Issues and Challenges for Vehicles in the Cloud

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The expansion of computer hardware and software for use in commercial and consumer vehicles has grown rapidly to the point where a majority of drivers on the road, in the United States especially, are driving highly-networked vehicles. Vehicles in the Cloud was born out of the idea of using this fact to create applications that leverage the large amount of data generated by the advanced networks of sensors and control units that exist in your vehicle (as well as the vehicles around you) to make driving safer, smarter, and more efficient for everyone involved. Moreover, vehicles that are connected to the cloud can allow for powerful computations that might be unfeasible to produce within the vehicle itself.

One of the most persistent challenges for any application that hopes to incorporate vehicle sensor and driving data is the desire for vehicle manufacturers to keep their data proprietary, as well as the vast differences in data availability from manufacturer to manufacturer. This raises the question of whether development should be focused on applications that have a broader utility or those that are focused on individual vehicle makes and models that have access to much richer driving data parameters. There are also hardware questions to consider: should vehicle manufacturers helped to implement cloud connectivity directly into the vehicle itself, should specialized hardware be developed that utilizes the vehicle OBD port, or should existing hardware be combined with a laptop or a smartphone in order to achieve cloud connectivity? There are also additional challenges that will arise as various firms continue to research and develop automated vehicles or driver-less cars. How can cloud computing help ensure the safety of the passengers in these vehicles, as well as the other drivers on the road?

The availability of high-bandwidth communication channels is another important challenge that needs to be taken into account. Naturally, mobility is a part of the very definition of a vehicle, which brings into questions of mobility management. How can a connected vehicle account for patches of non-connectivity or insufficient connectivity between base stations? Applications and hardware need to have the capability to store data that is being collected so that it can be uploaded to the cloud once connectivity is restored. Furthermore, if applications are designed that rely on constantly updated data from the cloud, there need to be designs in place that can handle connection issues without a serious break in functionality.

Obviously, any project such as this one that is collecting large amounts of data and storing it in the cloud also needs to ensure that the driver data cannot be compromised by unexpected or unwanted third parties. The data about a user's driving behavior should be considered sensitive from a privacy standpoint, especially since the Vehicle Identification Number (VIN) can be accessed from standard OBD-II commands. Users need to feel certain that private information such as driving patterns, GPS locations, and the VIN will not be available to unauthorized users. And any time commands are being sent to a vehicle's CAN-bus network, it is essential that sufficient encryption and protection is put into place to prevent MITM attacks or other intrusions from accessing vehicle computer networks. While OBD-II commands cannot impact the driver's safety in a significant capacity, unfettered access to the CAN-bus network could pose a serious danger.

There are many different applications that can come of combining cloud computing with connected vehicles. One such application is utilizing the vehicle data in the cloud to identify patterns of driving behavior and recognize dangerous behaviors in the process, as well as eventually identify the

driver as well. Another possible application is utilizing the data from various vehicles, combined with GPS data, to recognize where cloud-connected cars are in relation to one another on the road. This can then lead to traffic-rerouting applications as well as automated emergency response applications immediately following a crash. Figure 1 displays a potential framework for the vehicles in the cloud architecture.

This avenue of research has the potential to create many exciting developments that are highly valued from both a commercial and a consumer standpoint. In addition, the improvement in public safety these applications might bring make this an exciting and worthwhile endeavor. And finally, as driver-less vehicles begin to join the roadway, cloud-connected vehicles will become an even more important area of study.

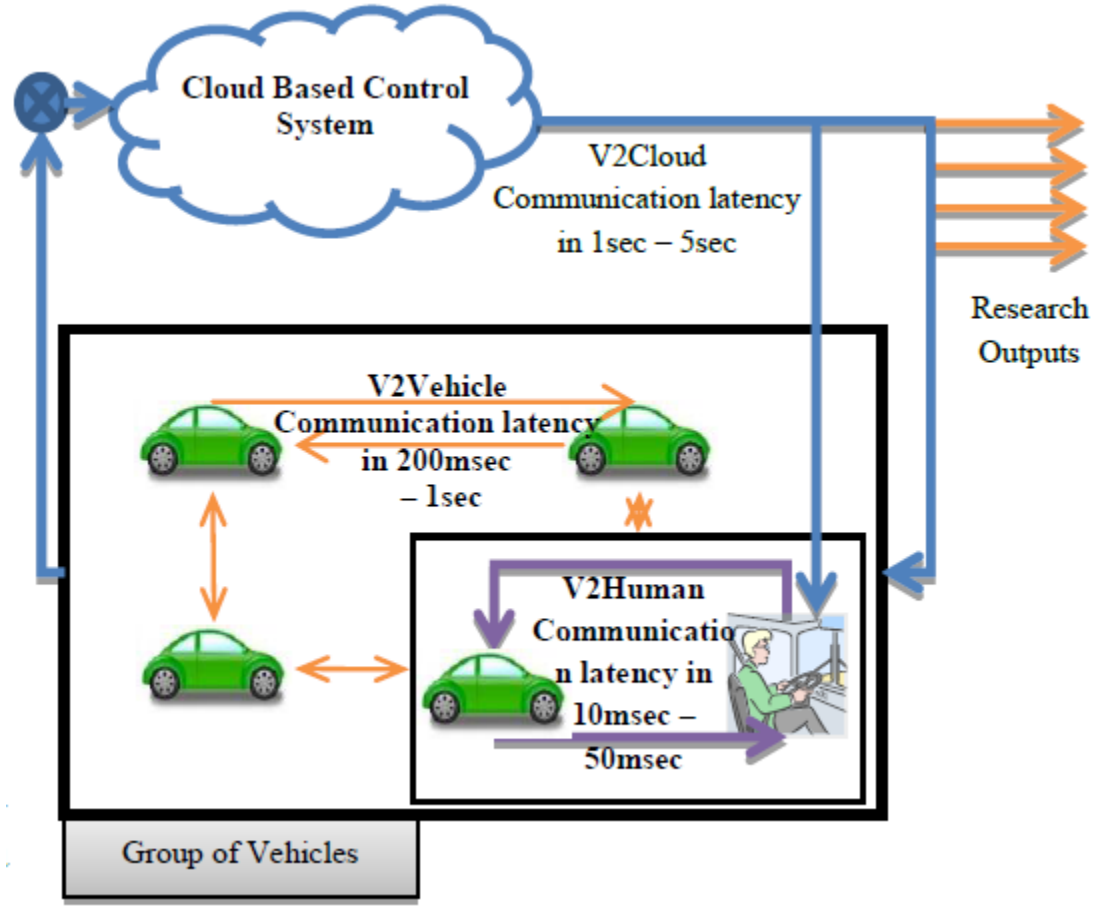

Figure 1 - Vehicles in the Cloud Framework

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