



# Ahead of the Curve with Intelligent Transportation

Advanced technologies to ensure the safe, efficient,  
and secure movement of passengers and freight.

**OAK RIDGE NATIONAL LABORATORY**

MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

# Intelligent transportation is changing the way America moves.

Through seamless networks and advanced technologies, smart vehicles and infrastructure will talk to one another and share information with users to improve safety, reduce congestion and travel time, and decrease fuel consumption and emissions.

Marshalling its resources as the U.S. Department of Energy's (DOE) largest science and energy laboratory, Oak Ridge National Laboratory (ORNL) is actively partnering with federal and state agencies, industry, and academia to broaden the reach of intelligent transportation throughout America's civilian, commercial, and military sectors. Working with these partners, researchers from across the laboratory are developing and integrating new technologies that capture, analyze, and share data and information, and solve problems related to passenger and freight movement. Several examples are highlighted in this brochure.

## Capture

**Software defined and cognitive radio** – ORNL's software defined and cognitive radio research supports the U.S. Department of Transportation's (DOT) IntelliDrive<sup>SM</sup> Program objective to connect vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and vehicle-to-personal device (V2P), enabling communication among technologies such as cell phones, navigation systems, radio towers, and traffic lights.



*ORNL cognitive radio technologies are helping connect users, vehicles, and infrastructures.*

**Trusted Corridor** – ORNL has been working with Southeastern states to form a network of information collection points at weigh stations to prototype the interoperability of multiple sensor types and data bases to support federal, state, and local security, compliance, and safety needs. From passing trucks, the weigh stations collect real-time data from as many as seventeen sensor types. Plans are to initiate additional sensor collection points at bridges and underpasses.

**Tracking sensors** – ORNL works with the U.S. Department of Defense (DOD) to develop and evaluate cognitive radio devices that incorporate sensors and act as mobile, active radio frequency identification readers for military cargo to provide just-in-time, condition-based, in-transit visibility of critical assets throughout the entire supply chain, and continuous global connectivity.

**Real-time evacuation data** – ORNL, in partnership with a local private firm, has developed a real-time data gathering system that emergency management agencies and other public safety organizations can rapidly deploy to improve the operation of large-scale emergency vehicular evacuations. It includes the use of portable and easily deployable next generation loop detectors that can capture real-time vehicle speed and location. Prototype field testing plans are under way.

**Gamma/optical imaging** – Through a partnership with the U.S. Department of Homeland Security (DHS), ORNL researchers are using mobile, roadside gamma/optical imaging systems at border crossings to detect nuclear material in moving vehicles.

**Performance-based data** – Through a partnership with DOT's Federal Motor Carrier Safety Administration, state agencies, and academia, ORNL helped establish the Commercial Motor Vehicle Roadside Technology Corridor on Interstate 40/75/81. Using V2I technologies, on-board systems wirelessly collect vehicle, driver, and carrier data, identifying those that should be pulled over for further inspection. Performance-based brake testing and infrared truck inspection technologies are also being tested.



*Inside weigh station along the Commercial Motor Vehicle Roadside Technology Corridor.*

## Analyze

**Oak Ridge evacuation modeling system** – The Oak Ridge Evacuation Modeling System (OREMS) is a Windows-based software program designed for cities and communities to analyze and evaluate large-scale vehicular emergency evacuations, conduct evacuation time estimation studies, and develop evacuation plans.

**RealSim** – RealSim is an ORNL architecture that accommodates the ingestion of real-time data into simulations running on desk-top multiprocessing machines, clusters, and high-performance computers. Primary application testing has been performed for performance evaluation of software and hardware systems that support transportation and asset tracking simulations that are updated using real-time data from disparate data types such as sensors and video.

**ITS deployment tracking** – ORNL's Intelligent Transportation Systems (ITS) Deployment Tracking project provides critical support to DOT's IntelliDrive<sup>SM</sup> program by assessing national deployment and integration of intelligent transportation technology. Data is gathered through national surveys and analyzed by ORNL to support ITS decision making.

