

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

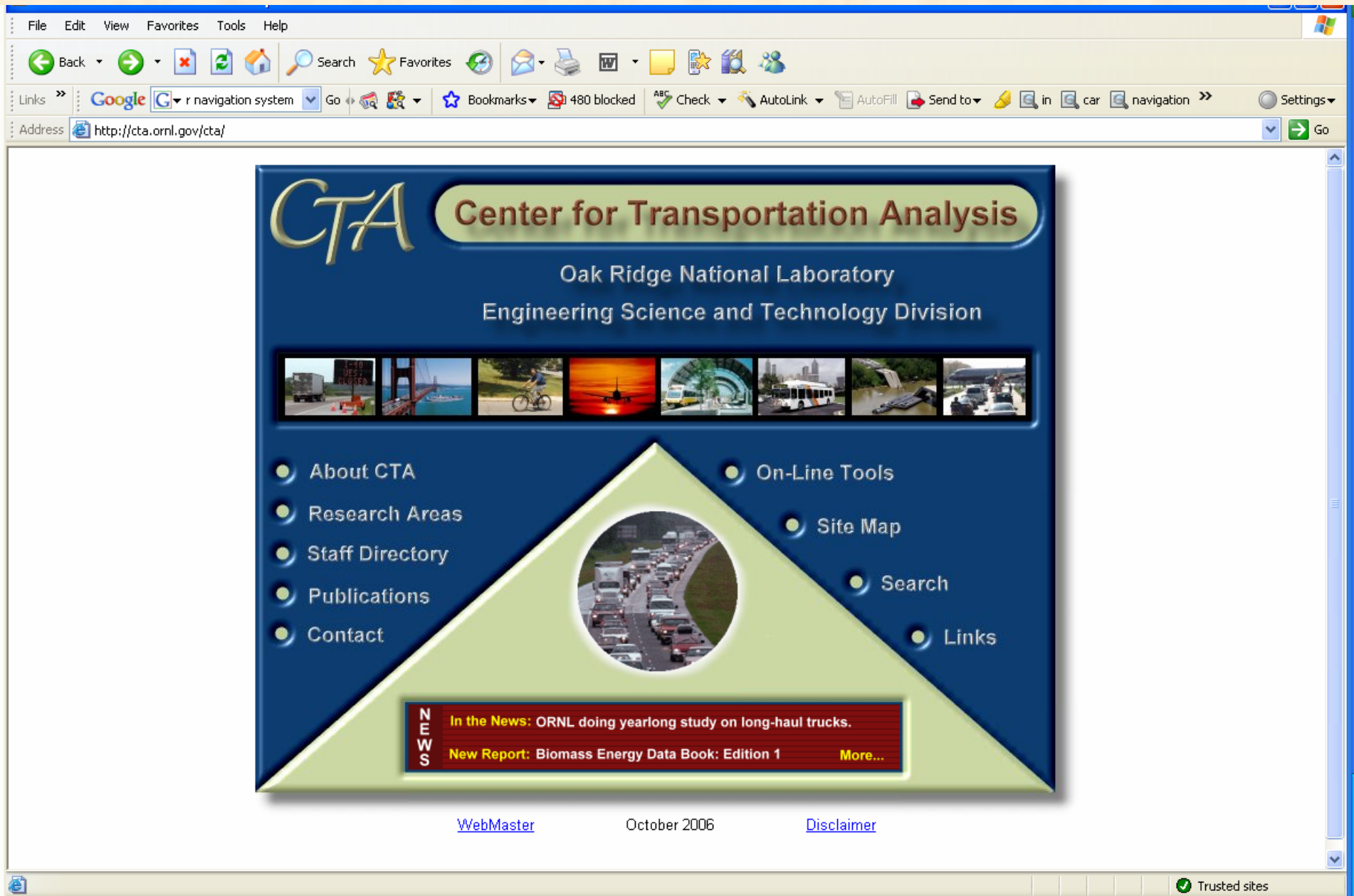
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U. S. DEPARTMENT OF ENERGY



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





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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.

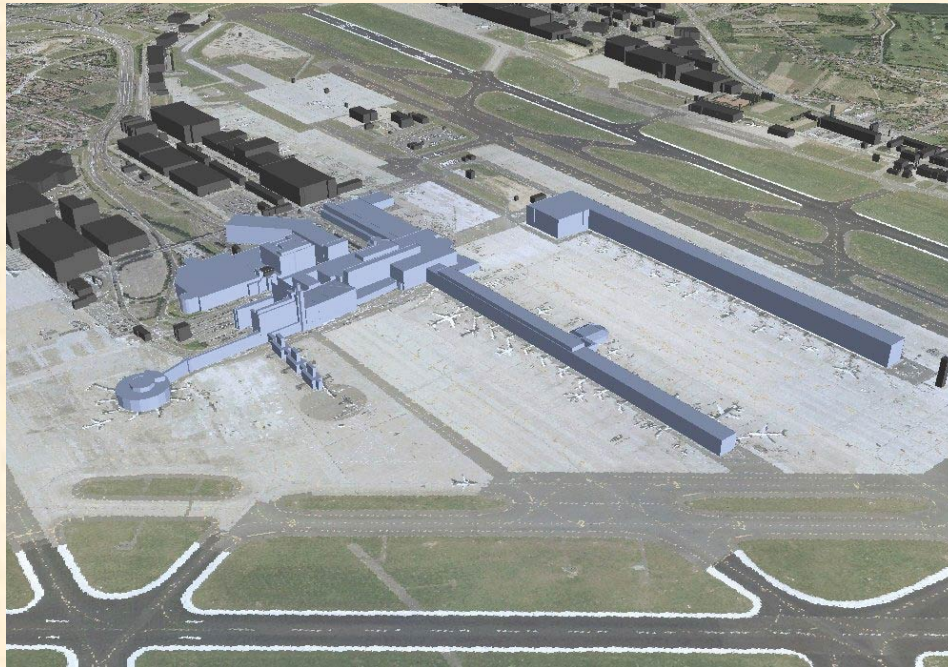
Commercial Applications

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

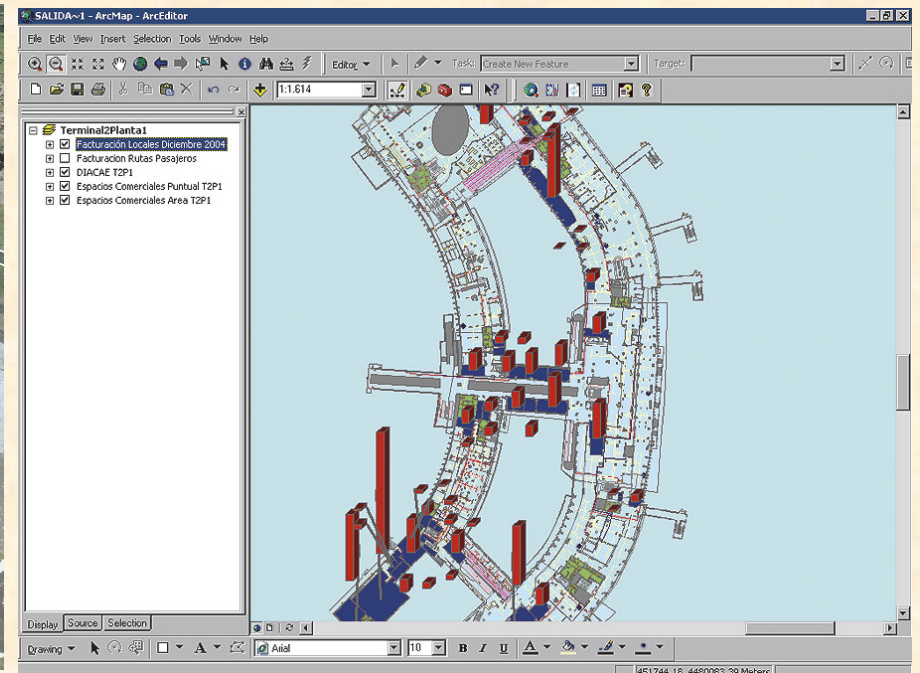
Commercial Applications - Aviation

- **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**

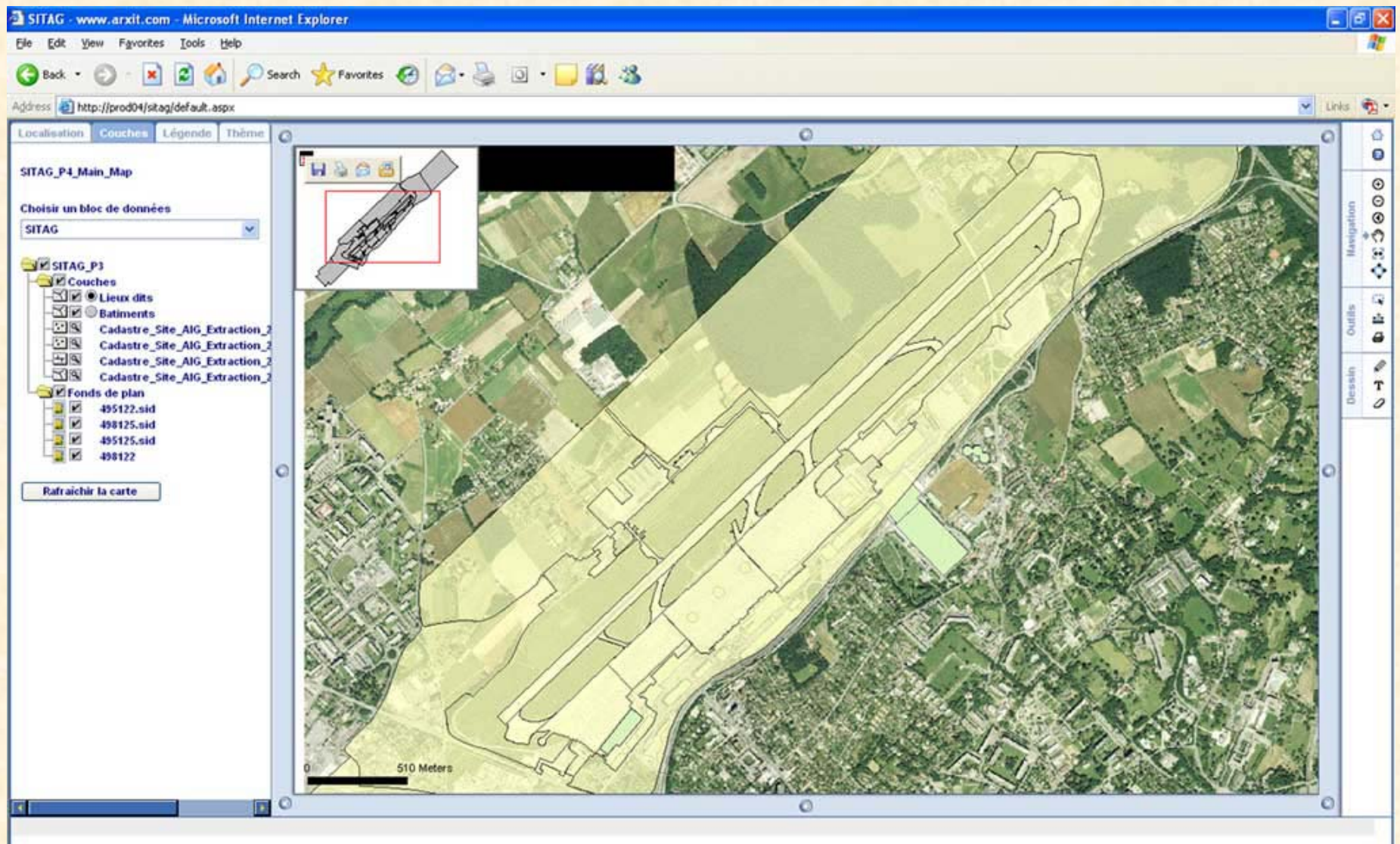


**Airport Facilities Management at
Madrid International Airport**

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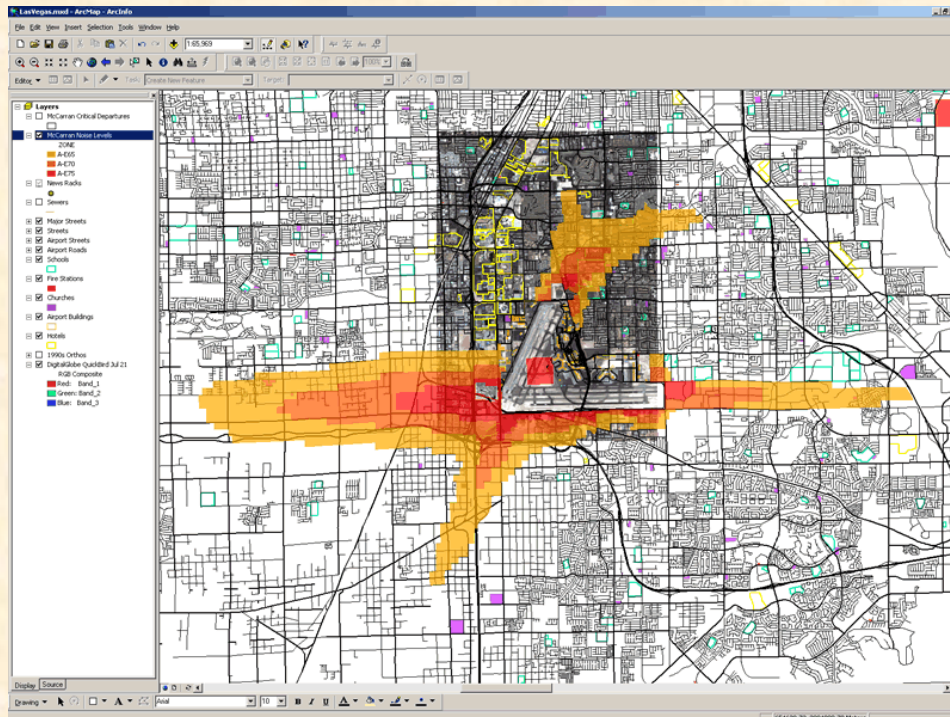
Commercial Applications - Aviation



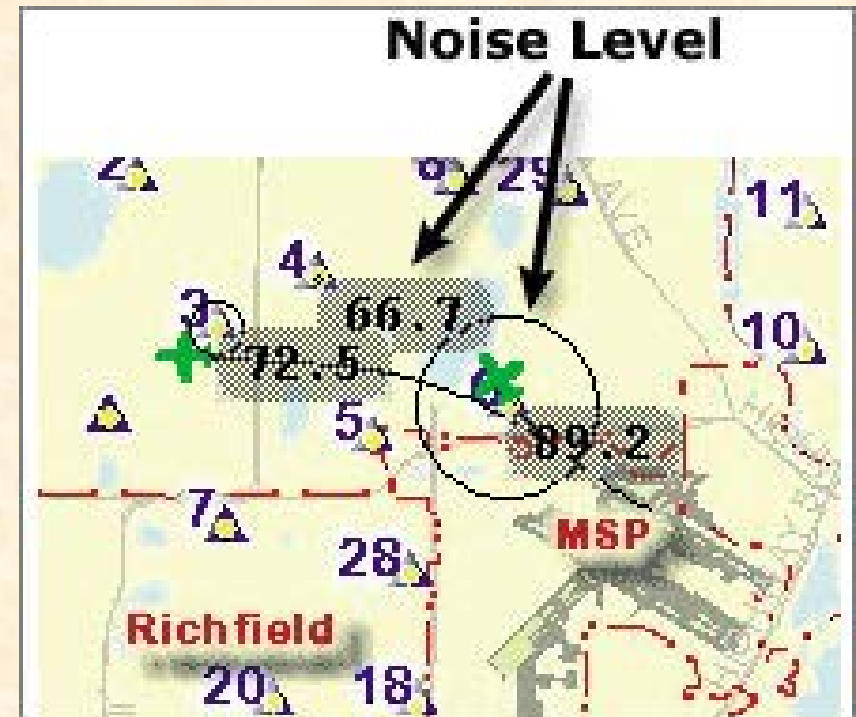
OAK RIDGE NAT. Land use around the Geneva International Airport.
U. S. DEPARTMENT OF ENERGY



