Advanced Networking Infrastructure for Emerging Connected Vehicles

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Background and Motivation

This project promotes vehicular application design for Connected Vehicles (CV)'s in emerging heterogeneous network scenarios (as illustrated in Figure 1). The project relies on recent advances in Software-defined Networking (SDN) to provide a versatile and robust wireless infrastructure that is essential for connected vehicular systems. The broader impact will be improved traffic safety, and enhanced vehicular traffic management.

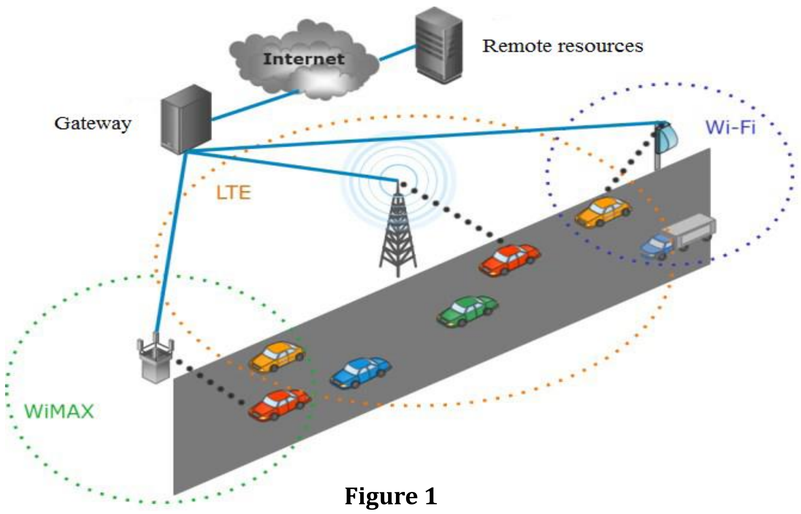

Figure 1

The project will illustrate how CV applications can leverage SDN through OpenFlow along with a set of 4G wireless networks to better support CVs compared to the current network model that is limited to Dedicated Short-Range Communications (DSRC). Our first step is the demonstration of an SDN-based solution for the handover (both vertical and horizontal handovers) over different wireless technologies in a HetNet scenario. The proposed solution will function on any OpenFlow enabled networks and can be deployed by other researchers based on our documents.

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Implementation Details

The test-bed for the connected highway is built in partnership with the South Carolina Department of Transportation (SCDOT) along the I-85 near Clemson's International Center for Automotive Research (CUICAR) and two WiMax base stations located in Greenville. Figure[2] shows the location.

Figure 2

SDN techniques are adopted to enable transparent and efficient handover over heterogeneous networks. The basic principle is to dynamically insert flows on switches to build paths for client packets so that they can be forwarded through the desired network interface.

Figure [3] demonstrates the overall structure of the handover scheme. Whenever the client triggers the handover, flows are written or removed on related switches to ensure seamless transition.

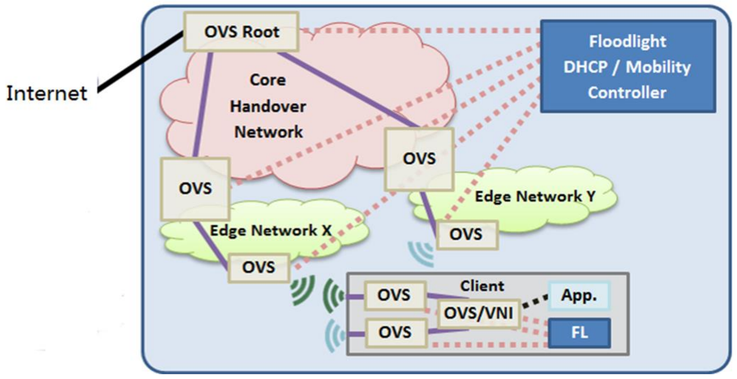

Figure 3

Demo Configuration & Results

The demo consists of a WiFi-WiFi handover between two AP's. A root Linux machine runs an instance of the floodlight controller and oversees the entire handover process. The network topology is shown in Figure[4].

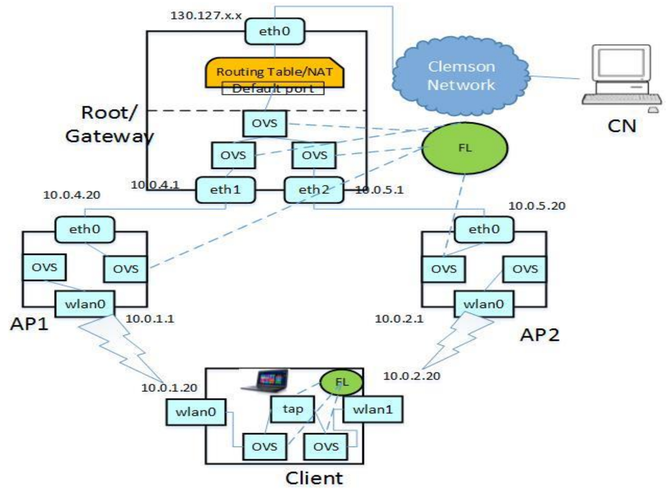

Figure 4

Figure [5] visualizes the inter-packet arrival times observed at the iperf transmission side. Huge spikes represent a handover.

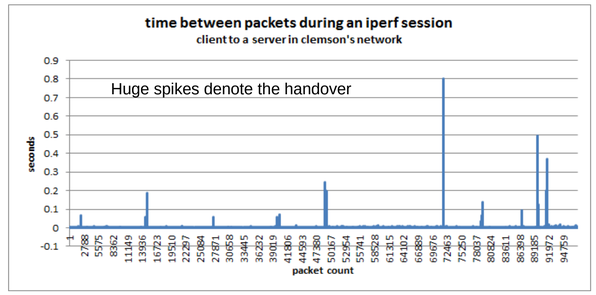

Figure 5

Future Work

Our demonstration shows that SDN solution of CV in a HetNet environment can offer substantial scalability and robustness benefits and is appropriate for safety critical vehicular applications. The future work involves the integration of DSRC connectivity with the roadside units as well as the integration of public wireless networks, such as the SciWiNet.