

High-Performance Computing and Data Analytics

Our Expertise

High-Performance Computing | High-Fidelity Modeling | Simulation | Digital Twins | Artificial Intelligence and Machine Learning | Data Analytics | Energy-Efficient Operation and Control | Traffic Signal Optimization | Infrastructure Planning and Optimization | At-Scale Data Management and Visualization | Computational Fluid Dynamics

The Need

Slashing Transportation Emissions While Improving the Driver Experience

The transportation sector accounts for 27% of greenhouse gas emissions. Traffic congestion, as an example, plays a role in increasing these emissions through stop-and-go fluctuations within traffic patterns and by longer vehicle idling due to traffic light delays.

Finding ways to reduce these emissions while optimizing travel solutions, increasing road safety, and lowering associated costs is critical to accelerating widespread transportation decarbonization to mitigate the impacts of climate change while simultaneously improving the driving experience.

The Solution

Optimizing Energy Efficiency and Safety in Transportation

High-performance computing (HPC) and data analytics are powering research into transportation solutions that lower emissions, improve travel, and bring down costs. NREL researchers investigate ways to reduce greenhouse gas emissions and optimize travel by leveraging our marquee capabilities across HPC, data analytics, artificial intelligence, and machine learning.

Some of NREL's premier HPC-powered solutions include:

- Simulations of real-time traffic conditions, which illuminate new control strategies to increase mobility energy efficiency.
- A digital twin of the Dallas-Fort Worth airport that predicts traffic demand and anticipated challenges to help airport operations staff model the results of potential traffic management policy changes, infrastructure developments, and disruption scenarios.
- A data-driven approach to modeling airport shuttle fleets for route and schedule optimization, in particular

with the Airport Shuttle Planning and Improved Routing Event-driven Simulation platform.

- HPC, data analytics, and machine-learning techniques to combat traffic congestion.
- High-fidelity modeling of curbside driving behavior at airports.

The Infrastructure Perception and Control (IPC) laboratory applies advanced sensing and computational controls to coordinated vehicle movement to improve safety and equity, reduce travel time, and strengthen mobility energy efficiency. The IPC lab enables research across advanced traffic control at intersections, longitudinal light signals, automated valet service integrated with automated electric charging, wayfinding and local positioning for navigating within large facilities. It also supports new tools and methods for observing and understanding human behavior and the adoption of mobility technologies.

The Impact

Driving Cleaner Air, Clearer Roadways, and Cost-Effective Solutions

NREL's world-class HPC and advanced computing capabilities and resources provide a modern, data-informed, and cost-effective pathway to accelerate the clean energy transition and combat growing transportation-related emissions through

high-power, high-fidelity computing. Advanced computing capabilities enable researchers to hasten the pace of delivering safe and cost-effective transportation solutions that are good for both people and the planet.

Partners

City of Chattanooga | Dallas-Fort Worth International Airport | Oak Ridge National Laboratory | Tennessee Department of Transportation | TomTom | U.S. Department of Energy