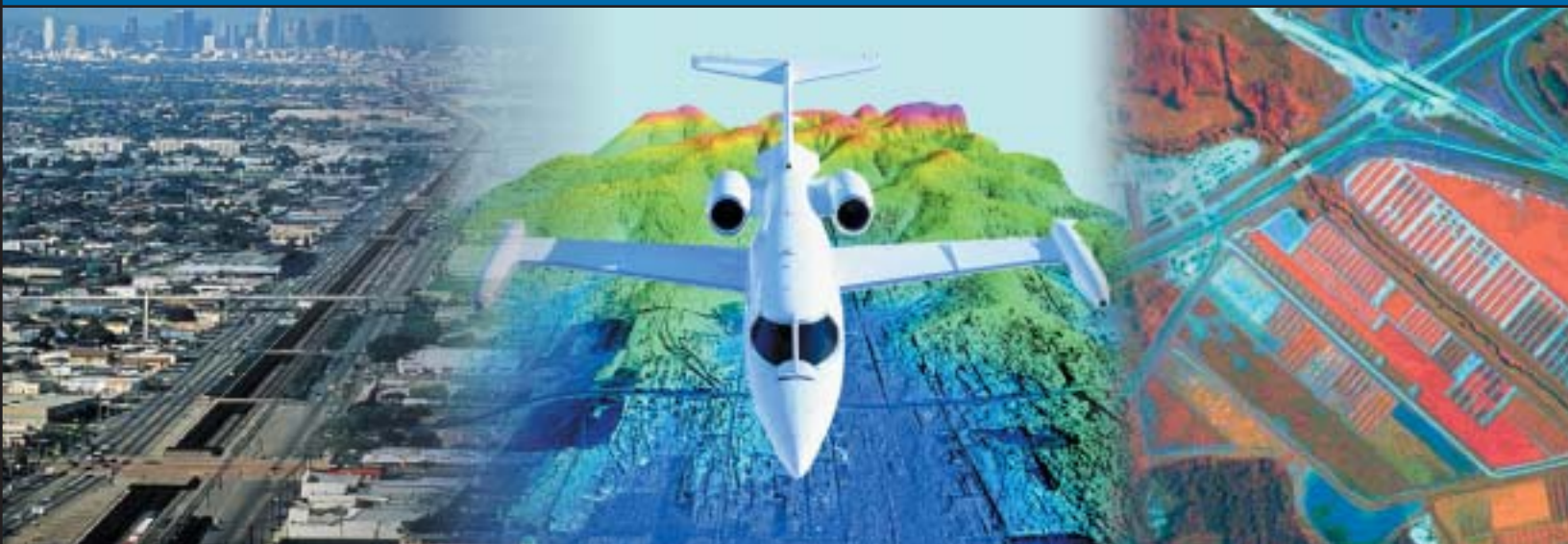


Remote Sensing and Geospatial Information Technologies Application to Multimodal Transportation



U.S. DOT Research Pays Off in Achieving Smarter
Transportation Services, Safety and Security

May 2003



A U.S. DOT Collaborative Program With NASA

Exploring And Implementing Technology Advances For 21st Century Transportation Using Remote Sensing and Geospatial Information Technologies

“Our Nation’s Transportation Systems face significant challenges in congestion, intermodal connectivity, freight efficiency, and project delivery. Nothing has as great an impact on our economic development and quality of life as transportation”—Secretary Norman Mineta

The national program on commercial remote sensing and geospatial information technology application was authorized under Section 5113 of the Transportation Equity Act for the 21st century. The collaborative program with NASA is administered by the U.S. Department of Transportation (U.S. DOT) Research and Special Programs Administration (RSPA). The program focuses on exploring applications of remote sensing technologies for delivering smarter, more efficient and responsive transportation services with enhanced safety and security.

