Research Title:

Global Traffic Management for Zero Transportation Externalities

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Background

The development of real-time scheduling algorithms addresses critical challenges in effectively managing intersections. Consequently, managing and scheduling traffic becomes crucial. By optimizing traffic flow, societies can increase the overall efficiency of transportation systems, reduce travel times, and improve the economy by facilitating the movement of goods, platoons, and services. Additionally, it helps to ensure the safety of drivers, passengers, and pedestrians on the roads. By regulating traffic flow, societies can reduce the risk of accidents and minimize the impact of congestion on emergency services. Finally, efficient traffic management can improve air quality by reducing the time cars spend idling in traffic, thus reducing emissions.

Overall, this work not only enhances the efficiency of transportation management but also improves user experience by reducing travel times and promoting sustainability through minimized fuel consumption.

Schedule emergency situations

The main idea of this subject is to find a routing and timing for vehicles, and allow emergency vehicles to pass through the network. And prioritize them as needed. The ability to prioritize certain vehicles in the road network opens the door to further benefits, for example, prioritizing platoons, which can motivate their formation.

Thus, during each time unit, the algorithm considers the following principles: (a) minimization of travel time, (b) continuous travel, and (c) priority. It identifies the path that requires the least time to travel from the source to the destination without stopping at intersections, while maintaining the priority mode.

Vehicle Platoons

A platoon of vehicles is defined as a group of cars moving in the same direction as a selected car, called a representative vehicle, and at a distance from each other that is less than a given threshold. When dynamically managing traffic, there are known benefits in forming vehicle platoons [3], especially for autonomous driving. The vehicles in the platoon can autonomously follow the representative vehicle, which may be driven by a human, thus making autonomous driving easier and safer, as the representative vehicle's human driver can cause the whole platoon to stop in case of emergency. Furthermore, fuel efficiency gains can be made by platoon vehicles, among other benefits. Prioritizing platoons in the scheduling encourages vehicles to form platoons. The priority is determined by the simultaneous schedule assignment policy for all vehicles that are part of a platoon.

Such a policy yields a high priority that seems like a correct and simple solution, but this approach may create a major problem: starving other vehicles when a platoon passes through a junction. Suppose that a lengthy platoon was formed (as we hope) and that the representative vehicle in this platoon began crossing the junction, due to the prioritization of all vehicles in the platoon above the rest, they will all be scheduled instead of the other vehicles waiting to cross, therefore the platoon vehicles will be assigned adjacent spots in the junction schedule, which will cause them to pass through the junction while blocking traffic continuously. The situation is exacerbated when vehicles dynamically join the platoon before the current junction. It therefore has the potential to create an endless stream of vehicles that closes that junction to all other vehicles. For this reason, the following approach is taken.

Conclusions

In conclusion, this work presents an integrated approach to intelligent traffic management that prioritizes emergency vehicles, minimizes travel time, and maintains continuous traffic flow through dynamic scheduling and routing algorithms. Furthermore, a solution was presented to utilize the mechanism to accommodate and incentivize the formation of vehicle platoons. By leveraging digital twins, the A2A agent protocol, and simulation via the SUMO platform, the system enables real-time policy updates and optimized navigation. The proposed framework ensures fairness, adaptability, and reliability in complex urban environments.