Geographic Information Systems – Applications in Transportation

For
GIS Day
University of Kansas

15 November 2006

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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
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.

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

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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

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
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

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Commercial Applications - Motor Carrier

- Fleet management of tractors and trailers
- Routing and scheduling of the fleet through a sequence of delivery and pickup 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

Location Information

Tractor

Trailer

Container

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

Transportation Operations Center → Network Operations Center → Mobile Telephone Network

Internet Transfer Location & Communication → Internet Transfer Location & Communication

Location Information & Communications

Rail Car
Tractor
Trailer
Container
Barge

DoD GPS Satellites

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Vehicle Location Technology using Global Location and Communication Satellite

Transportation Operations Center

Network Operations Center

Private Sector Tracking & Communications Satellites

Location & Communication Information

Internet Transfer Location & Communication

Internet Transfer Location & Communication

Rail Car

Tractor

Trailer

Container

Barge
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.
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

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State and Local Government - Evacuation Modeling
Evacuation Model Inputs
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

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Federal Government – US Department of Transportation

Freight Analysis Framework

[Maps showing freight flows in Kansas]
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
A real-time tracking system was developed for use by DOE to track spent nuclear fuel shipments.
Joint Flow and Analysis System for Transportation

Deployment Planning

Sealift Planning

Airlift Planning

Highway and Rail Planning

Federal Government – Department of Defense
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
ArcView Network Analyst is being used in Bagdad to reroute military convoys.
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