Commercial Applications - Aviation



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



Minneapolis-St. Paul International Airport Noise Information System

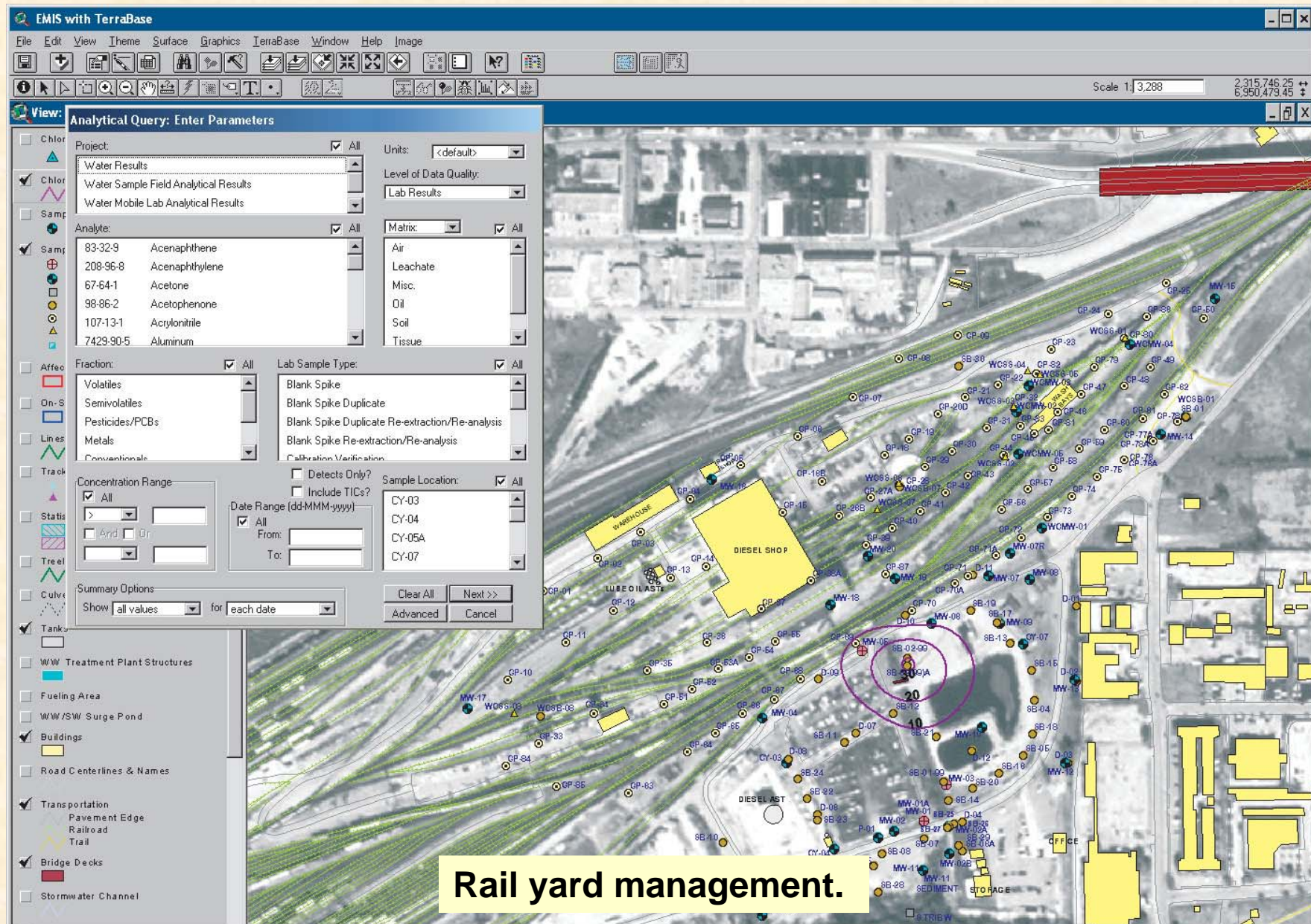
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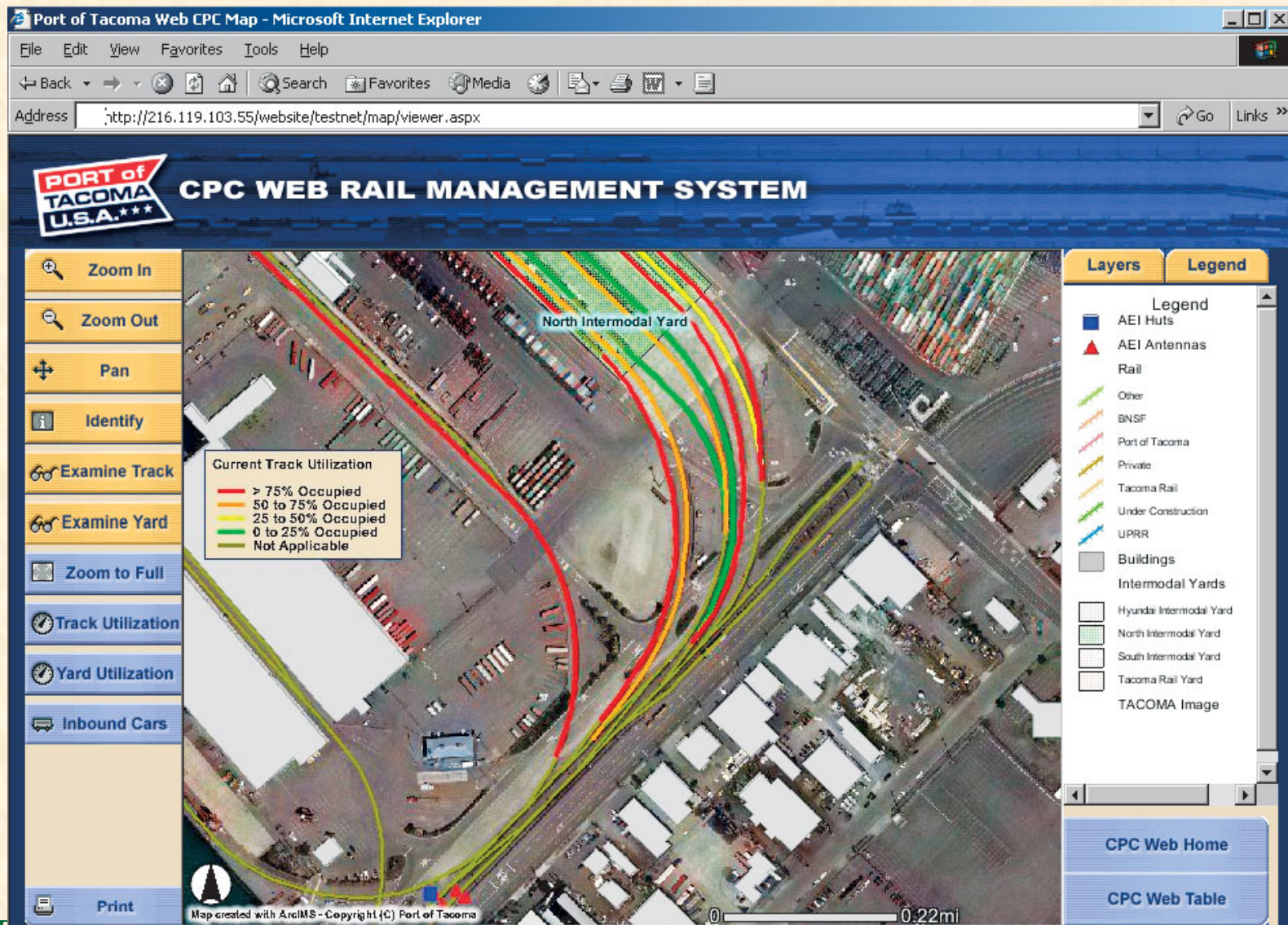
Commercial Applications - Railroads

- **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



Commercial Applications - Railroads



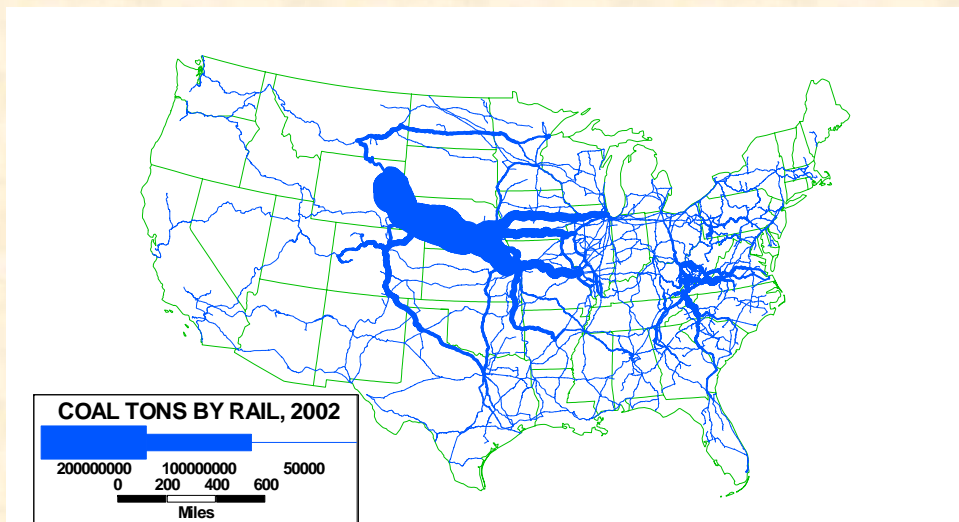
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Intermodal rail operations at the Port of Tacoma, Washington.

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Commercial Applications - Railroads