**Real-time, real-world duty cycles** – The Heavy Truck Duty Cycle project sponsored by DOE and the Medium Truck Duty Cycle project sponsored by DOE and DOT encompass performance data collection and analysis related to truck classes 6, 7, and 8 operating in real-world environments. ORNL developed the software for cleansing, managing, and analyzing the data that looks at engine performance, location, direction, speed, time-of-day, fuel consumption, road conditions, road grade, brake performance and tire performance, etc.



*As part of the Heavy Truck Duty Cycle project, ORNL led a four-year study that found wide single truck tires to be up to ten percent more fuel efficient than dual tires.*

## Share

**Sensorpedia** – Funded by DHS and supported in part by DOE, Sensorpedia is an ORNL initiative that utilizes Web 2.0 social networking principles to organize and provide access to online sensor network data and related data sets. It provides near-real-time collaboration among communities and permits users to publish, subscribe to, search for, connect to, and view sensor information.

**IntelliFreight Tracking 2.0** – Using Sensorpedia principles, ORNL's IntelliFreight Tracking 2.0 software integrates transportation sensor data across supply chains, enabling shippers, receivers, and local, state, and federal agencies to follow freight movement across state lines and within participating freight tracking systems.

**SensorNet** – ORNL's SensorNet is an incident management system available to federal, state, and local governments, and the private sector for the real-time detection, identification, and assessment of chemical, biological, radiological, nuclear, and explosive hazards through common response protocols and data highways. SensorNet was developed in partnership with the National Oceanic and Atmospheric Administration, the Open Geographic Information Systems Consortium, and private industry.



*ORNL technologies, such as Sensorpedia and IntelliFreight Tracking 2.0, are helping users share information to improve mobility and transportation efficiencies.*

## Solve

**Anomaly detection and data fusion** – From data collected through the aforementioned trusted corridor, researchers analyze anomalies found in these disparate data types and develop operations concepts for further investigation. Summary reports are developed within minutes and provided to station operators to support decision making. To improve anomaly detection, researchers are addressing systems and analytics issues related to data fusion. These include sharing and trust; social platforms; data streaming; tagging; distributed multi-model repositories and networks; mobile platforms; workflow capture; and large-scale data analytics.

**Vehicle diagnostics sensors** – ORNL researchers are working under DOE sponsorship of the U.S. Marine Corps to improve light armored vehicles using sensors imbedded in the vehicles to monitor real-time diagnostic and systems performance. The data can be used to enhance maintenance and longevity of future vehicles and reduce maintenance costs.



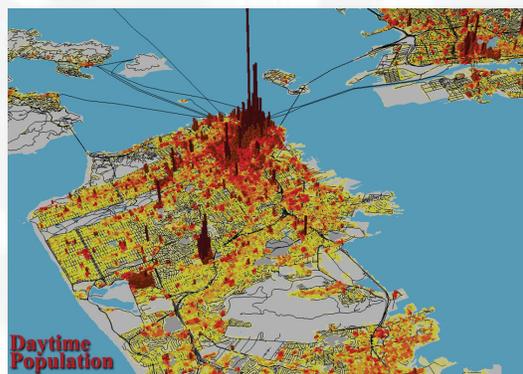
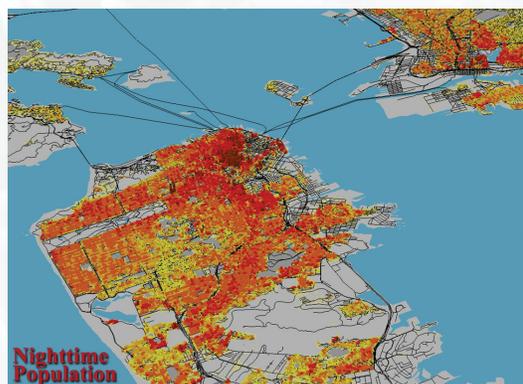
*ORNL sensor and analysis technology is being used to improve military vehicle readiness.*

**Fuel tax evasion** – This ORNL exploratory advanced research project detects fuel dilution and mixing to avoid fuel tax evasion. It involves the development of a nano-marker material capable of being put into gasoline and diesel shipments, and associated sensor technology that detects the nano-marker density in the fuel. The project also employs vehicle tracking, geo-fencing, and wireless communication of hatch and valve openings.