The partnership program has built a technology base for applications to high-priority transportation service requirements, and has established a track record for implementing high payoff products in partnership with state transportation agencies. Four major priority areas of transportation requirements are the focus of national consortia, each consisting of teams from leading institutions, industries and service providers for the program. The program accomplishments have created a new model for R&D application by combining resources in technology implementation expertise from U.S. DOT with NASA research capabilities in remote sensing technologies in partnerships with universities and technology service providers. The partnership research delivered high payoff products in major service areas of importance to transportation:

- ❖ Faster and Cheaper Environmental Services: Achieved a technology application process for streamlining multimodal corridor planning and environmental data services for faster decision making at reduced costs.
- ❖ New Frontiers for Infrastructure Management Services: Developed and implemented new solutions for critical infrastructure asset management, and for improving maintenance service efficiency.
- ❖ Expanded Horizons for Traffic and Transportation Flow Services: Developed new horizons for monitoring and managing traffic and freight flow integrating remote sensing technology with intelligent transportation systems (ITS)
- ❖ Responsive and Robust Models for Disaster and Emergency Assistance Services: Applied technology advances for improving the preparedness response for unplanned disasters and security of critical transportation lifeline systems.

The annual report presents a ‘snapshot’ of products from the program that are poised to make new beginnings for advancing transportation service efficiency for the 21st Century. The product advances also represent a significant potential for U.S. transportation technology competitiveness to reach the global transportation services markets.

A U.S. DOT Collaborative Program With NASA

NASA

Ames Research Center
Dryden Flight Research Center
Glenn Research Center at Lewis Field
Jet Propulsion Laboratory
Johnson Space Center
Kennedy Space Center
Langley Research Center
George C. Marshall Space Flight Center
Goddard Space Flight Center
John C. Stennis Space Center

USDOT

Bureau of Transportation Statistics
Federal Aviation Administration
Federal Highway Administration
Federal Motor Carrier Safety Administration
Federal Railroad Administration
Federal Transit Administration
Maritime Administration
National Highway Traffic Safety Administration
Research and Special Programs Administration

Program Management

Research and Special Programs Administration

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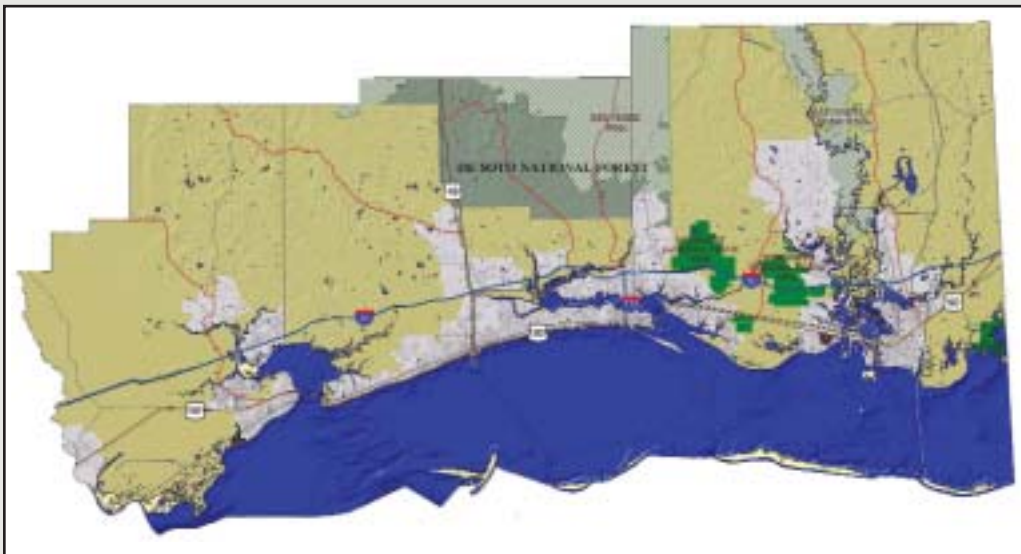
Faster Multimodal Project Planning and Delivery By Streamlining Environmental Impact Assessments for Transportation Agencies

Ground breaking applications of remote sensing and geospatial information technology tools for corridor planning decision-making are now underway for relocating a railroad from Gulf Coast townships in Mississippi.

Planning a transportation corridor is a high-stakes process. Many potential solutions exist, many variables must be weighed, many viewpoints considered, and costs and benefits analyzed. The process is expensive and can take several years. Remote sensing and geospatial information technology are providing decision makers smarter decision support tools for application in multimodal corridor planning at significantly reduced cost and time.