Rail Resource Planning

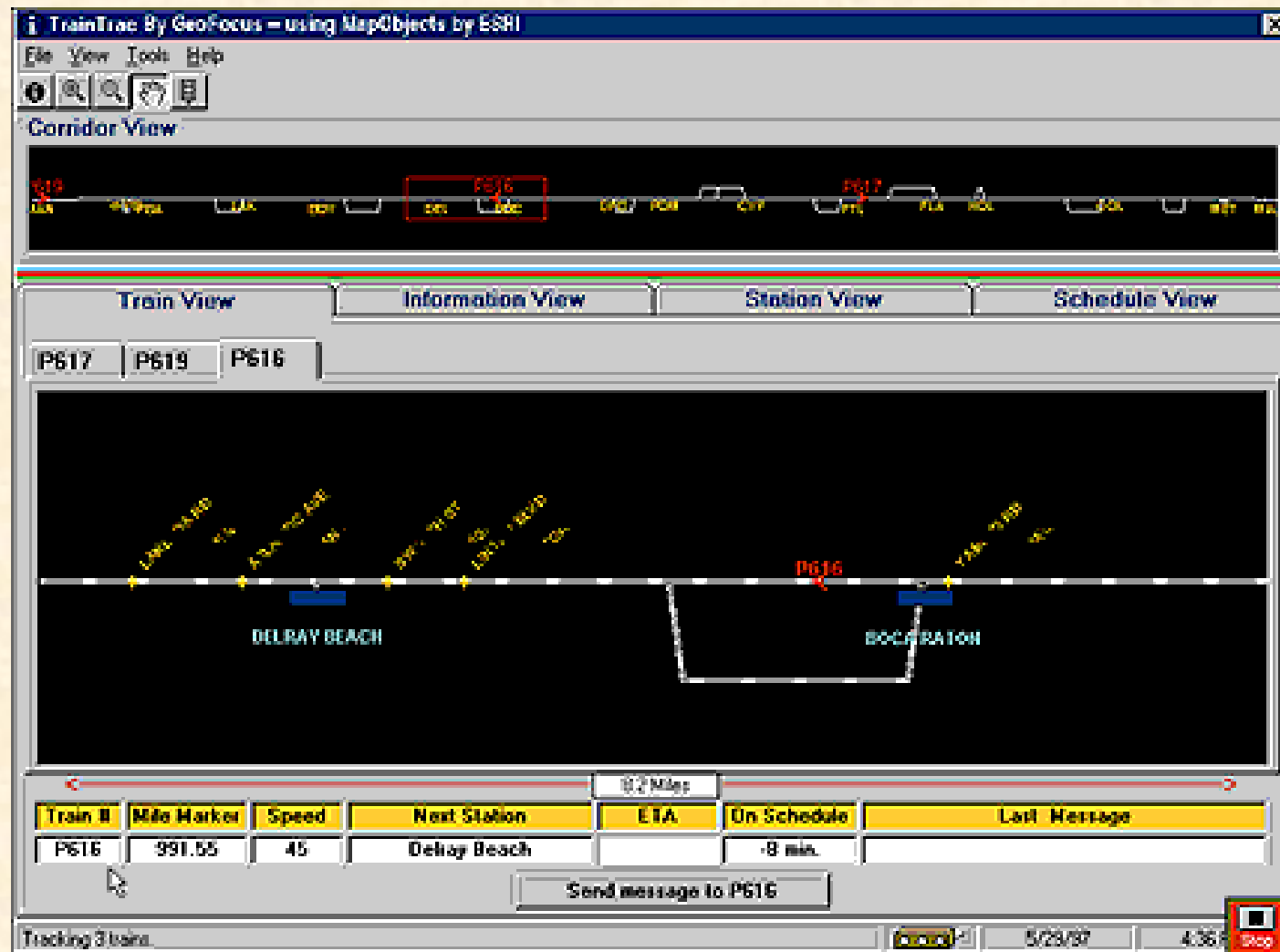


Coal shipments by rail



Wheat shipments by rail

Commercial Applications - Railroads



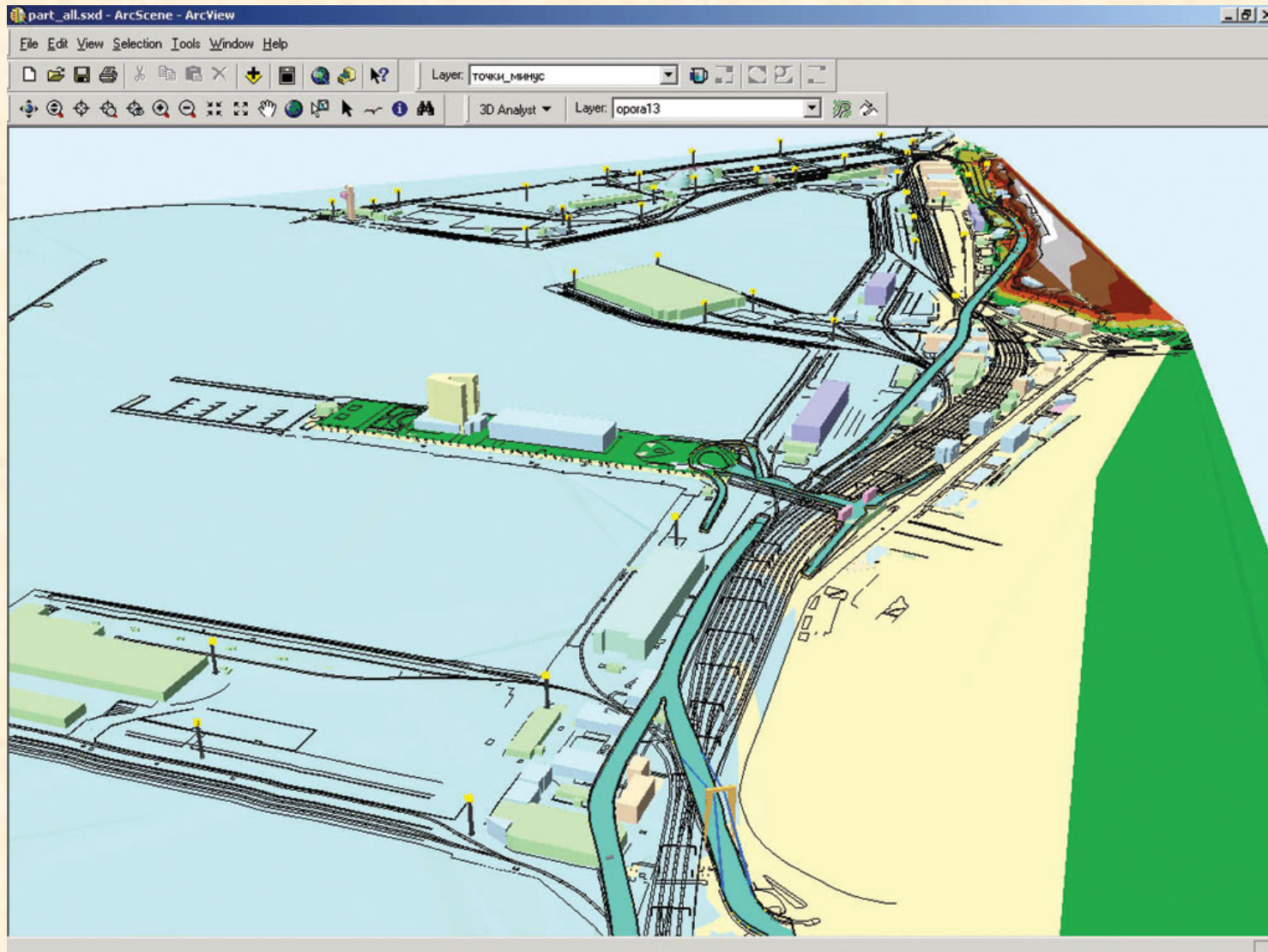
OAK RI Rolling stock tracking on a line near Delray Beach, Florida.
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Commercial Applications - Waterways

- **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

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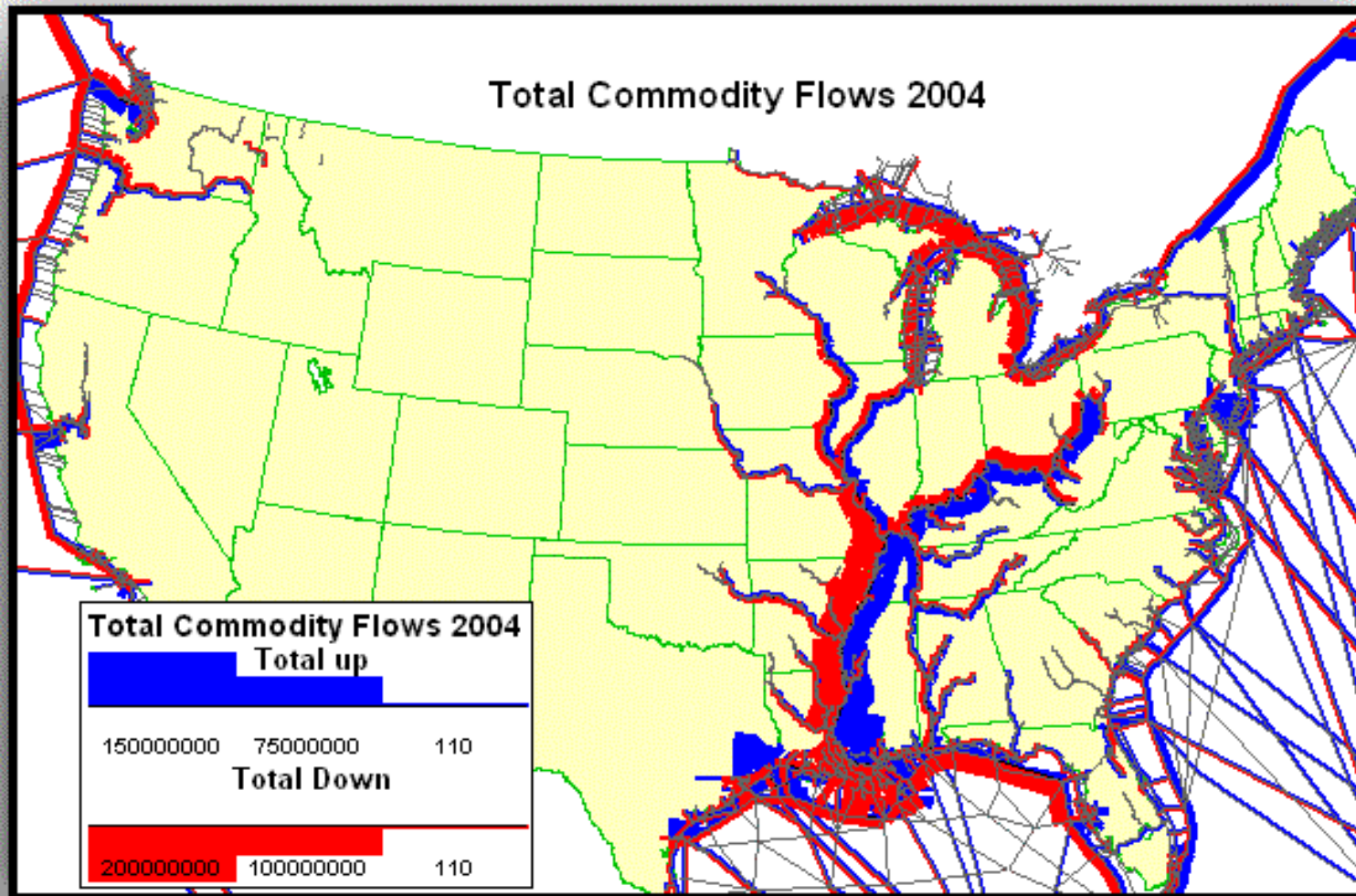
Commercial Applications - Waterways



OAK RIDGE Ship navigation management in the port of Rotterdam, Netherlands
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Commercial Applications - Waterways



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

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Commercial Applications - Waterways

