DRISI

Caltrans Division of Research, Innovation and System Information

Research Results

UTC-Dynamic Routing of Trucks and Truck Platoons Using Real-Time Traffic Simulators

Research the feasibility of using real time traffic simulators for routing trucks and truck platoons

Transportation Safety and Mobility

OCTOBER 2021

Project Title:
UTC-Dynamic Routing of Trucks and Truck Platoons Using Real-Time Traffic Simulators

Task Number: 3423

Start Date: January 1, 2020

Completion Date: June 30, 2021

Task Manager:
Supanpreet Kaur,
Transportation Engineer (Electrical)
Supanpreet.Kaur@dot.ca.gov

WHAT WAS THE NEED?

Recent advances in sensing and navigation technologies makes it easier to route vehicles from origin to destination based on assumed traffic characteristics from historical data and available real time traffic data. Google maps and Waze are some of the most popular commercial applications used for routing instructions. These applications do not distinguish between different classes of vehicles and associated dynamics which often have a big impact on travel time and traffic flow characteristics. There is a need to research the feasibility of using real time traffic simulators for routing trucks and truck platoons, both diesel and electric, in a configuration with a route optimizer in order to improve truck routing.

WHAT DID WE DO?

The research team at the University of Southern California (USC) will analyze existing optimization tools and focus on how such tools can be integrated with a real-time simulator in order to improve truck routing. They will develop a dynamic routing system for trucks and truck platoons that relies on a real-time traffic simulation model to provide information of the predicted state of traffic complimenting historical and real time traffic information as well as take into account truck and platoon dynamics. In particular, they plan to do the following:

- Develop a traffic flow simulation model with ability to reconfigure itself in real time and account for the dynamics of different classes of vehicles to predict travel times and flows
- Integrate the real time traffic simulator with vehicle routing optimization and evaluate the feasibility of the scheme for fast real time routing decisions
- Examine the impact of truck platoons, diesel and electric, on traffic flow and vehicle routing decisions
- Address scalability issues and trade offs

WHAT WAS OUR GOAL?

Our goal is to have researchers use existing optimization tools and focus on how such tools can be integrated with a real-time simulator in order to improve truck routing.

WHAT WAS THE OUTCOME?

We have proposed a mixed fleet freight centrally coordinated dynamic routing system based on a multi-layer co-simulation optimization method to achieve freight load balance across the road network. The interactions with background traffic have been considered in the problem and as well as inclusions of electric trucks with their penetration varying from 0% to 100%. The electric trucks have additional constraints that include limited range, longer refueling (charging) times and in addition the depletion rate of the battery life depends on traffic conditions. We have solved the problem by using a multi-layer optimization method; one layer for the traffic simulator to accurately predict the states of the transportation system and another layer of service network to generate the optimum routes. Different techniques of truck platooning are incorporated with the method and tested. Realistic traffic networks including the Los Angeles/ Long Beach network that includes the two ports and the larger Los Angeles Metropolitan network have been used to evaluate the approach and the impact of electric trucks in a mixed fleet.
The system shows 24% savings over one without optimized load balancing and 15% savings over one without co-simulation. Another result reveals that although the use of electric trucks can notably reduce the emissions, the charging time cost makes the operational cost of electric trucks comparable or higher than diesel trucks. The results on the performance of distributed optimized load balancing co-simulation reveal the trade-offs between computation time and assignment optimality with respect to the number of subnetworks, boundary nodes and demands. The use of truck platoons may have benefits whose level depends on the distance travelled by the platoons as merging and exiting the platoon may take away some of the benefits.

Based on the tests the percentage energy improvement produced by the electric engine when compared with the diesel on are summarized as follows:

- % Energy improvement by electric during suburban cycle: 23%
- % Energy improvement by electric during transient cycle: 32%
- % Energy improvement by electric during cruise cycle: 75%
- % Energy improvement by electric during creep cycle: -423%
- % Energy improvement by electric during composite cycle: 67%

WHAT IS THE BENEFIT?

Improving the efficiency of routing trucks, such as choosing the best route for the truck platoon that minimizes impact on traffic in the road network, would have a positive impact on highway traffic flow with vehicles of all classes benefiting. The public will benefit with improved traffic flow on the roads.