The rail relocation and corridor planning study currently underway in the Gulf Coast area will develop options for relocating the railroad and intermodal connectors, providing improved port access, and reducing transportation bottlenecks and the number of grade crossings. The pioneering study applies remote sensing and

geospatial information technologies for developing an Environmental Impact Statement (EIS). The project is carried out in cooperation with Mississippi DOT with the goal of achieving increased efficiency of project planning, shortening project timelines for delivery, and significantly reducing costs for developing options for multimodal corridor relocation.



Airborne Sensor Data Fusion Enables a Fast Track NEPA Streamlining

The application of airborne remote sensing technology was tested for streamlining environmental permitting process in collaboration with the North Carolina DOT. The

results demonstrated the feasibility of using aerial remote sensing imagery analysis to collect data faster and at a lower cost for preliminary planning before engineering design activities. This application helps to streamline the NEPA permitting process and allows a faster, cost-effective development of potential options within existing project budgets.

Intermodal Connector Analysis Tool (ICAT)

Remote sensing imagery was successfully applied for analysis of intermodal connectors in the Alameda Corridor area of southern Los Angeles, a \$2.8 billion freight transportation system connecting the ports of Los Angeles and Long Beach with the intercontinental rail system. An "Intermodal Connector Analysis" tool was made available to transportation planners with operational guidelines for a step-by-step integration of remote sensing imagery and geo-spatial information systems for planning freight corridor transfer stations and offport freight inspection facilities.

New Frontiers Are Emerging for Smarter Management of Transportation Infrastructure

Airborne and satellite sensors present a high-resolution, synoptic overview of the highway system, for monitoring assets, reviewing structural integrity, and assessing damage following any unplanned events or service disruptions.

The infrastructure lifecycle begins with planning, design, and construction. Subsequent maintenance management of critical infrastructure demands accurate mapping and periodic condition assessment at a significant maintenance cost and site inspection time.

Faster Bridge Inventory, Asset Management and Condition Identification

The health of a bridge structure can be evaluated by measuring the magnitude of change in the structure from a sequence of images acquired before and immediately after a major incident causing damage or disturbance. Successful remote sensing toolboxes were demonstrated in cooperation with Wisconsin DOT to facilitate the location of bridges from remotely sensed imagery with attribute information from databases, such as the National Bridge Inventory for optimizing the field inspection process.

LIDAR Application Cuts Costs for Preliminary Roadway Design and Location Planning

LIDAR is a relatively new terrain survey technology. A study in cooperation with Iowa DOT evaluated the benefits of LIDAR for preliminary design of roadways. The results show that LIDAR can be used effectively in combination with photogrammetry to reduce costs and to provide timely terrain models for an entire transportation corridor. Cost savings exceeding 50% are estimated by applying the LIDAR technology.

Merging Growth with Land Use Planning for Aviation Infrastructure

Remote sensing data were successfully applied to form an easily deployable GIS solution for use by several airports, including the Portland International Jetport, City of Portland Council of Governments, and Maine DOT transportation planners. The method facilitates cost effective regional planning of airports and estimates potential impact of airport configuration changes on multimodal corridors and land areas.



Remote Sensing Tools for Disaster Preparedness and Lifelines Security

Remote sensing and geospatial information technologies provide tools for enhancing the security of transportation systems. Real-time information on the transportation network through imagery allows agencies to effectively manage traffic and to plan community evacuation and relief operations in case of transportation lifeline emergencies.

Rapid Evacuation Planning and Disaster Preparedness for Communities

During the Oakland Hills fires of 1991, 25 people perished in their cars while evacuating their neighborhood due to a lack of preparedness. The relatively large emergency fire evacuations that occurred in Colorado, New Mexico, and Oregon in the summer of 2002 point out the growing need for hazard preparedness at the community level.

Remotely sensed imagery helps to identify the most fire-prone areas and to develop fire propagation models. Detailed neighborhood maps with microsimulation models allow emergency evacuation to be modeled at the level of the individual vehicle for avoiding congestion during evacuation.

Evacuation Tool Kits Assist Local Planners in Emergency Response Preparedness

Evacuation simulations using road networks and population estimations derived from remotely sensed imagery and GIS databases support evacuation planning analysis for a nuclear power plant site in Hamilton County, Tennessee. Local emergency planners can use the evacuation model for enhancing community preparedness.

