Solving Transportation Problem with Wireless Vehicle Networks

by David H.C. Du, University of Minnesota, Minneapolis, MN 55455

The transportation problem becomes more serious as population growing in many US cities. The increase of time spending on the road from home to work has a huge impact on the overall productivity of US as a country. The extra energy consumed by driving a car for longer commute creates carbon dioxide problem and damage our living environment. Public transit systems like buses and subways can be a solution to this problem. However, unlike European and Asian countries most of the US households are living in scattered suburban areas. It is hard to convince people to leave their vehicles instead of using public transit system for their daily commute. In quest for a solution, Personal Rapid Transit (PRT) has developed and experienced. A PRT is like automated (driverless) taxis operating on a system of guide-ways. The advantages of PRT include operating on demand, energy saving, and high level of service. However, its disadvantages are high cost (both infrastructure and special vehicles have to be constructed) and restricted service areas. Therefore, there is no large deployment of PRTs today.

Considering all the technological improvements recently, we envision a possible solution to US transportation problem as follows. Each vehicle will be equipped with GPS and DSRC communication capability. In most likely to be congested areas or even city-wide, RSUs are deployed to form a multi-tier control system. Each vehicle entering these areas will report its trajectory (i.e., a selective path to a destination) based on GPS to the Control Center via a RSU. RSUs can monitor the vehicles passing by and assist the data delivery between Control Center and vehicle or vehicle to vehicle. The Control Center will be responsible for smoothing the traffic based on the current traffic load by adjusting the trajectories of some vehicles if necessary. The nearby vehicles are self-driving and coordinated with each other via DSRC for shorter response time. The goal is to achieve safety and maintain certain speed for each vehicle. The advantages of the proposed infrastructure include its low cost when compared with other alternatives and its effectiveness by fully taking the benefits of current technology advancements.

To accomplish this vision, many research issues remain to be investigated. These include how to develop new architectures, protocols, algorithms, data structures, and innovative solutions for this critical transportation problem. The challenges are how the proposed infrastructure capable of providing this type of time critical applications, and how the existing DSRC devices and their protocols can deliver time critical information for both safety and traffic control. The required protocols and algorithms will extend our understanding of vehicle-to-vehicle and vehicle-to-infrastructure communications to another level. The proposed road infrastructure can allow further development of many new applications to improve vehicle safety. Solving the fundamental communication issues of vehicle-to-vehicle and vehicle-to-infrastructure can benefit other DTN (Delay Tolerant Network) applications. The required multi-tier control architecture can be used and adapted by a number of CPS (Cyber Physical System) applications. Therefore, the potential benefits go beyond the transportation problem. If successful, the potential benefit to the society is extremely large. Not only the commute of each person can be shortened, the total energy saving to the society can be huge. As the original objectives of providing communication capability to each vehicle, the safety of driving can be greatly enhanced too.