Office of Operations R&D

The Office of Operations Research and Development (R&D) produces technology and tools to improve transportation system productivity, efficiency, and performance by proactively anticipating congestion and managing traffic.

Reducing the Impacts of Congestion

Advancing Speed Harmonization

Speed harmonization uses transportation network data to generate optimal speed recommendations to drivers. It has the potential to create smoother and safer traffic flow during recurring congestion periods, reduce travel time, and reduce fuel consumption. In collaboration with partners at the Virginia Department of Transportation, researchers will select a living laboratory section of freeway in northern Virginia to simulate speed harmonization. Traffic flow optimization models and algorithms will be developed and tested to establish target speeds on different sections of the freeway. The target speed guidance will be communicated directly to vehicles with minimal distraction of the driver, allowing the driver to maintain supervisory control at all times.

Using Intelligent Traffic Signals

The Federal Highway Administration (FHWA) Saxton Transportation Operations Lab's Intelligent Intersection uses advanced signal controls to enable operations applications. For example, the intersection's signal phase and timing (SPaT) message was updated to allow for actuated and active signal control. The new SPaT format is deployed in Ann Arbor, MI, as part of the Safety Pilot Model Deployment initiative. To further advance the development of vehicle-to-infrastructure enabling technologies, SPaT messages will be integrated with more accurate positioning solutions; wireless communications technologies; larger scale, more detailed maps with attribute layers such as lane lines, pavement edges, and road signs; and more robust interoperable roadside equipment. All of these developments will support cutting edge safety, mobility, and environmental applications.

Predicting Congestion in Work Zones

This research seeks to determine how driver car-following behavior differs between freeways and work zones. An instrumented vehicle equipped with radar, a Global Positioning System, speed sensors, and cameras will measure the relative distance and speed under the two network conditions. Participants will be recruited to drive the vehicle through a living laboratory established along a freeway work zone in northern Virginia. This research will provide threshold values to improve the calibration of car-following algorithms in simulation. These improved simulations will allow operators to predict congestion in freeway work zones and test strategies to improve throughput and travel time.

Improving System Mobility, Efficiency, and Reliability

Improving Environmental Performance Through Connected Vehicle Technology

Applications for the Environment: Real-Time Information Synthesis (AERIS) is a U.S. Department of Transportation Intelligent Transportation Systems (ITS) initiative to identify transformative concepts that will substantially improve environmental performance of vehicles. Through seven initial projects, researchers applied their previous work to AERIS to identify eco-friendly technologies and applications. The most promising applications were selected to undergo a comprehensive benefit-cost analysis. For example, the Eco Approach to Traffic Signals application will allow vehicles to utilize the most fuel-efficient and lowest emissions-producing speed when approaching and leaving an intersection. The application was tested at FHWA's Turner-Fairbank Highway Research Center, where a test vehicle equipped with connected vehicle technology suggested a vehicle speed for approaching and departing the intersection through an algorithm designed to improve environmental performance. The experiment demonstrates up to a 12 percent reduction in environmental emissions (and fuel consumption) depending on approach speed. This experiment will allow for realistic modeling to assess the contribution ITS can make to improving environmental performance.

Using State-of-the-Art Laboratories

The Saxton Lab houses state-of-the-art modeling and simulation tools and cutting-edge communication technologies to support the development of applications for advanced operations. The lab allows multidisciplinary teams to work together to generate new ideas and advance the state of the practice. R&D capabilities at the Saxton Lab are organized into three testbeds: the Data Resources Testbed (DRT), the Concepts and Analysis Testbed (CoAT), and the Cooperative Vehicle-Highway Testbed (CVHT).

DRT supports the collection, processing, analysis, formatting, and storage of data from the Saxton Lab to support the development and advancement of applications. CoAT enables the development and evaluation of the potential benefits of large-scale deployments of these applications through modeling and simulation. The Saxton Lab's modeling capabilities provide opportunities for researchers to explore innovative solutions with no safety risks and minimal expenses. The results of these simulations provide a basis for testing the best outcomes on CVHT. CVHT provides testing facilities for collecting data on the performance impacts that new concepts and equipment will have.

Delivering Next Generation Cruise Control

The ITS Dynamic Mobility Applications (DMA) program seeks to create applications that fully leverage frequently collected and rapidly disseminated multisource data gathered from connected travelers, vehicles, and infrastructure. The goal of this program is to improve transportation network efficiency and mobility while reducing negative environmental impacts and safety risks. Under this program, a high-priority mobility application, Intelligent Network Flow Optimization, builds on the results of a recent Exploratory Advanced Research (EAR) project that suggests that cooperative adaptive cruise control (CACC) can effectively double the practical capacity of an urban freeway. With CACC, vehicles communicate with each other and with the infrastructure to safely follow each other at closer distances, eliminating gaps in traffic and improving traffic flow at congested intersections. Based on the success of the EAR project, the DMA program will facilitate the ongoing development of CACC technologies and applications in order to advance the benefits of the application to transportation system operations.