Robust and Integrated Emergency Response Planning Tools for Rural Areas

In a collaborative work with McKinley County, New Mexico, the New Mexico State Highway and Transportation Department, and the Hopi Reservation produced tool sets for developing robust emergency response and preparedness plans.

Expanding Horizons in Traffic and Freight Flow Monitoring, Surveillance and Safety

Remotely sensed data from airborne and satellite imagery have the advantage of capturing traffic patterns on a wider scale for multimodal transportation management, providing cheaper and more accurate traffic flow measures.

Cost Effective and Smarter Monitoring of Traffic Flow

Average Annual Daily Traffic (AADT) and Vehicle Miles Traveled (VMT) are two important measures of traffic flow collected by the 50 DOTs for use in traffic planning and management. Combining remotely sensed imagery with ground data reduces the cost of ground-based sampling efforts by more than 50% while substantially increasing the accuracy of AADT and VMT estimates. Airborne imagery enables collection of peak hour volumes, vehicle classification counts, turning movements at intersections and interchanges, and vehicle speeds. In security applications, unmanned aerial vehicles (UAVs) can monitor an incident on highways and can follow questionable vehicles along their routes.

Cost Effective Solutions for Safe Landings at National Airports

Integrating LIDAR with high resolution airborne and satellite imagery was demonstrated at the Santa Barbara Municipal Airport. Results provided current geospatial information on airport facilities and helped to identify obstructions surrounding the airspace for the safety of airport landings.

Versatile New Remote Sensing Platforms Using Unmanned Aerial Vehicles (UAV)

Pioneering UAV demonstrations have shown the ability to collect information on new land uses, traffic congestion, parking lot utilization, and condition of highway signage in urban and rural transportation settings.

UAVs can be programmed off-line and controlled in real time to navigate and to collect transportation surveillance data. The vehicles weigh from 10 to 55 lbs and can carry a variety of multiple and interchangeable imaging devices, including day and night real-time video, multispectral and hyperspectral sensors, thermal, synthetic aperture radar, moving target indicator radar, laser scanners, and chemical, biological and radiological sensors.

Successful Multimodal Application Using UAV

UAVs were successfully tested for following urban and rural transportation routes, tracking moving vehicles, and hovering over junctions of traffic congestion. Geospatial imagery collected by UAVs helped the Cape Cod Regional Transit Authority (CCRTA) to improve transit and paratransit operations management.



Results and Products for Enhancing the Potential for U.S. Transportation Service Competitiveness in the Global Market

Collaborative partnership agreements have been entered for application of U.S. transportation services using remote sensing technologies in other countries. These collaborative agreements provide potential pathways for U.S. transportation service providers to reach global transportation markets. The U.S. consortia and program partners have entered into a memoranda of understanding for technology transfer with partners in Western Europe, the People's Republic of China, and India.

Partnership Projects Producing Payoffs for Multimodal Transportation

ENVIRONMENTAL IMPACT FOR MULTIMODAL CORRIDOR PLANNING

Mississippi State University Consortium
www.ncrste.msstate.edu

Streamlining the decision process for corridor planning and relocation

- ❖ Developing new solutions for transportation relocation and corridor planning.
- ❖ Developing algorithms for using raster and vector geospatial data in corridor planning.
- ❖ Relocating the CSX railroad in the Mississippi coastal corridor.
- ❖ Assessing urban growth in coastal corridors.
- ❖ LIDAR applications for terrain mapping and hydrologic analysis.
- ❖ LIDAR application for alignment optimization.
- ❖ Hyperspectral image data for wetland vegetation mapping and analysis.
- ❖ Geospatial data fusion application to transportation environmental assessment.
- ❖ Analysis of transportation, development, and population growth impacts on urban watersheds.
- ❖ LIDAR measurements of air pollutants and air quality modeling.
- ❖ Assessing urban growth and transportation impacts on human and natural environments.
- ❖ Developing computational mapping resources and geospatial data libraries for environmental assessment and transportation corridor planning.
- ❖ Assessing user needs for geospatial and remote sensing technologies in transportation.