Barge Tracking on the Inland Waterways



Regional Level on the Ohio River

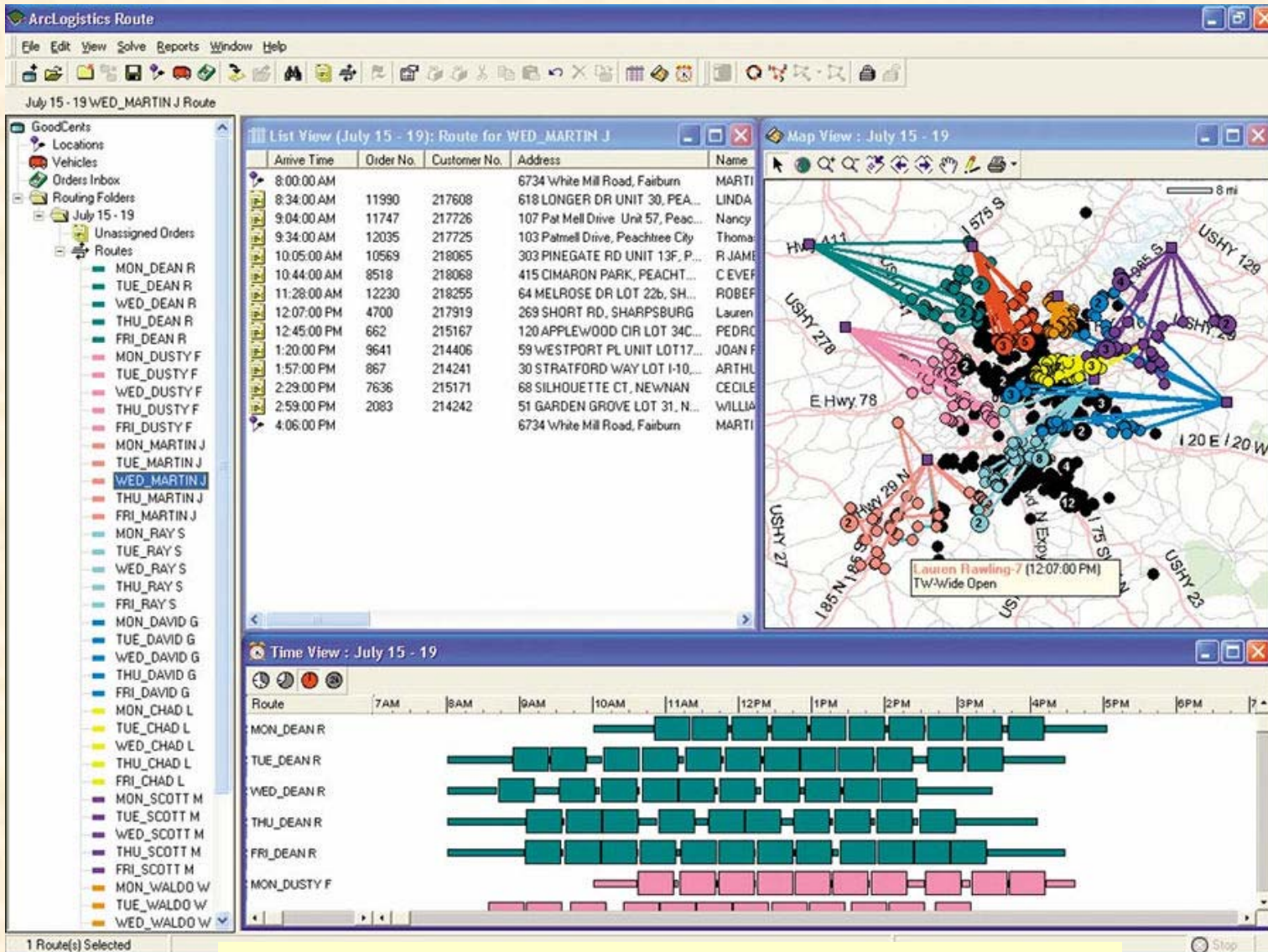


Local Level on the Kanawha River, WV

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

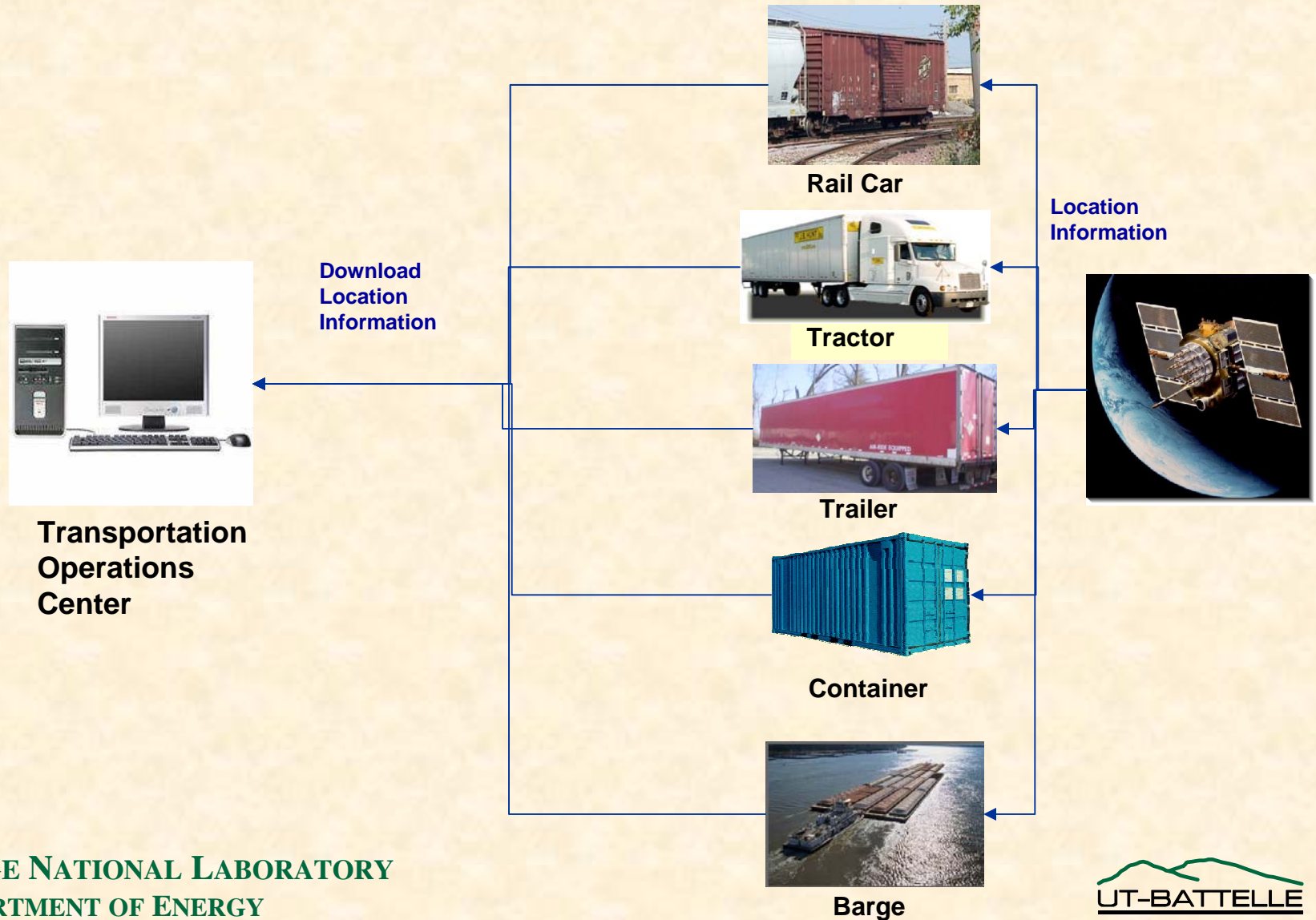


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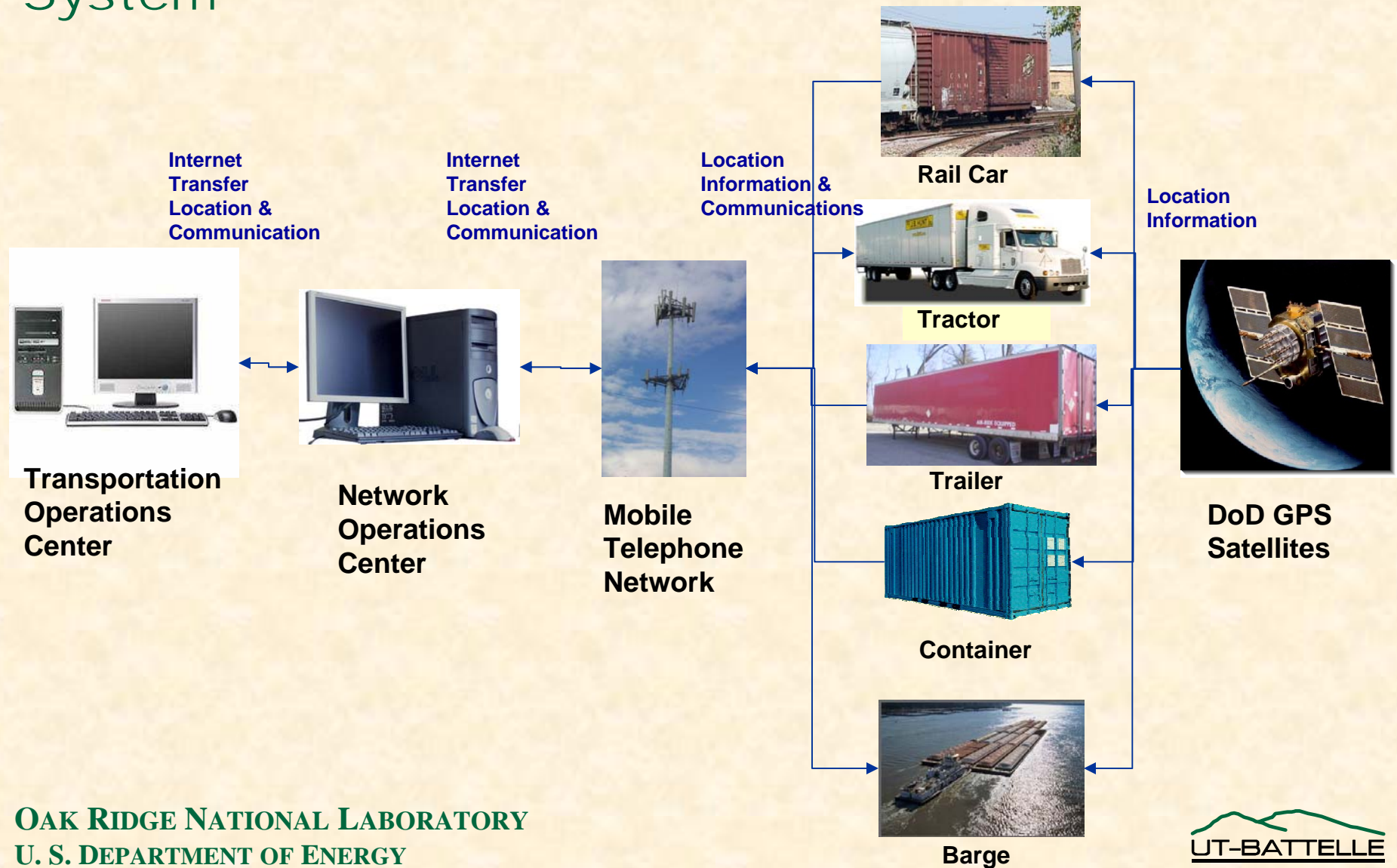
GIS ArcLogistics Route software used for
planning for multiple delivery routes.



Vehicle Location Technology using Global Positioning System



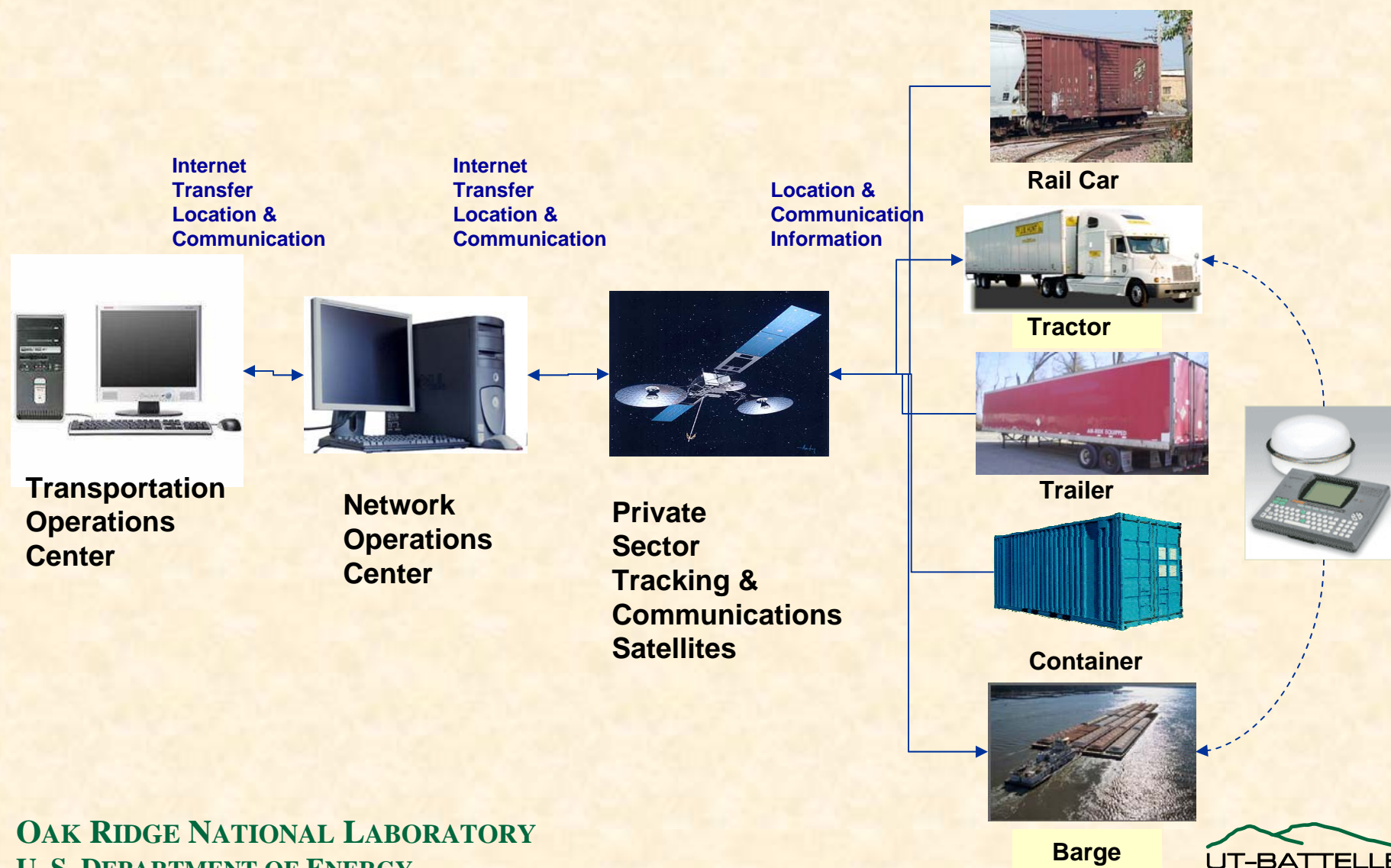
Vehicle Location Technology using Global Positioning System Satellites and Mobile Telephone System



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Vehicle Location Technology using Global Location and Communication Satellite



Vehicle Location Technology using Global Location and Communication Satellite

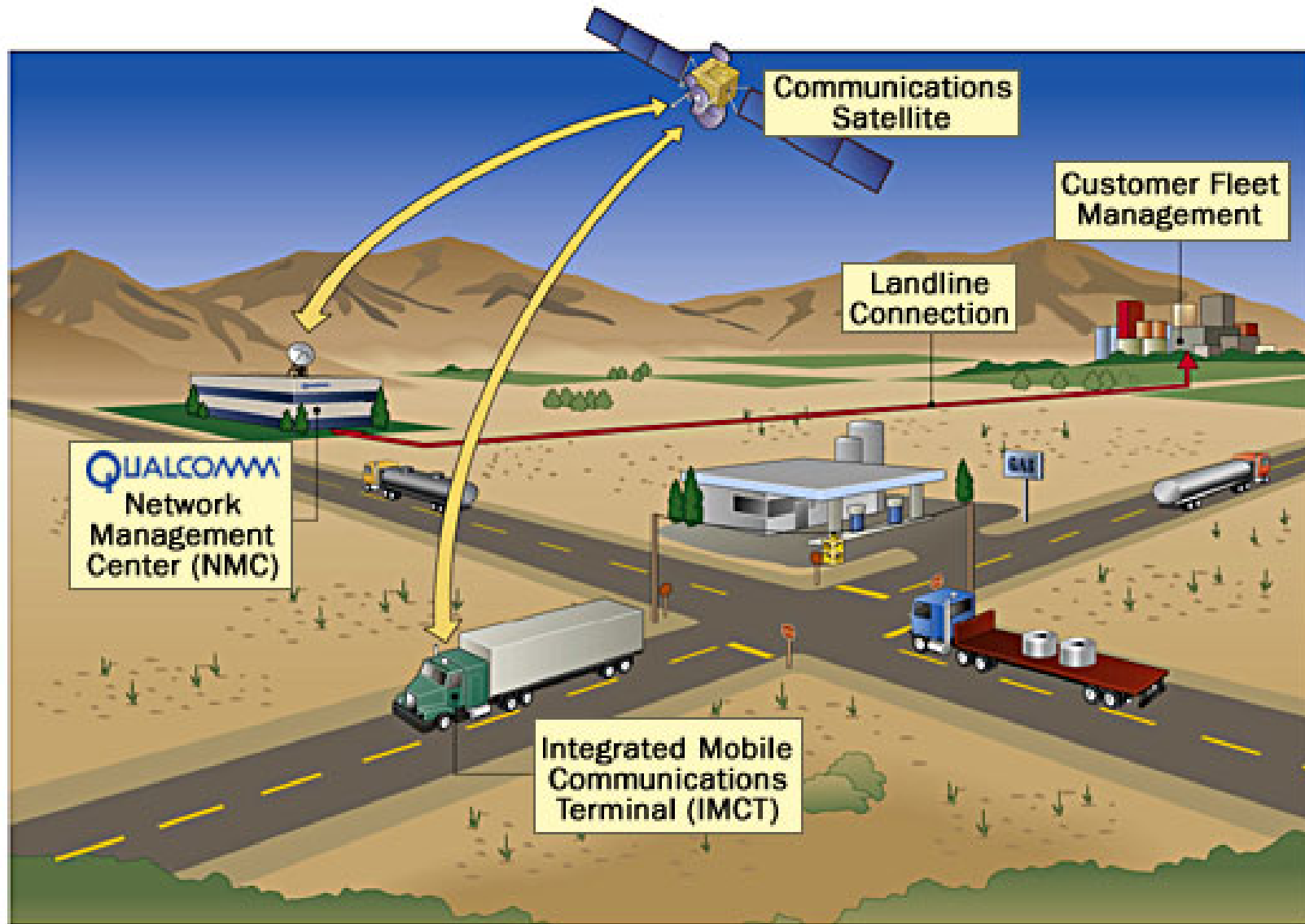
- **Qualcomm Equipment**



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Vehicle Location Technology using Global Location and Communication Satellite



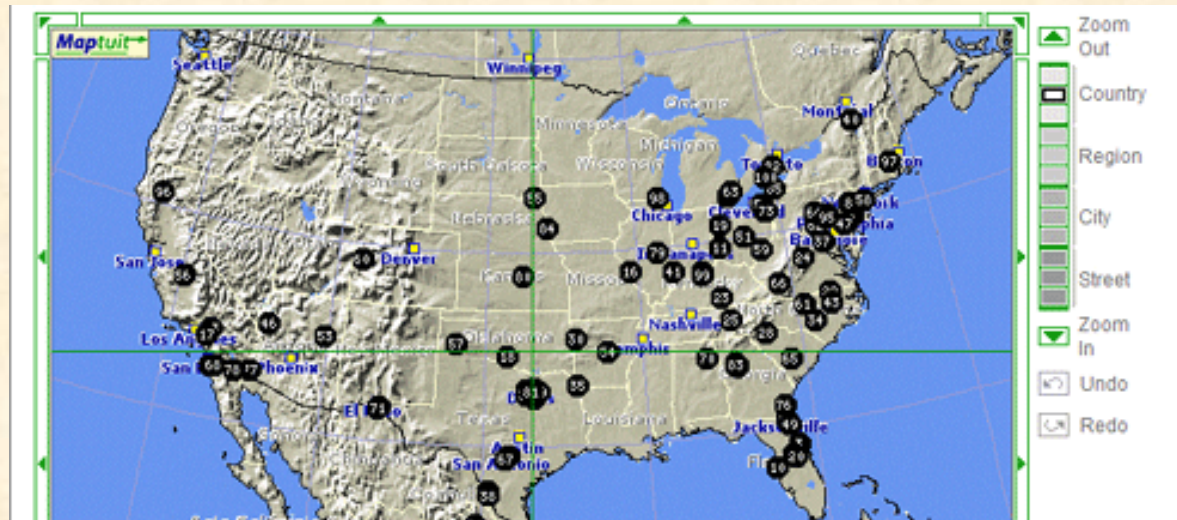
Commercial Applications - Motor Carrier

● Information

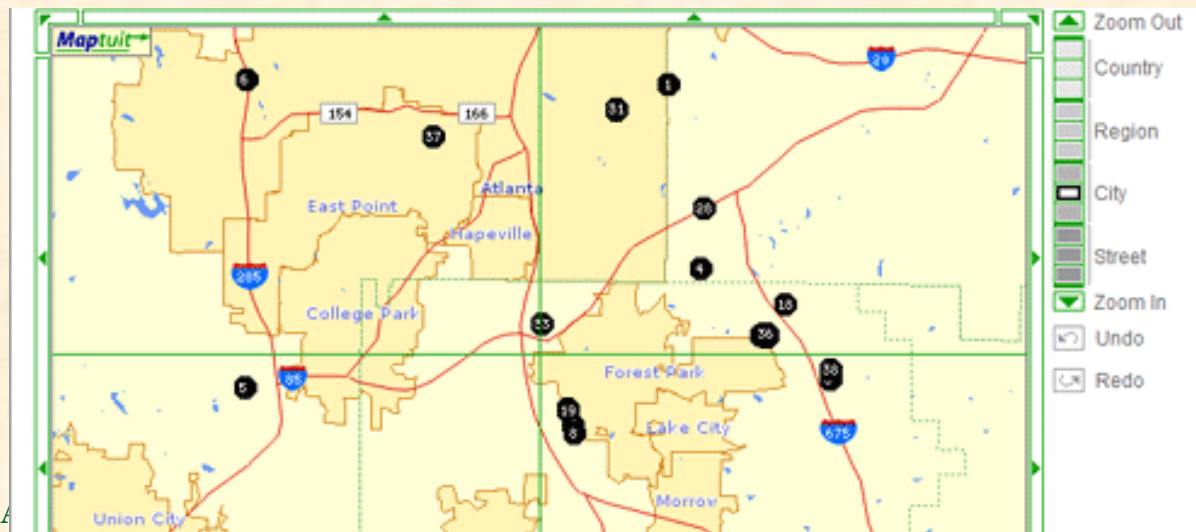
- Location – current and past
- Speed and vehicle performance (tire pressure, engine performance, fuel levels) data
- Direction
- History
- Loading and unloading times
- Tractor to trailer matching
- Trailer door opening tracking
- Next step is video of load in the trailer or container



