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

Petros Ioannou University of Southern California

ioannou@usc.edu

Project Objective

The objective of this project is to develop an innovative approach of routing trucks and truck platoons using a centralized coordinator in order to benefit the overall system in terms of less congestion and less pollution and examine the impact of the penetration of electric trucks and truck platoons on routing.

Problem Statement

Today's vehicle navigation systems have limited ability to predict. For example, when many vehicles with similar origins and destinations are routed on what appears at the time as a minimum time route, the route may turn out to be non-optimal as a result of the increased traffic assigned to the route. The lack of coordination among different shippers and of information on the transport network make it difficult to predict changes in the transportation networks due to upcoming loads. In general, the current freight transportation system is full of inefficiencies leading to imbalances in traffic with respect to space and time, and these imbalances have significant individual and environmental costs. Information technologies, software and hardware technologies such as the integration of battery electric trucks (BEHTs) and techniques of truck platooning, offer a strong potential for dramatic improvements in balancing freight loads in multimodal networks. However, electric trucks impose additional constraints due to the limitation of range and charging time of batteries. Truck platoons offer a strong potential for saving labor cost and reducing energy consumption due to reduction in aerodynamic drag however their use as part of a centrally coordinated routing system needs to be analyzed.

Research Methodology

Figure 1 depicts the framework of the research methodology. From left to right, the information of origin to destination (O/D) demands, mixed freight distribution, road networks, etc. are input into the optimum load balancing module where a higher-level service network is constructed using traffic data generated by traffic simulator. The service network is used to generate a minimum cost route for each demand by solving an optimization problem which does not take into account the unknown factor of the impact of the added loads to the selected routes. The load balancing scheme is then used to assign certain number of trucks of a certain type to fulfill the demand based on the marginal cost of each route in the route collection. The resulting assignment is then simulated using the traffic simulator which generates updated traffic states which are fed back to the optimization which updates the optimum routes. This procedure is repeated till the overall cost does not change much between two operations. The final solution is taken as the assignment for the mixed freight fleet.

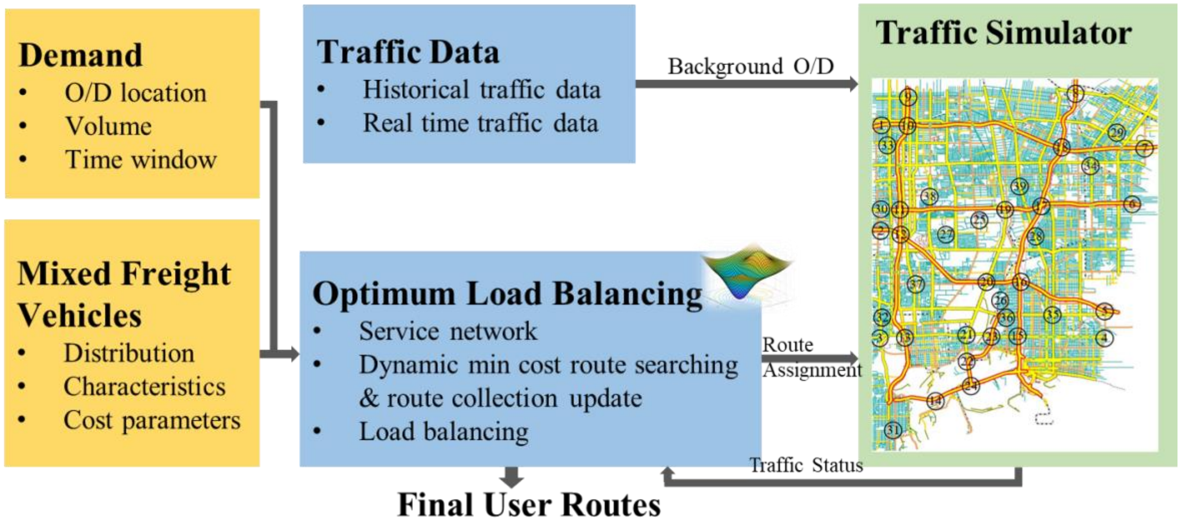

Figure 1: Framework of research methodology

Results

To show the benefits of applying load balancing co-simulation optimization assignment, we compared the proposed approach against a mixed freight assignment system without optimized load balancing or co-simulation. The results are shown in Figure 2. The system with load balancing achieves the lowest total cost.

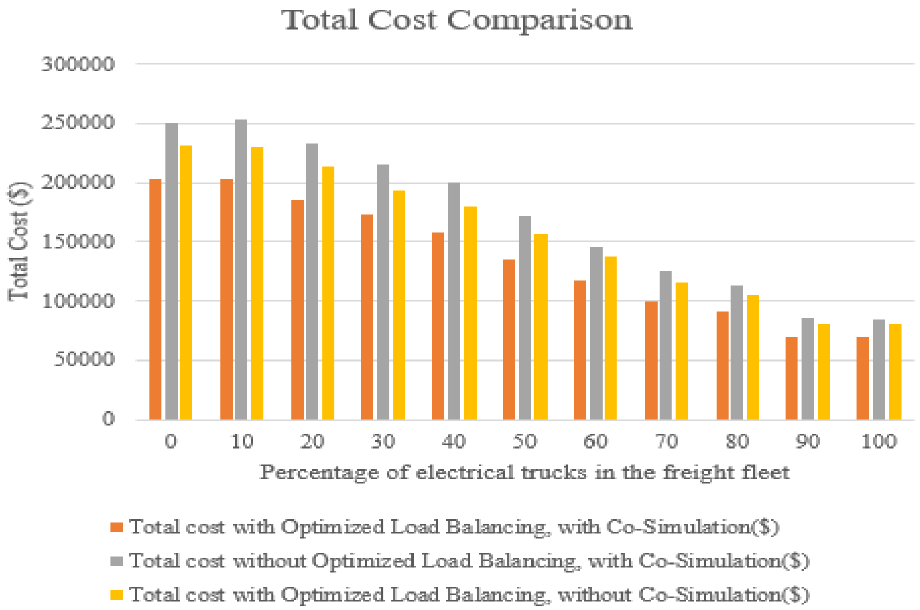

Figure 2: Comparison with cases without optimized load balancing or co-simulation

The optimized load balancing co-simulation system is tested under different scenarios of various percentages of electric vehicles and truck platoons where the total emissions are reduced as the percentage of electric trucks increases. The overall cost however may increase due to the cost of the charging time if done when the driver is on duty. This cost can be reduced if charging is done when drivers are off duty.