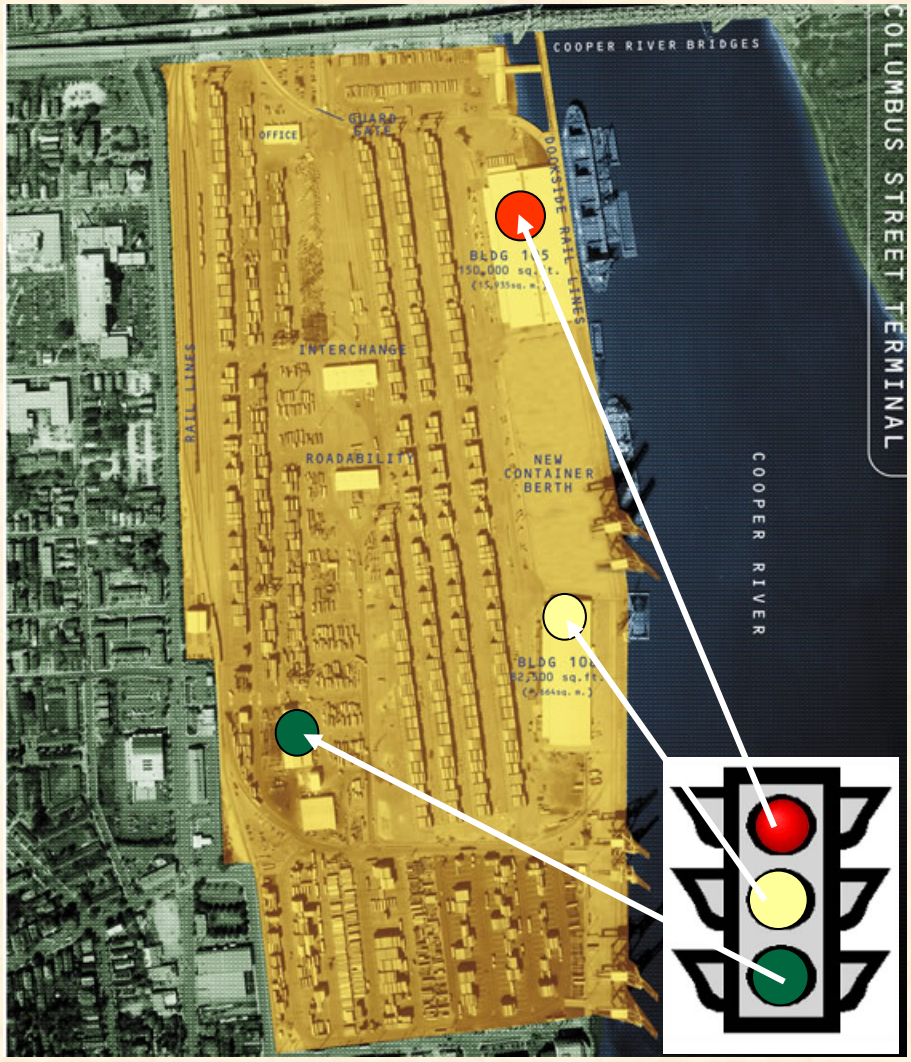
Federal Government – Department of Defense



ArcView Network Analyst is being used in Bagdad to reroute military convoys.

Federal Government – Department of Homeland Security





Readiness, mitigation, preparedness, response, recovery assessment review for transportation facilitates is tied to a GIS.

Federal Government – Department of Homeland Security

Rail Corridor Security

Future Trends

- Distributed Geographic Information Services
- Shift from static GIS-T representations for planning to dynamic representations for asset/traffic management.
- Increased shift toward the private sector for GIS-T products and services
  - In-vehicle and personal tracking and navigation systems using GPS, GIS, and routing algorithms.
  - Vehicle fleet operations use of GIS-T routing and scheduling functions for pick-up and delivery, fleet management (tractors and trailers), and drivers.
- Integration of GIS-T with 3D, satellite images, and visualization functionality