Mississippi State University
Univ. of Alabama in Huntsville
University of Mississippi
Auburn University
USRA
NASA Marshall Space Flight Ctr.
DigitalGlobe
Intermap Technologies Corp.
Earth Data Technologies, LLC
ITRES Corporation

Virginia DOT
EarthData
ICF Consulting
Washington State DOT
Veridian Systems Division

INFRASTRUCTURE ASSET MANAGEMENT AND SAFETY

University of California Santa Barbara Consortium
www.ncgia.ucsb.edu/ncrst

New solutions for infrastructure asset management

- ❖ Responding to security threats, hazards and disasters.
- ❖ Evacuating a small neighborhood: infrastructure adequacy.
- ❖ Meeting the challenge of inventory assessment.
- ❖ Urban hyperspectral sensing and road mapping.
- ❖ LIDAR applications for highway design and construction.
- ❖ LIDAR for engineering design.
- ❖ BridgeView – a tool for bridge inventory and assessment.
- ❖ Security siting of off-port inspection facilities.
- ❖ Tools for managing highway bridges for the National Bridge Inventory.
- ❖ Aviation infrastructure planning and development support.

Univ. of California, Santa Barbara
University of Wisconsin-Madison
Iowa State University
University of Florida
Digital Geographic Research Corp.
Geographic Paradigm Computing Inc.

Florida DOT
University of Massachusetts
Orbital Imaging Corporation
Tetra Tech, Inc.

DISASTER PREPAREDNESS AND LIFELINES SECURITY

University of New Mexico Consortium
www.trans-dash.org

Hazards, disasters, and security response

- ❖ Integrating remote sensing technology for planning evacuations in emergencies.
- ❖ Detecting damaged bridges for emergency response in southern California.
- ❖ Planning community evacuations for large populations.
- ❖ Tools for managing highway bridges.
- ❖ Transportation hazards consequence tool.
- ❖ Accessing and delivering geospatial data and toolkits for transportation applications.
- ❖ Protecting the critical infrastructure using Rational Mapper—a tool for processing high-resolution images.
- ❖ Assessing pipeline and airport safety using automated processing of LIDAR data.
- ❖ Hyperspectral analysis of urban surface materials.
- ❖ Lane-based evacuation routing tools to reduce evacuation times.
- ❖ Detailed evacuation simulations for identifying communities that could be trapped in a bottleneck.
- ❖ Mapping areas of potential damage to highways and pipelines due to land subsidence.
- ❖ New remote sensing technologies for planning and maintaining pipeline corridors.
- ❖ Managing rural roads in Indian reservations.
- ❖ Calculating mileages for highway performance monitoring for FHWA.
- ❖ Identifying glide path safety obstructions at the Santa Barbara Municipal Airport.
- ❖ Weather-Related Road Hazards Assessment and Monitoring System for real-time weather monitoring and rural road condition assessment.
- ❖ High-resolution satellite data updates E-911 road information.

University of New Mexico
University of Utah
Oak Ridge National Laboratory
George Washington University
York University

ImageCat, Inc.
DigitalGlobe
AERIS Inc.

MULTIMODAL TRANSPORTATION FLOW MANAGEMENT

Ohio State University Consortium
www.ncrst.org

Integrating remote sensing for transportation operations

- ❖ Improving a real-time bus information system with image-based backdrops.
- ❖ Applications for traffic operations.
- ❖ Cheaper and more accurate traffic measures using satellite and airborne imagery.
- ❖ Determining highway level of service using airborne imagery.
- ❖ Improving freight flow management.
- ❖ High resolution georeferencing from airborne images for traffic flow.
- ❖ "Bird's-eye" views of transportation networks for mitigating urban congestion.
- ❖ Exploring LIDAR applications for traffic flow.
- ❖ Pioneering traffic data collection from UAVs.
- ❖ Automated vehicle tracking from airborne video.
- ❖ UAV applications for multi-modal operations.
- ❖ Airborne Data Acquisition System (ADAS) for traffic surveillance.

The Ohio State University
George Mason University
University of Arizona

GeoData Systems Inc.
TerraMetrics Inc.
Veridian
Grafton Technologies
Technology Service Corp.
Bridgewater State College