Motor Carrier Tracking



National Level



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Local Level

Details on Motor Carrier Activity

REPORTS: TrackYourTruck.Com

Client: Track Your Truck

Report: GPS Detail From: 5/1/2004 00:00 To: 5/1/2004 23:59 Verbose

Truck: Bull Dog Delivery Van Last Known Position

Paged Excel Print Close

Truck Name	GPS Date	Time	Location	Speed	Heading	Lat	Lon
Bull Dog Delivery Van	05/01/04	10:06:08	9534 Keirman St/W 95th Ave, St. John, 46373,IN	13.125	N (358.000)	41.445830000	-87.472430000
Bull Dog Delivery Van	05/01/04	10:08:08	12204 W 93rd Ave/Kardel Dr, St. John, 46373,IN	35.625	W (270.000)	41.450000000	-87.482470000
Bull Dog Delivery Van	05/01/04	10:10:08	13853 93rd Ave/, 46311,IN	23.750	SW (222.000)	41.450620000	-87.502500000
Bull Dog Delivery Van	05/01/04	10:12:08	14478 W 91st Ave/Eggert Ln, St. John, 46373,IN	0	SW (224.000)	41.453430000	-87.507820000
Bull Dog Delivery Van	05/01/04	10:14:08	14668 93rd Ave/Henry St, 46311,IN	38.750	W (270.000)	41.450130000	-87.513030000
Bull Dog Delivery Van	05/01/04	10:16:08	10067 Sheffield Ave/101st Ave/, 46311,IN	7.500	S (184.000)	41.435900000	-87.517970000
Bull Dog Delivery Van	05/01/04	10:18:08	10761 Colunet Ave/St Rd II, St. John, 46311,IN	49.375	S (180.000)	41.427780000	-87.508300000
Bull Dog Delivery Van	05/01/04	10:20:08	11704 Colunet Ave/W 117th Ave/, 46303,IN	58.125	S (180.000)	41.406420000	-87.508180000
Bull Dog Delivery Van	05/01/04	10:22:08	W 130th Ct/Colunet Ave/, 46303,IN	8.125	E (86.000)	41.383270000	-87.507780000
Bull Dog Delivery Van	05/01/04	10:24:08	13136 Colunet Ave/W 132nd Ave/, 46303,IN	37.500	N (360.000)	41.379870000	-87.507980000
Bull Dog Delivery Van	05/01/04	10:26:08	14071 W 129th Pl/Rhodes Rd, 46303,IN	0.625	SE (152.000)	41.383880000	-87.503900000
Bull Dog Delivery Van	05/01/04	10:26:58	14071 W 129th Pl/Rhodes Rd, 46303,IN	0.625	SE (128.000)	41.383830000	-87.503920000
Bull Dog Delivery Van	05/01/04	11:29:32	14071 W 129th Pl/Rhodes Rd, 46303,IN	1.875	E (104.000)	41.383870000	-87.503900000
Bull Dog Delivery Van	05/01/04	11:31:32	12568 Colunet Ave/W 125th Ave/, 46303,IN	46.875	N (0.000)	41.390800000	-87.508030000
Bull Dog Delivery Van	05/01/04	11:33:32	11221 Colunet Ave/, 46311,IN	51.875	N (360.000)	41.415080000	-87.508220000
Bull Dog Delivery Van	05/01/04	11:35:32	101st Ave/, 46311,IN	29.375	N (0.000)	41.435170000	-87.508300000
Bull Dog Delivery Van	05/01/04	11:37:32	3440 E Exchange St	53.125	W (274.000)	41.436200000	-87.530950000
Bull Dog Delivery Van	05/01/04	11:39:32	1635 E Exchange St	48.125	W (268.000)	41.436020000	-87.557280000
Bull Dog Delivery Van	05/01/04	11:41:32	1534 E Exchange St	31.875	W (268.000)	41.442950000	-87.576000000
Bull Dog Delivery Van	05/01/04	11:43:32	Illinois Route 394	65.625	N (360.000)	41.455570000	-87.576880000
Bull Dog Delivery Van	05/01/04	11:45:32	Illinois Route 394	57.500	N (360.000)	41.477970000	-87.577230000
Bull Dog Delivery Van	05/01/04	11:47:32	Illinois Route 394/Currency B	50.000	N (0.000)	41.497100000	-87.577470000
Bull Dog Delivery Van	05/01/04	11:49:32	Illinois Route 394/Voll	68.750	N (354.000)	41.526800000	-87.582150000
Bull Dog Delivery Van	05/01/04	11:51:32	18520 Dorchester Ave	65.000	N (360.000)	41.559220000	-87.583450000
Bull Dog Delivery Van	05/01/04	11:53:32	16926 Van Dam Rd	48.750	N (0.000)	41.589100000	-87.583380000
Bull Dog Delivery Van	05/01/04	11:55:32	Woodlawn East Ave/Woodlawn	1.250	W (264.000)	41.600850000	-87.588050000
Bull Dog Delivery Van	05/01/04	11:57:32	16481 Greenwood Ave/E 165th St	21.875	W (270.000)	41.595700000	-87.589500000
Bull Dog Delivery Van	05/01/04	11:59:52	16509 Dobson Ave/E 165th St South Holland, 60473,IL	2.500	SW (246.000)	41.595570000	-87.591850000
Bull Dog Delivery Van	05/01/04	14:02:34	1007 E 165th St/Dobson Ave, South Holland, 60473,IL	0.625	SE (124.000)	41.595620000	-87.591780000
Bull Dog Delivery Van	05/01/04	14:04:29	1118 E 165th St/Greenwood Ave, South Holland, 60473,IL	3.125	E (86.000)	41.595570000	-87.588800000
Bull Dog Delivery Van	05/01/04	14:06:29	16213 Prince Dr/Woodlawn East Ave, South Holland, 60473,IL	19.375	E (88.000)	41.600680000	-87.587470000
Bull Dog Delivery Van	05/01/04	14:08:29	I-94/, IL	51.875	S (172.000)	41.579670000	-87.581950000
Bull Dog Delivery Van	05/01/04	14:10:29	Illinois Route 394/, IL	60.625	S (172.000)	41.550480000	-87.583370000
Bull Dog Delivery Van	05/01/04	14:12:29	Illinois Route 394/, IL	64.375	SE (156.000)	41.519630000	-87.579480000
Bull Dog Delivery Van	05/01/04	14:14:29	Illinois Route 394/Seuk Trl, Seuk Village, 60411,IL	38.750	S (180.000)	41.489230000	-87.577620000
Bull Dog Delivery Van	05/01/04	14:16:29	Illinois Route 394/E Steger Rd, Seuk Village, 60417,IL	46.875	S (180.000)	41.472330000	-87.577420000
Bull Dog Delivery Van	05/01/04	14:18:29	Illinois Route 394/E Steger Rd, Seuk Village, 60417,IL	46.875	S (180.000)	41.472330000	-87.577420000

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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

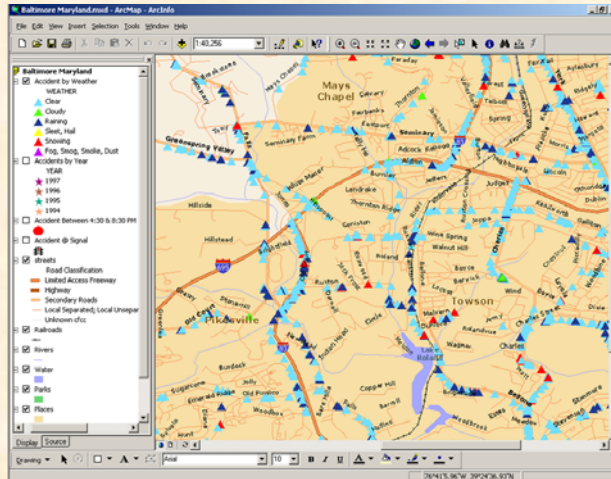
- State and Local government
- Federal government

Government Applications – State and Local Government

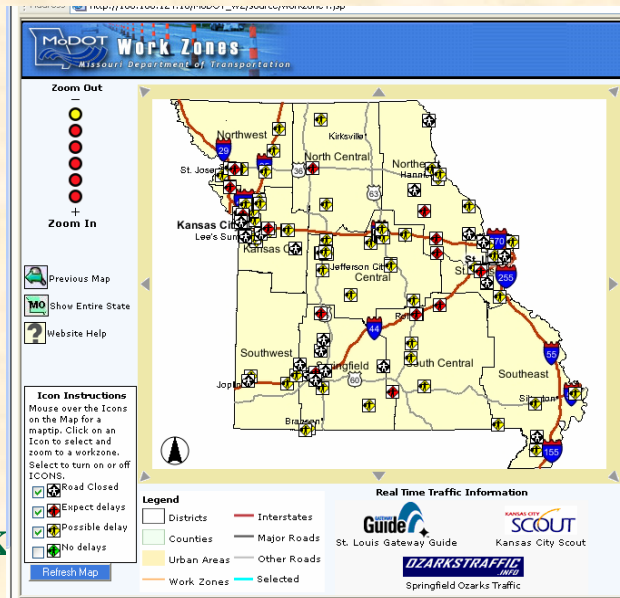
- **Roadway Management**
 - Accident analysis
 - Maintenance management
 - Work Zones
- **Planning and design for future transportation systems**
 - Highway
 - Transit
- **Operations**
 - Driver information
 - Incident management

State and Local Government - Roadway Management

Highway accident location and report.



Work Zone Locations.

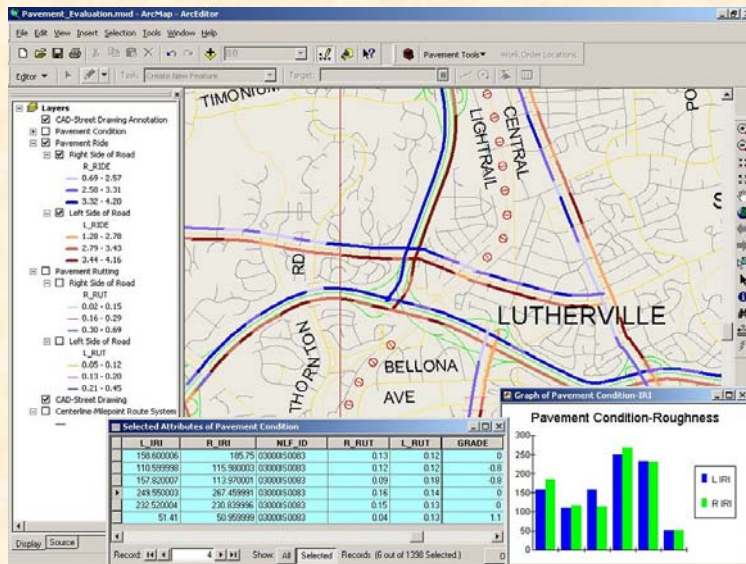


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State and Local Government - Roadway Management

Pavement, bridge, and other infrastructure management and maintenance.



Work Order Management System for Potholes.

The screenshot shows a 'Work Order Management System for Potholes' interface. It includes a map of a city area and a 'Service Request # 17110 Potholes / Potholes' form. The form contains fields for Description, ID, Status, Priority, Category, and various dates and times.

Service Request # 17110 Potholes / Potholes

Description: Potholes
ID: 17110
Status: 2 Medium
Priority: 2 Medium
Category: 2 DEFECT
Submitted By: INSPECTOR
Submitted Date: 6/2/2006 4:23:00 PM
Opened By: INSPECTOR
Opened Date: 6/2/2006 4:23:00 PM
Dispatched To: MM/DD/YYYY
Closed By: MM/DD/YYYY
Enter SFI Completion Date: []

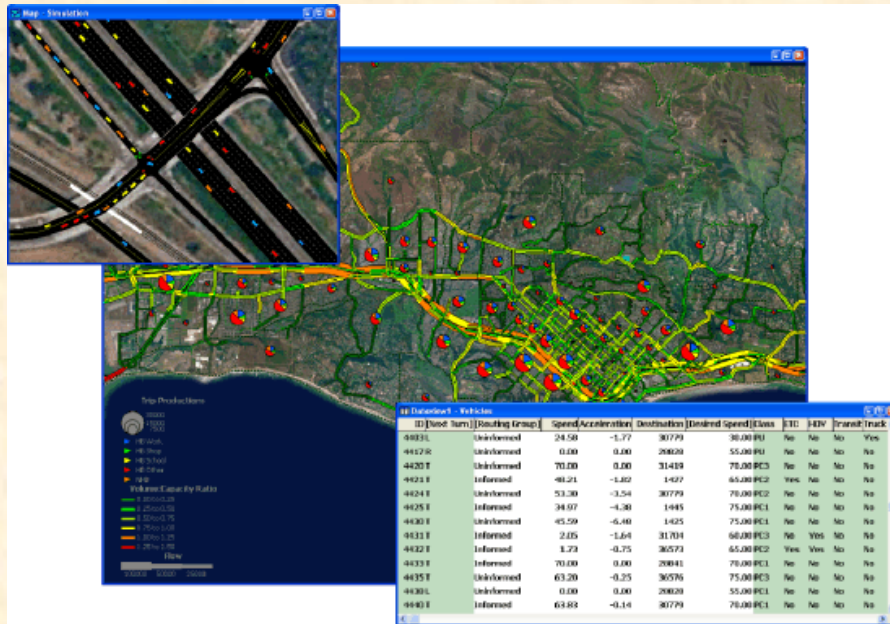
Incident Address: 1234 PINE ST
City: Philadelphia
State: PA
Zip: 19101
Date/Time: 6/2/2006 4:23:00 PM
First Name: []
Last Name: []
Address: []
City: []
Home Phone: []
Other Phone: []
Email: []
Caller Information: SWP02053

Customer Contacted on Site? []
Customer Contacted Afterwards? []



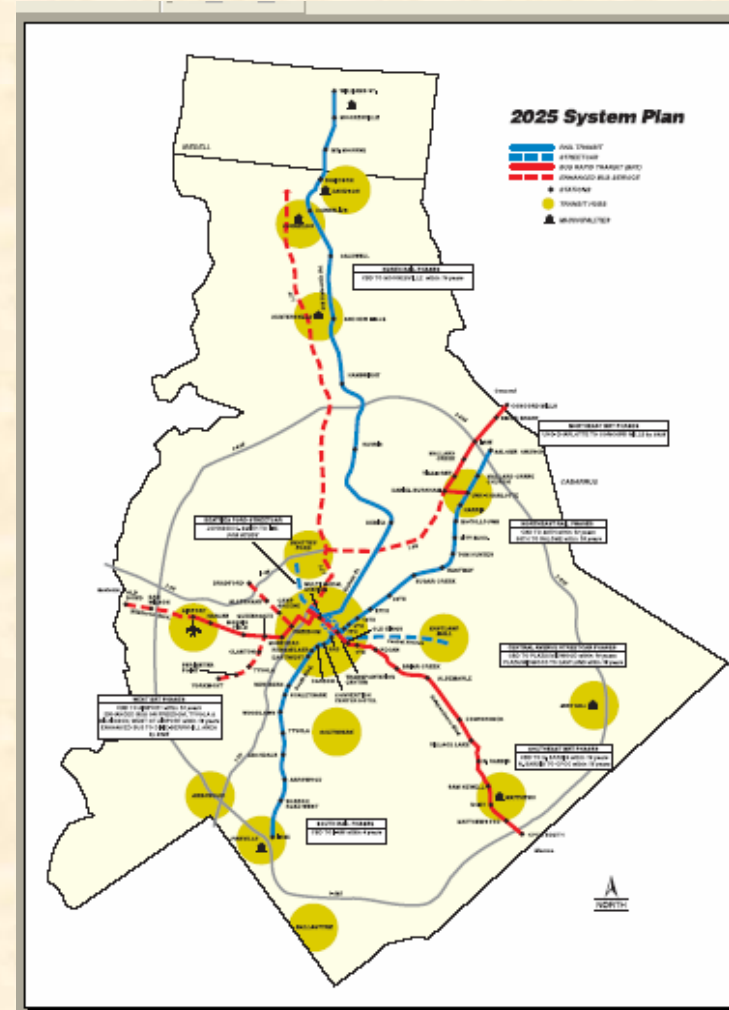
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State and Local Government - Planning and design for future transportation systems



