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CS 35L Lab 5

Building a Better Network for Connected Cars

Vehicle-to-vehicle (V2V) communication is an emerging technology that will allow cars of any make and model to communicate with each other through a standard protocol, transmitting data such as traffic conditions, nearby obstacles, and road closures to any other car within range. Currently, several major car manufacturers, including General Motors and Honda, are working with the National Highway Traffic Safety Administration of the United States on a V2V implementation; they expect to have a proposal drafted by the end of 2015 and a formal standard published within the next few years[1].

Basic vehicle communications technologies are already available today in various forms. For example, OnStar is a service provided by GM that connects a vehicle to the Verizon cell phone network. In the event of an accident, the OnStar equipment in the car will automatically contact and transmit its current GPS location to emergency services. However, this service is built on top of existing infrastructure meant for cellular phone service, so it is only effective in areas with network coverage, and it does not allow the car to interface with other vehicles on the road. Another technology in widespread use is crowdsourced smartphone maps[2]. Applications such as Google Maps and Waze combine automated data collection with user input to form an accurate view of traffic conditions on major roads and highways. While a large amount of useful data is gathered by this method, the technology is not integrated with the vehicle and so the

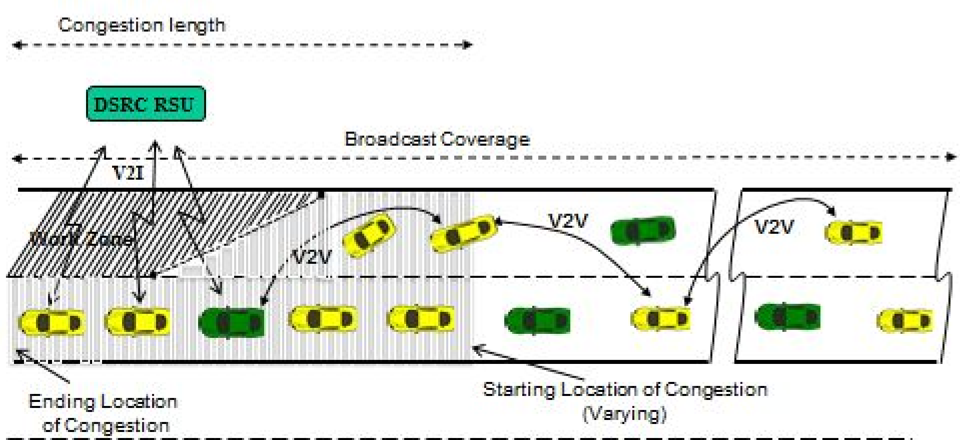
information must be viewed by the driver, limiting its effectiveness.

Automakers have already made significant progress on developing a V2V standard. Data is transmitted through the Dedicated Short Range Communications (DSRC) protocol using wireless channels reserved exclusively for vehicle communications[1]. Each car on the road becomes a node in a continuous mesh network, where it receives a signal, processes it in some manner, and then relays the data to nearby vehicles[3]. A large-scale trial was deployed by the University of Michigan and the US Department of Transportation in Ann Arbor, Michigan from August 2012 to February 2014. The test involved nearly 3,000 vehicles of various sizes and 27 roadside devices (all equipped with DSRC technology) across 75 miles of public roads[1]. Data from the trial has been made available to researchers, who are currently reviewing it for any problems that may arise in a real-world scenario and using it to further refine the V2V standard.

However, the effectiveness of V2V during its early stages of deployment is questionable. There will be few cars released with the technology initially, most likely at a price premium, which the average consumer will be reluctant to pay for. Since DSRC has a range of only 300 meters, the vehicles will be spaced too few and far between to communicate with one another, rendering the feature useless and therefore discouraging its adoption. Given an average car replacement time of over 10 years, it could take decades before V2V is widespread enough to produce noticeable results[3].

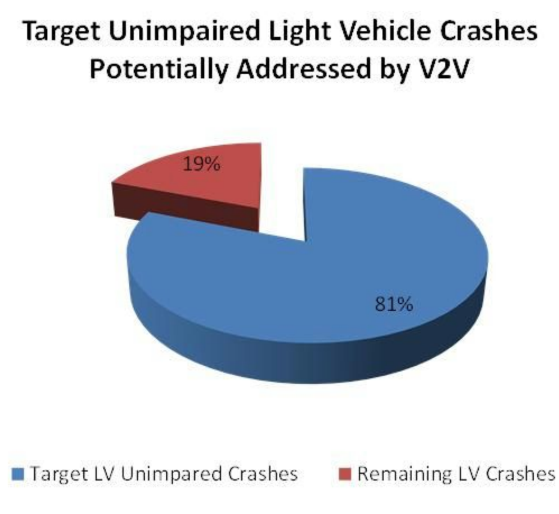
Yet even after V2V attains widespread use, relying only on the DSRC protocol to transmit data will reveal a major shortcoming – latency. In areas with high vehicle density, the mesh network structure of DSRC will require a signal to hop across many cars between the source and a target vehicle some distance away[3]. For instance, if a car accident occurred 20 cars in front of some vehicle A, and vehicle B involved in the crash immediately sent a warning, there could be up to 20 retransmissions of the signal, and thus a significant delay for the warning to propagate from vehicle A to vehicle B.

The proposed fix for both of these issues is to supplement vehicle-to-vehicle communications with existing wireless technologies like Wi-Fi and LTE, which travel further and offer large amounts of bandwidth[4]. These networks are widely deployed and well tested, so they can serve as a backup layer for when DSRC is out of range, or as a more direct route to reduce latency. Instead of data hopping through 20 nodes to reach the 20th car from the source, it can be uploaded to the Wi-Fi or LTE network, which can then broadcast the data across all vehicles in the area.



Another area of concern is security. The entire V2V network must be resilient to any hacking or tampering so that the messages sent between vehicles can be fully trusted[1]. Any spoofed data can cause vehicles to operate incorrectly and put people's lives at risk, making security even more critical here than in other applications. Further adding to the problem is that the system that must verify communications between millions of cars that have never contacted each other beforehand. The V2V developers have decided to use public key infrastructure (PKI) security; however, they acknowledge that no PKI system has been implemented on such a large scale where the safety of the key must be guaranteed[1].

Looking toward the future, I believe that vehicle-to-vehicle communication technology is just one aspect of making transportation safer and more efficient. Though they are surprisingly distinct areas of research right now, V2V should eventually converge with self-driving technology, resulting in cars that leverage enough data from their surroundings to navigate perfectly without needing human input. According to the NHTSA, even V2V alone should be enough to prevent 79 percent of all crashes[1]. But to reach that level, they must refine the technology so that it is extremely reliable and the public grows comfortable with it. The largest roadblock that I see for V2V adoption is security. The NHTSA admits in their *Readiness of V2V Technology for Application* report that no security architecture has ever been designed at this scale, and one compromised vehicle will become the weakest link in the chain, which therefore undermines the security of the rest of the vehicle network. Nevertheless, considering all of the benefits of AI-assisted vehicles, I hope to see this technology become mainstream within the next decade.



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