**GeoCTA** – GeoCTA is an ORNL tool that allows security managers and first responders to assess populations at risk, during the day and at night, and prepare for initial impacts of a disaster or transportation security incident. It provides up-to-date digital maps of high-threat urban areas, calculates populations at risk, and identifies alternative routes.

**Automated crowd flow pattern analysis** – ORNL has developed video analysis algorithms that interpret real-time streaming videos to detect anomalous crowd flow patterns, traffic volume, and pedestrian movement to improve situational planning and security management.

**High resolution population distribution and dynamics** – ORNL's LandScan USA is an activity-based population distribution and dynamics model that produces population data at unprecedented spatial and temporal resolutions. The databases incorporate demographic attributes and socioeconomic data and allow quick and easy assessment, estimation, and visualization of populations at risk. It's a valuable tool for transportation planning, emergency planning and management, rapid risk assessment, evacuation planning, consequence assessment, mitigation planning, and implementation. ORNL's LandScan global model provides a global-gridded population distribution estimate using the highest resolution database produced.



*LandScan USA images compare daytime and nighttime populations.*

**Evacuation modeling** – ORNL has developed meso- and micro-simulation based emergency evacuation models that can foster development of novel algorithms for human behavior and traffic assignments, and can simulate an evacuation of millions of people over a large geographic area. A number of modeling approaches, including agent based modeling and discrete event based simulations, are utilized to produce flexible and extensible modeling platforms.



**Integrated modeling, analysis, and visualization** iMAV is an ORNL-developed Web 2.0 software that integrates numerous data layers, analysis models, and graphical and spatial visualization tools into a web-based decision-making framework to determine how to improve today's transportation technologies and infrastructures.

*ORNL conducts a broad array of research focusing on evacuation planning and management.*

## Complementary research drives ORNL intelligent transportation technologies

ORNL is a leader in intelligent transportation research, addressing challenges related to transportation energy and environmental concerns, safety and security, planning and policy issues, systems engineering, transit visibility, and civilian, commercial, and military mobility.

### R & D Activities

- Testing and evaluation
- Data acquisition and analysis
- Transportation modeling
- Operations and performance
- Policy and planning
- Highway electrification
- Sensor technologies
- Imaging science
- Software configurable radio
- Wireless communications
- Field operational testing
- Test facilities for component evaluation
- Traffic engineering
- Traffic modeling
- Vehicle and sub-systems modeling

### Partners in Intelligent Transportation

- U.S. Department of Transportation
- U.S. Department of Defense
- U.S. Department of Energy
- U.S. Department of Homeland Security
- National Science Foundation
- National Oceanic and Atmospheric Administration
- Environmental Protection Agency
- State agencies
- Original equipment manufacturers
- Automotive and truck tier-1 suppliers
- Transportation stakeholder groups
- Network communication equipment manufacturers
- Private industry
- Academia



## Supporting Sustainable Transportation

ORNL's intelligent transportation research is aligned under the lab's Sustainable Transportation Program. The program brings together scientists and engineers, commercialization experts, and technology transfer specialists from across laboratory directorates to address today's transportation challenges. Through partnerships with government, industry, and academia, their research and development efforts are resulting in knowledge discovery and technology development, maturation, and implementation. The program drives four broad and integrated areas of concentration to advance the mobility of people and goods within America's transportation systems: vehicle, energy, information, and infrastructure.

*For more information about intelligent transportation research, contact:*

Sustainable Transportation Program, Oak Ridge National Laboratory

*Program Office Address:*

National Transportation Research Center

2360 Cherahala Blvd.

Knoxville, TN 37932

Phone: 865.946.1861 • Fax: 865.946.1214 • Email: [transportation@ornl.gov](mailto:transportation@ornl.gov)

[www.ornl.gov/ees/transportation](http://www.ornl.gov/ees/transportation)

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