IMAGES

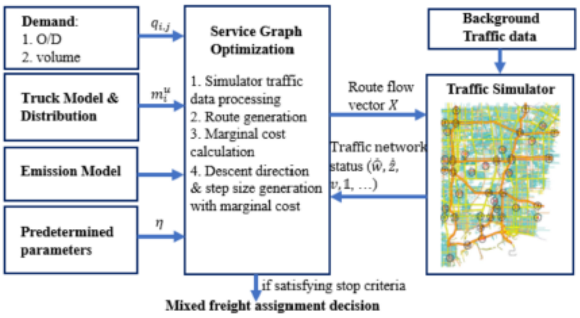

Image 1: Framework of proposed method

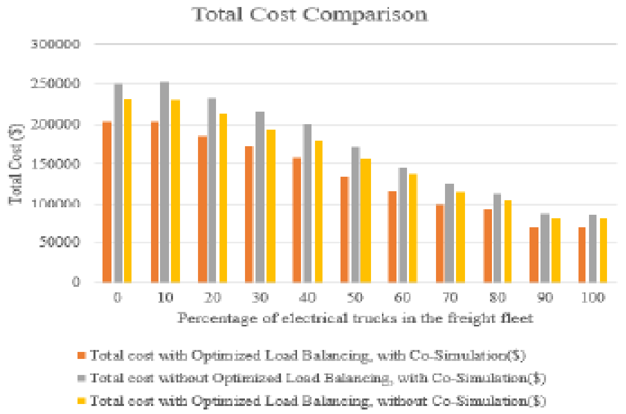

Image 2: Comparison with cases without optimized load balancing or co-simulation

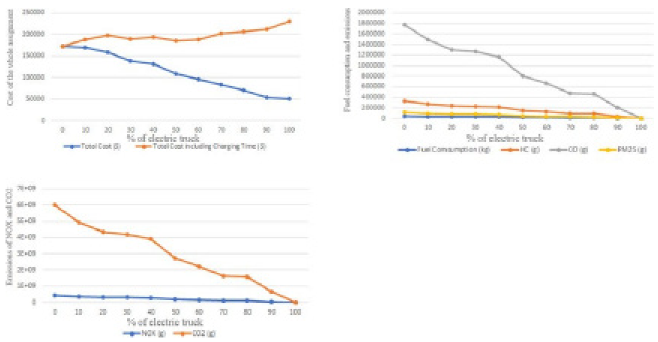

Image 3: Results under light traffic condition

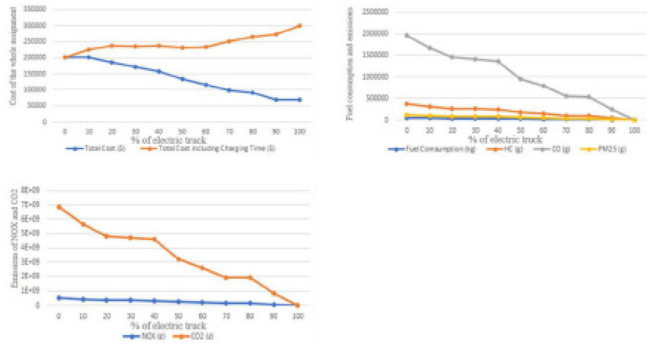

Image 4: Results under medium condition

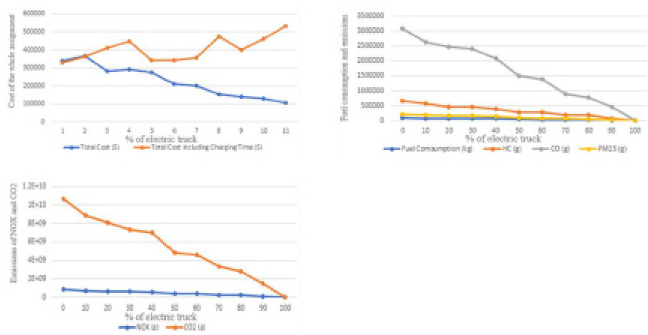

Image 5: Results under heavy traffic condition