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

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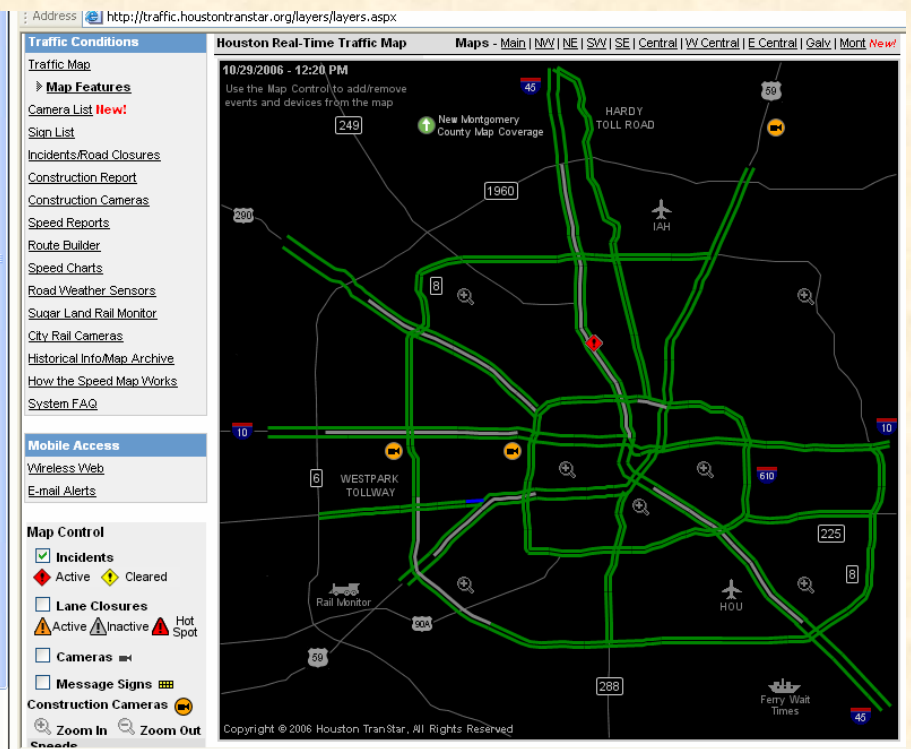


Transit system planning for the Charlotte, NC region.

State and Local Government – Operations

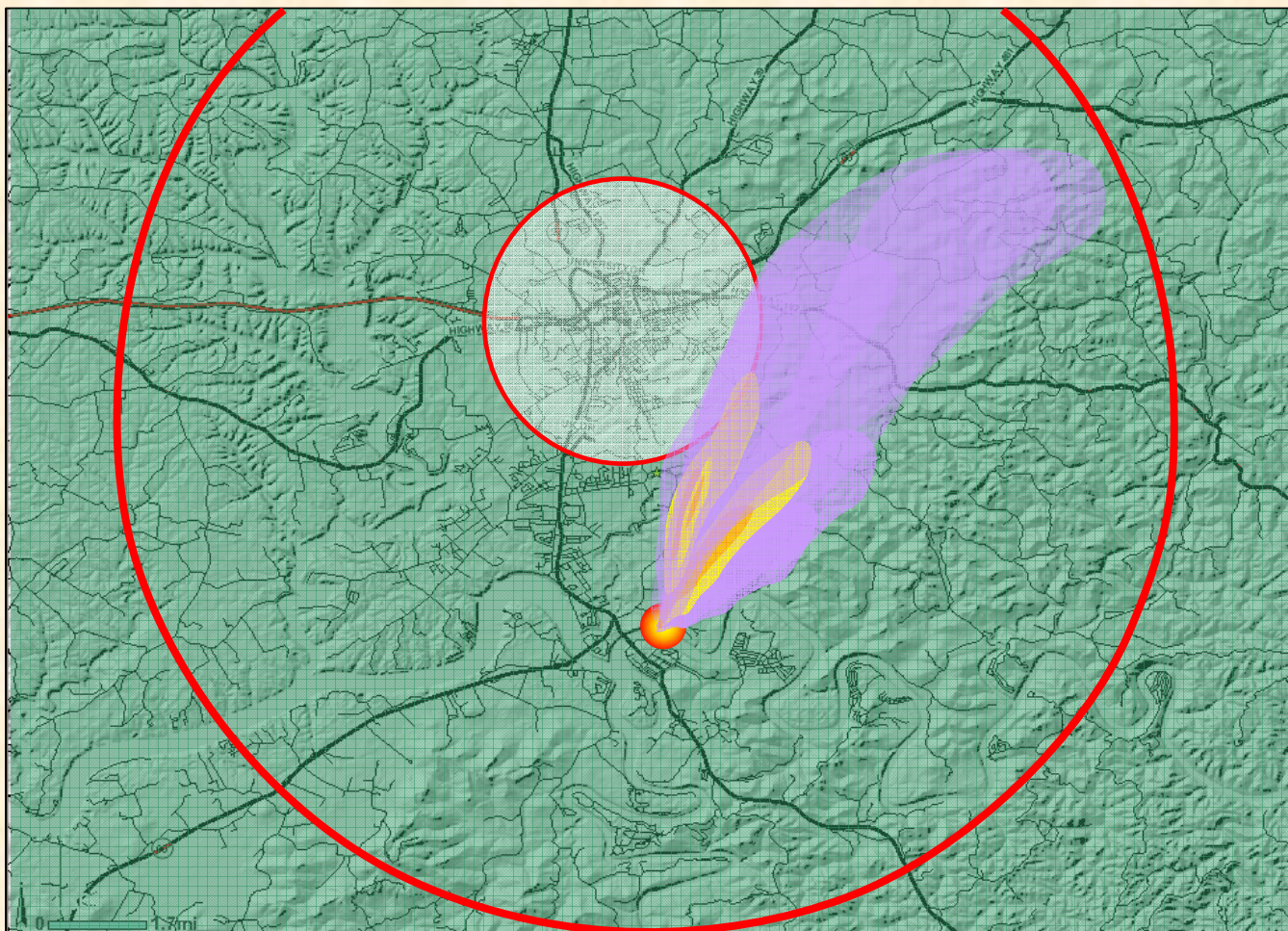


Traffic conditions map in Kentucky



Traffic conditions map in Houston

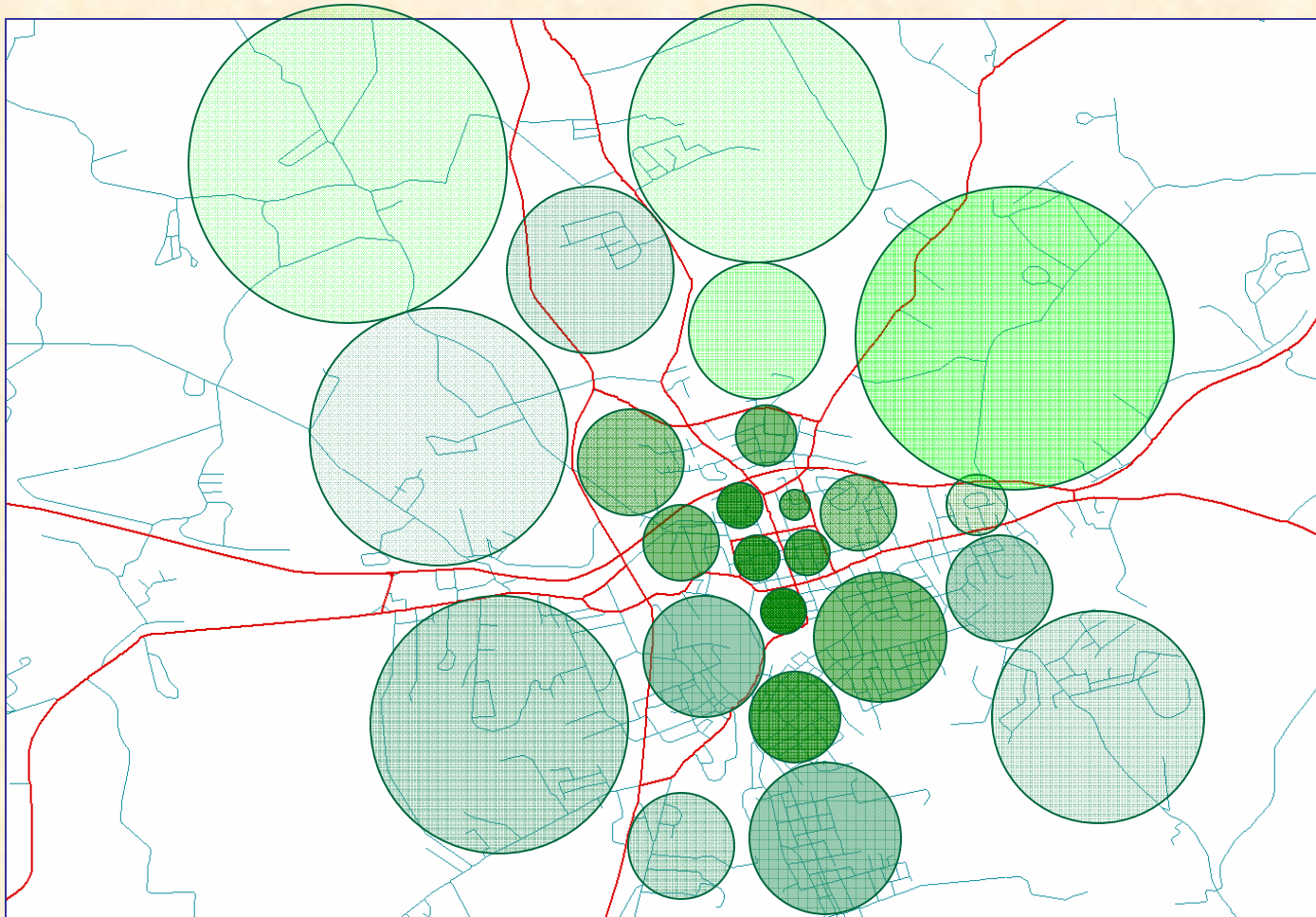
State and Local Government - Evacuation Modeling



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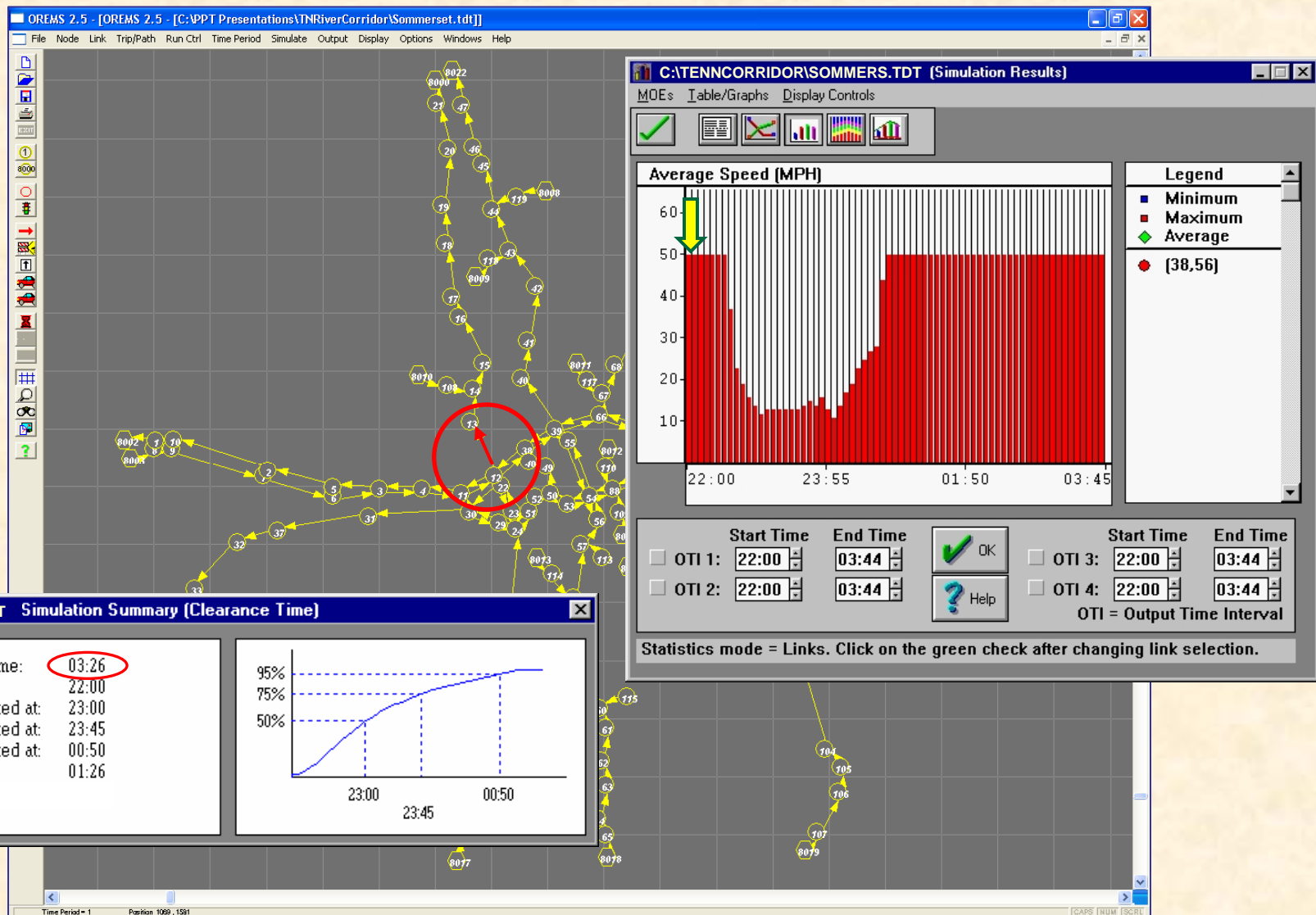