Advancing Operations Processes and Decisions

Creating Living Laboratories and Forming Innovative Partnerships

With the advent of new and emerging transportation technologies (e.g., cooperative vehicle-highway systems) and research disciplines (e.g., cyber physical systems), there is an increasing need for researchers and owners/operators of testing facilities to forge partnerships and quickly share their knowledge and transfer technologies. This need is especially pronounced when researchers are seeking on-road testing facilities (i.e., living laboratories) to perform operations-related field research. To leverage the growing investment in living laboratories throughout the United States, FHWA is developing a knowledge resource that will identify transportation operations research resources to allow for more efficient and timely exchange of information and technology. Ultimately, this project will accelerate the technology transfer of innovative solutions from laboratories to streets and will enable eventual national deployment.

Improving Transportation Analysis Tools

The Office of Operations R&D is conducting research to advance the understanding of traveler choices and their impacts on the operations and safety of the transportation system. This project will encourage the transportation community to develop and use national and regional traveler choice data and adjustment factors to improve transportation models and forecasts. It will provide a suite of traveler choice data and adjustment factors for State and local agencies to incorporate into and enhance their existing transportation analysis tools.

Improving Transportation Planning and Operations using New Data Hub Approach

Simulation models used in transportation analysis are not well integrated among different domains (e.g., operations, safety, and environment) and for different levels of analysis. A prototype data hub and data schema called Nexta was developed to input data and display simulation results in a common format in an open source environment. The prototype was tested in Portland, OR, and Tucson, AZ. Results from the tests showed that the data hub concept overcomes many of the previous shortcomings associated with integrated modeling applications and creates significant time savings when conducting analyses.

Managing Multisource Traffic Data

FHWA is investigating ways to take advantage of new types and sources of data that can support transportation operations solutions. Many of these new types of data have been enabled by the proliferation of wireless devices within the transportation system. Combined with traditional data, these new data sources can provide greater insight into the real-time status of transportation systems and can provide immediate feedback on the impacts of transportation management strategies. A research data exchange (RDE) is being developed under the ITS connected vehicle research program to host and provide public access to a wealth of data that can aid in the development of new transportation strategies that improve mobility, safety, and the environment. A weather data environment will work in conjunction with RDE to provide access to atmospheric weather, road weather, and mobile-based weather observations. In addition, a framework that allows individual transportation agencies to share their data is being developed so that operations data can be incorporated into regional planning analyses and the development of regional system performance measures.

Promoting Intermodal Freight

Fostering Automated Freight Capabilities for Energy Conservation

Automation and truck platooning can improve safety by reducing driver errors and improving mobility by allowing higher traffic flows. Moreover, automation demonstrates energy conservation benefits to the trucking industry by preventing fuel-draining stop and starts during heavy congestion times and at intersections. FHWA's EAR program is studying the automation of heavy trucks to improve the feasibility and operations of truck platooning. Improvements in the technology will promote the moving of goods across the country in a more efficient manner, enabling the trucking industry to increase cost savings, reduce fuel consumption, improve environmental impacts, and increase productivity.

Increasing Highway Safety and Resiliency

Improving Traveler Information Technologies to Enhance Safety and Mobility

FHWA is conducting research to better manage driver behavior in the dilemma zone (i.e., the decisionmaking dilemma of whether to speed through or slow to a stop during a yellow light at a signalized intersection). Increasingly effective applications, such as the prototypes of dedicated short-range communication (DSRC), roadside equipment, onboard equipment, and SPaT, are being developed to alleviate this problem, including the Small Business Innovation Research Program's dilemma zone warning system and highway incident detection and warning system. The dilemma zone warning system utilizes real-time traveler information technologies to advise drivers on whether to stop or proceed through an intersection in order to avoid a collision, thereby improving safety and efficiency at high-speed intersections. The incident detection and warning system reduces secondary crashes and delays by warning drivers of non-recurring incidents on the roadway. These warning systems can not only decrease crashes but also improve traffic flow at signalized intersections.

Using Enabling Technologies, Navigation, and Communications

Many of today's operations technologies were initially developed for non-transportation purposes and must now be tailored to meet the needs of the transportation environment. For example, wireless communications technologies such as DSRC are being improved to meet the critical safety needs of a connected vehicle environment. More accurate and reliable positioning, navigation, and timing technologies are being developed to determine specific vehicle locations within fast-moving traffic. Advanced sensors are being developed to automatically detect pedestrians at crosswalks, better identify motorcycles and bicycles, and determine arterial travel times and origin/destination pairs. Finally, assistive technologies are being adapted to address the unique needs of travelers with disabilities.

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