Evacuation Model Inputs

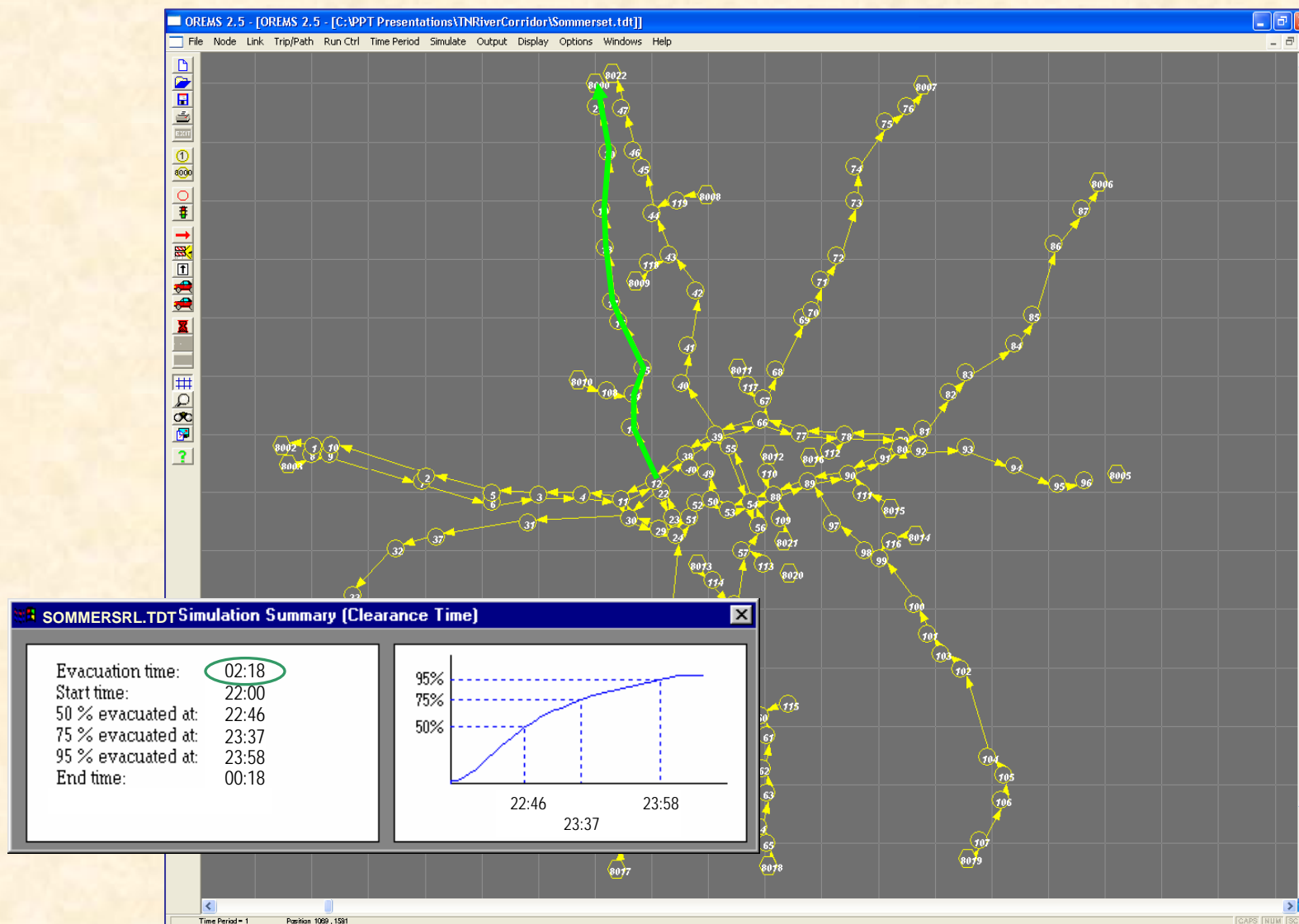


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Traffic Management Strategy



Government Applications – Federal Government

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

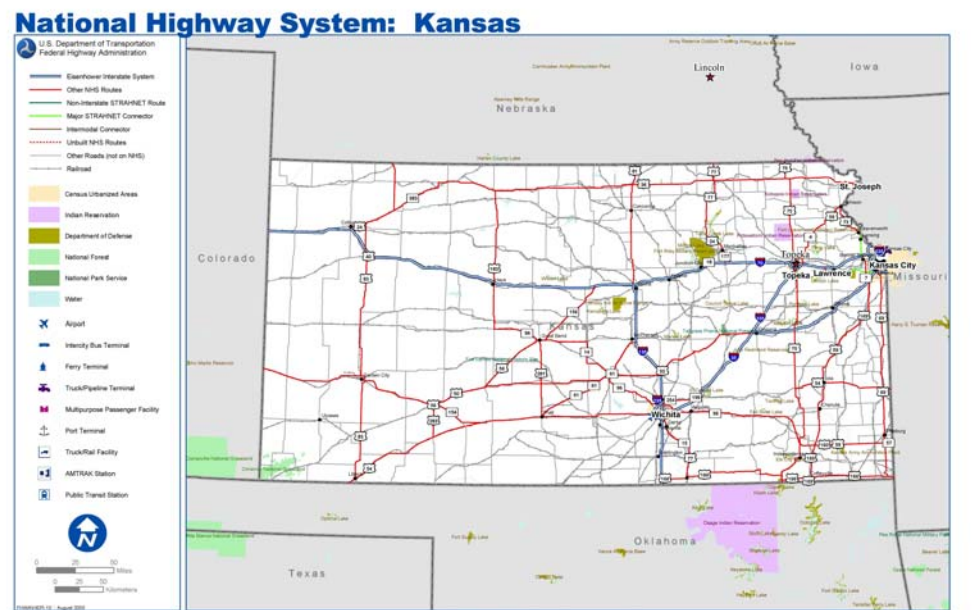
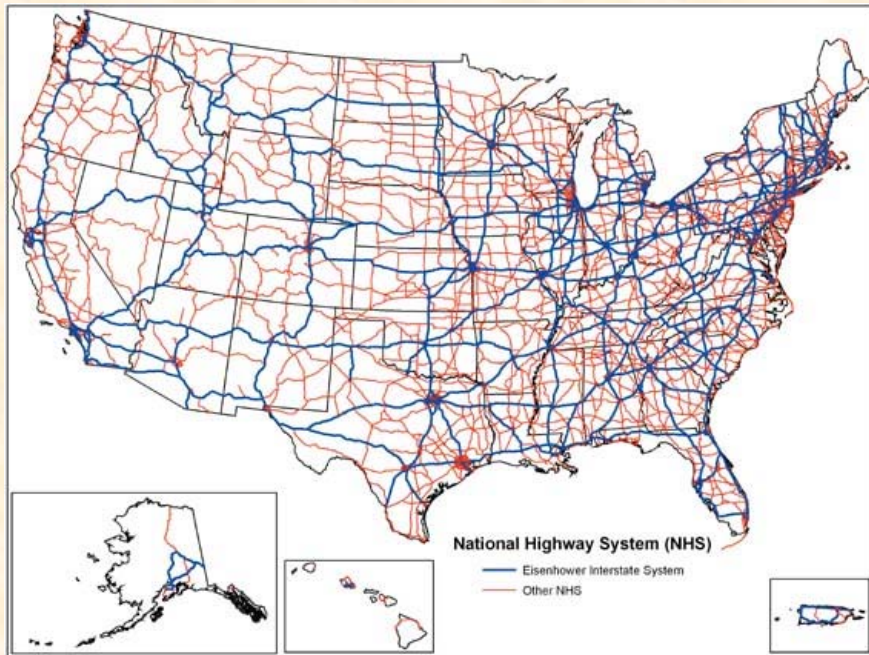


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Federal Government – US Department of Transportation

National Highway Planning Network

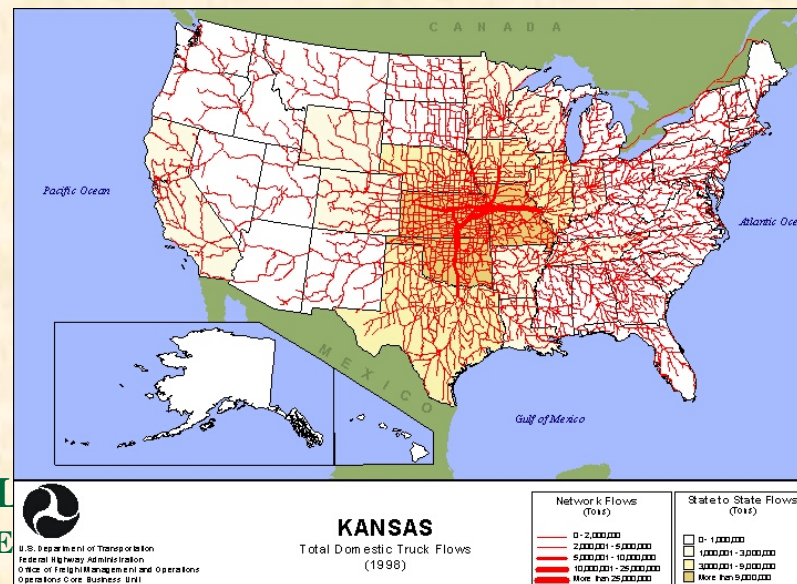
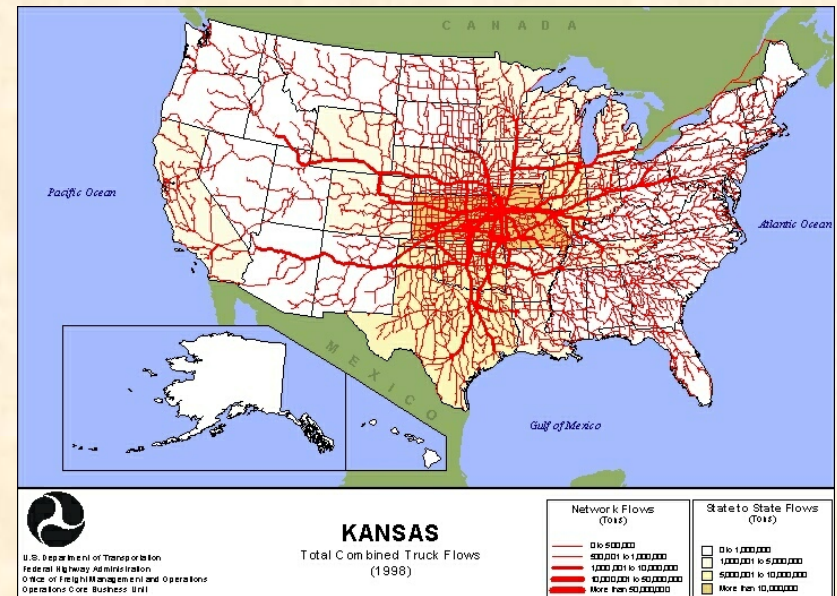
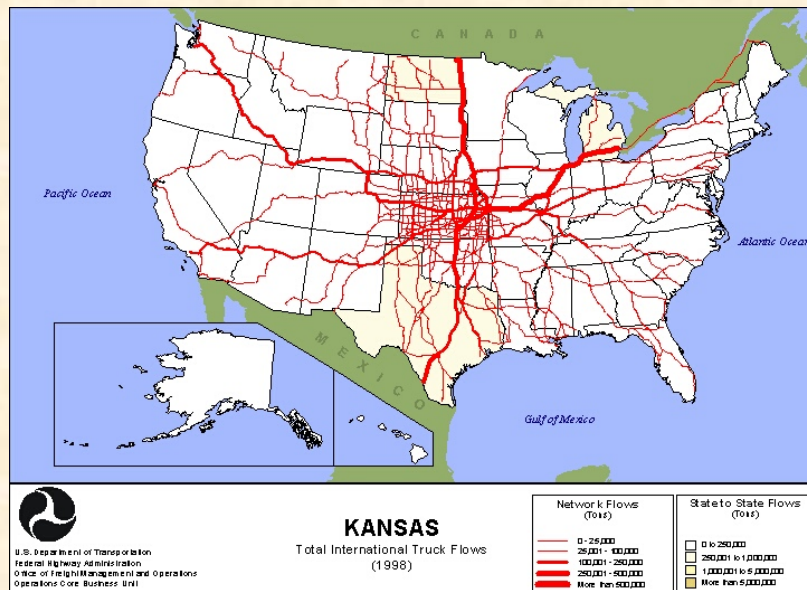


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Federal Government – US Department of Transportation

Freight Analysis Framework



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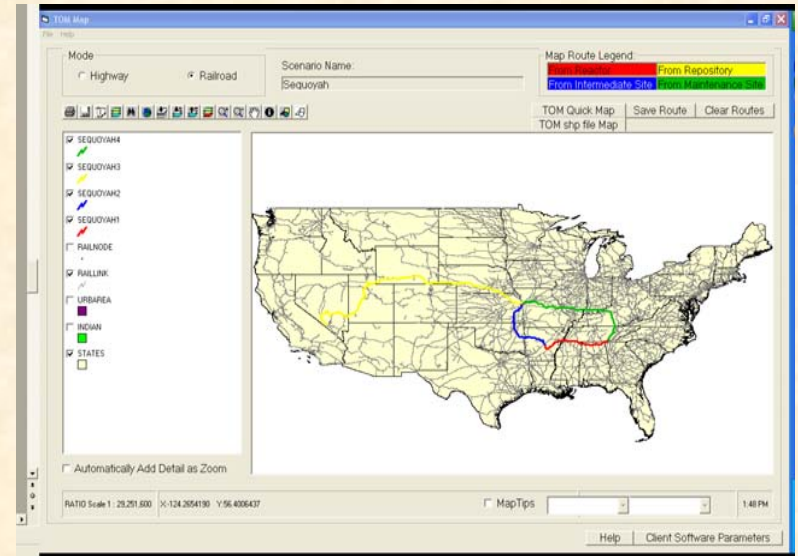
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Federal Government – Department of Energy

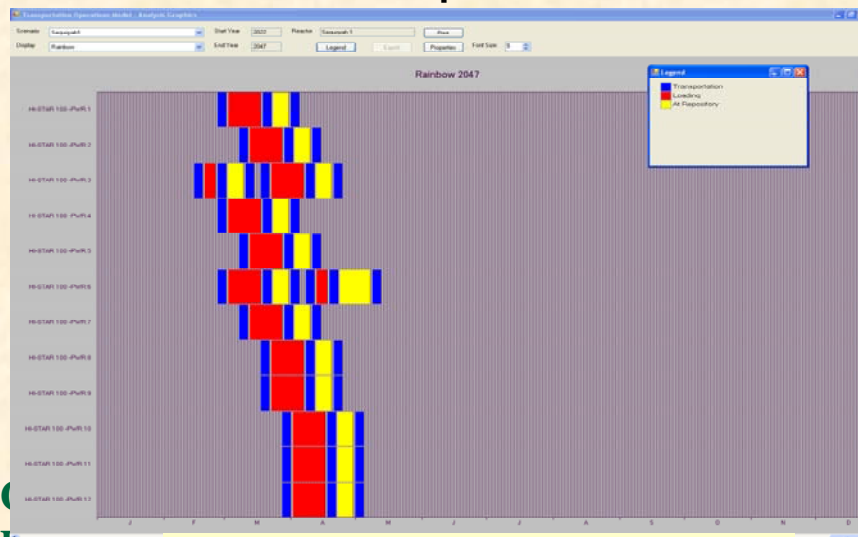
Route and Logistics Planning for Spent Nuclear Fuel Movements



National Transportation Network

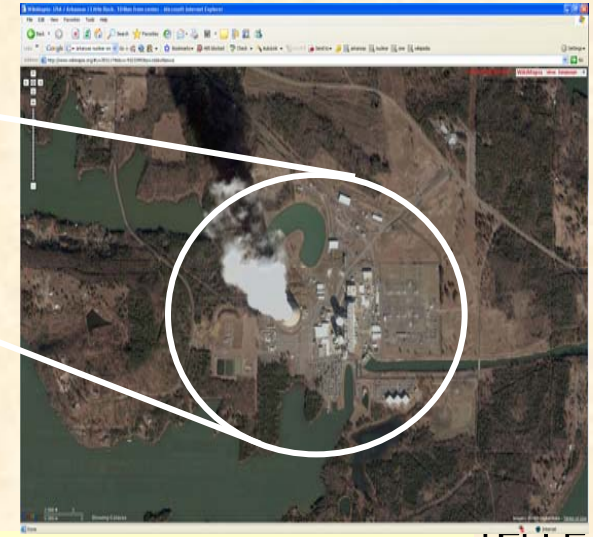
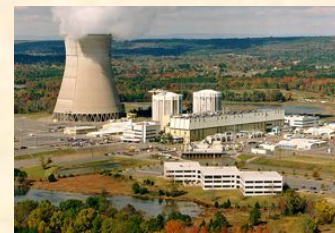


Individual Reactor Campaigns



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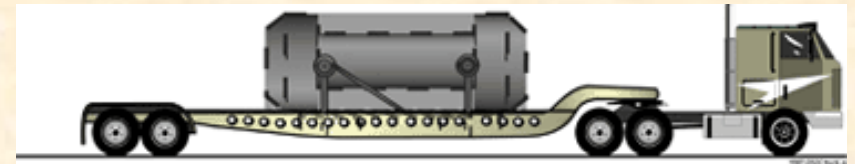
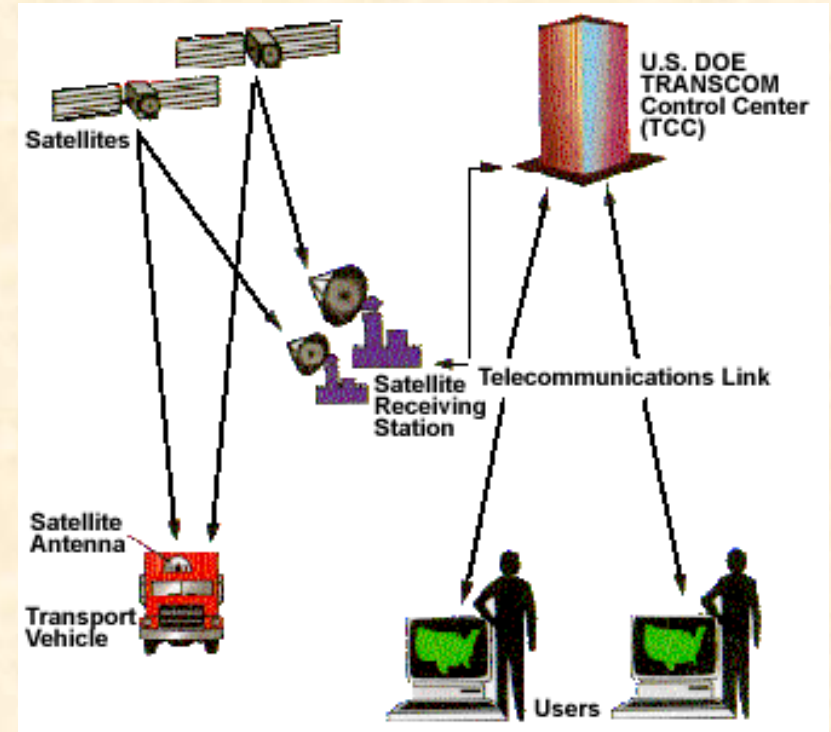
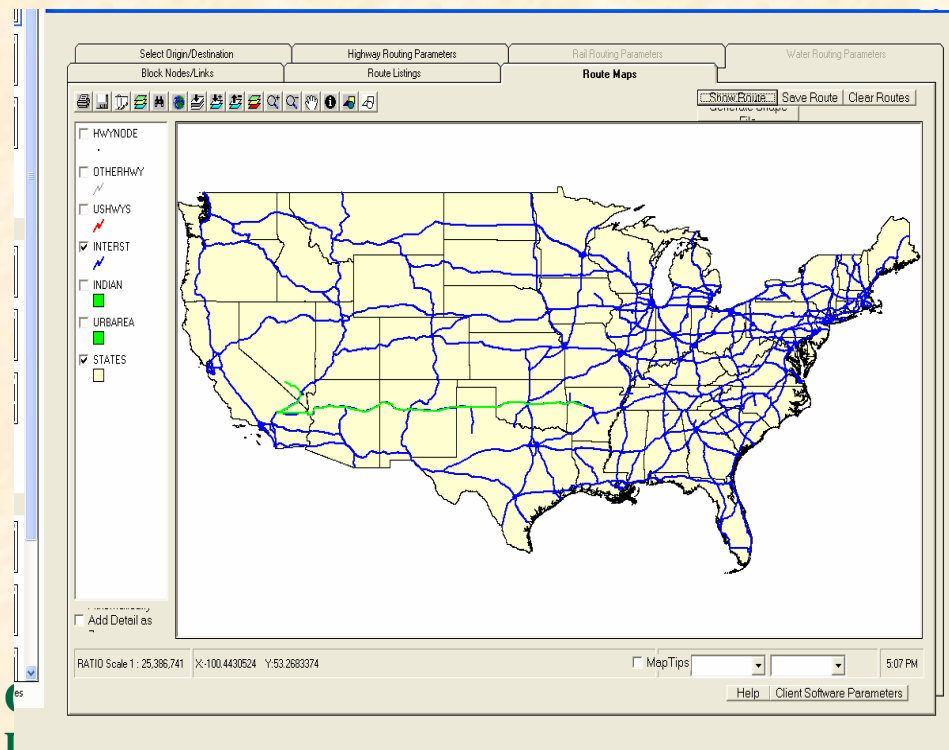
Cask Movement Schedule

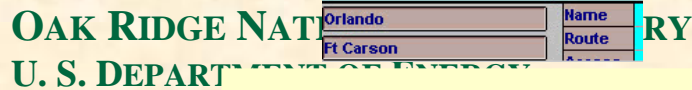
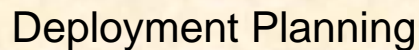


Logistics at the Reactor Site

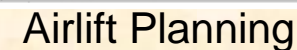
Federal Government – Department of Energy

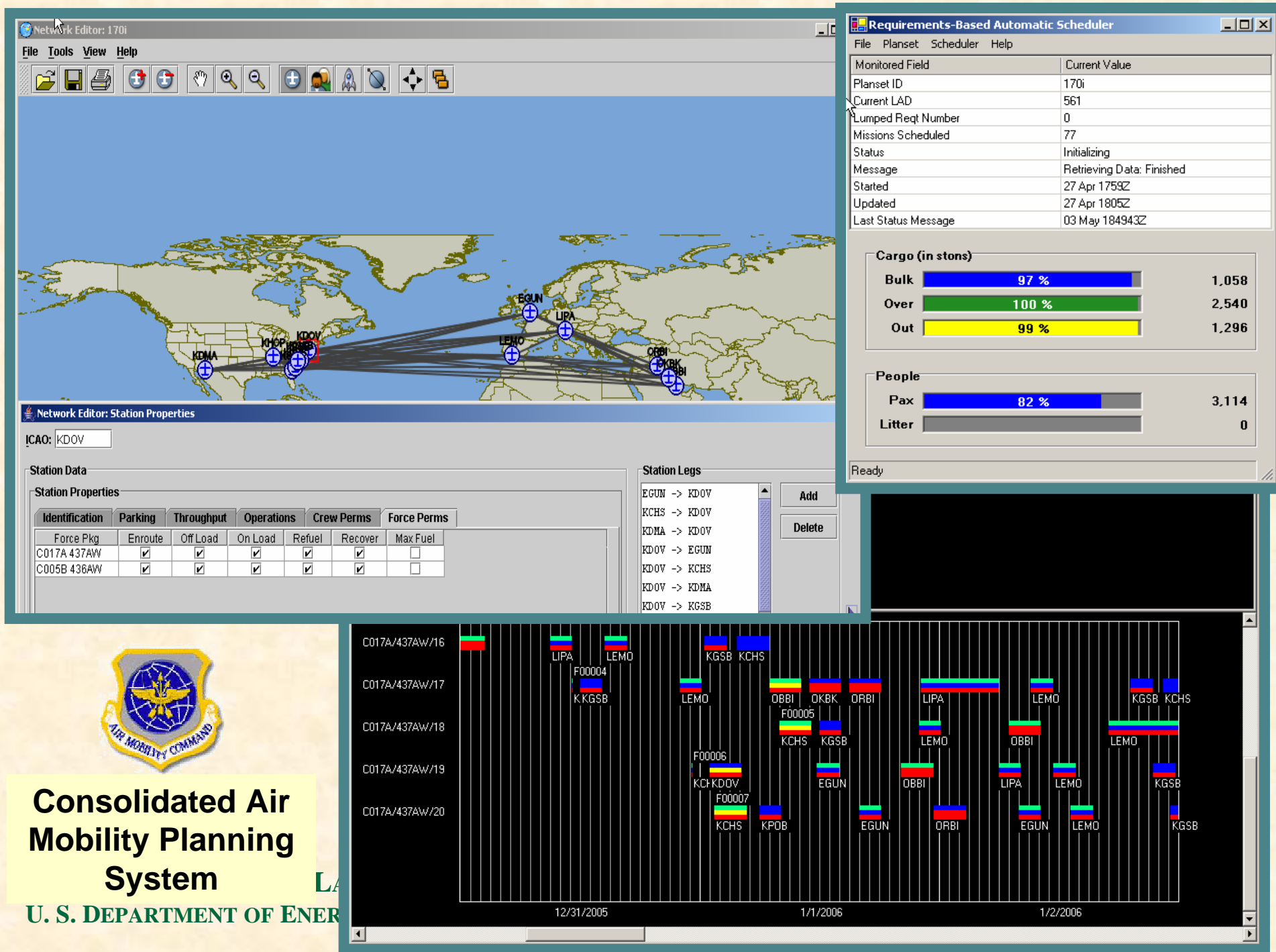
- A real-time tracking system was developed for use by DOE to track spent nuclear fuel shipments





Sealift Planning





c.Limited Distribution c.Space Imaging Inc., Licensed for DOD Title 50 c.Digital Globe Inc., Licensed for DOD Title 50

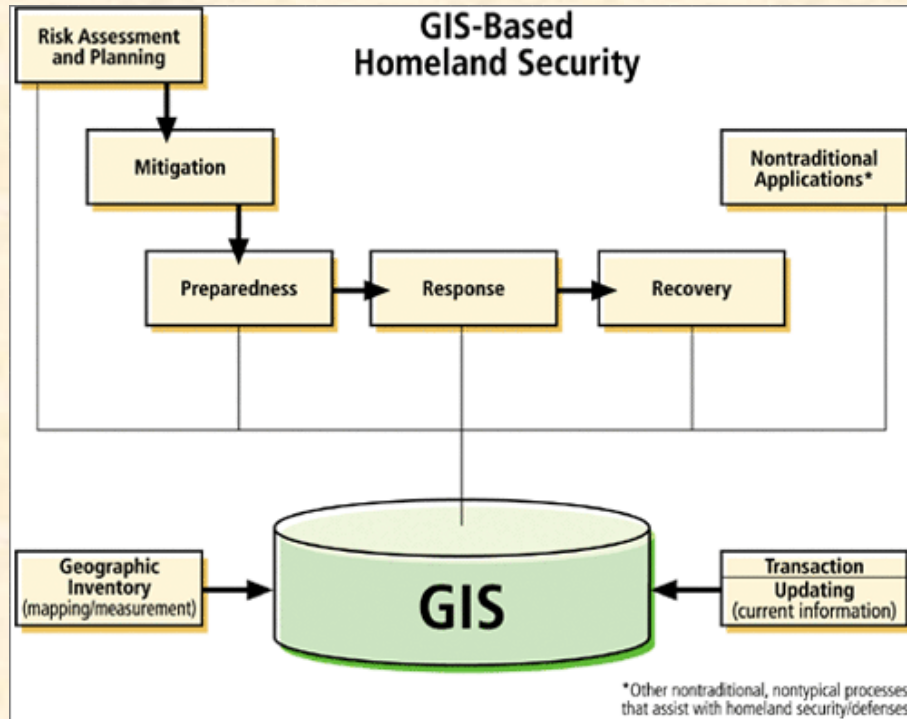
1. Transportation networks (road, rail & bridges)
2. Tracking data
3. Deployment infrastructure
4. Imagery & topographic layers
5. Real-time data (cameras, weather & traffic)
6. Critical energy nodes
7. Emergency response
8. Law enforcement
9. Military installations
10. Government agencies



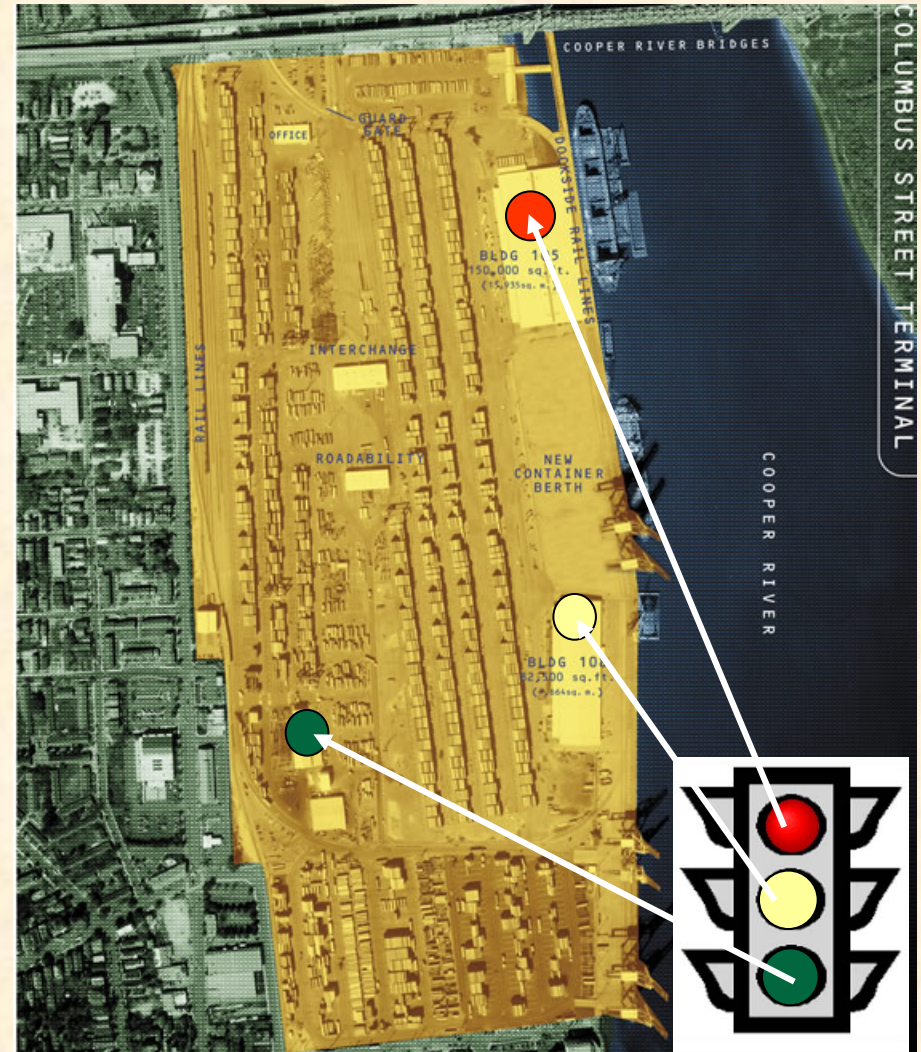
Federal Government – Department of Defense



Federal Government – Department of Homeland Security



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



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UT-BATTELLE

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