New York City Connected Vehicle Pilot Uses an Innovative Approach to Verify Location Accuracy in the City's Urban Canyons

Location accuracy is a key requirement for the Connected Vehicle (CV) Pilots as Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) technologies are deployed into the field in larger quantities. The New York City Department of Transportation (NYCDOT) CV Pilot team is working hard to ensure that the in-vehicle devices can establish their locations with sufficient accuracy to utilize their CV applications.

The NYCDOT CV Pilot team has utilized some innovative yet simple concepts when testing for vehicle location accuracy. To set the stage for these innovations, it is important to understand the location accuracy experienced in the City's urban canyons and the impacts of the technology being used to supplement the basic location referencing technology.

Locations are derived from the Geographic Positioning System (GPS) in CV devices. Signals are measured from sufficient satellites to define a user's location within a calculated Dilution of Precision (DOP). In the City's urban canyons, there are fewer satellites visible due to the tall buildings, causing the GPS signal at ground level to be degraded or lost, either through satellite signals being obscured or through signals bouncing off surroundings and forming multiple paths as they reach the street (or canyon floor). Figure 1 shows the uncorrected path of a vehicle while travelling around the same block several times using only GPS data.

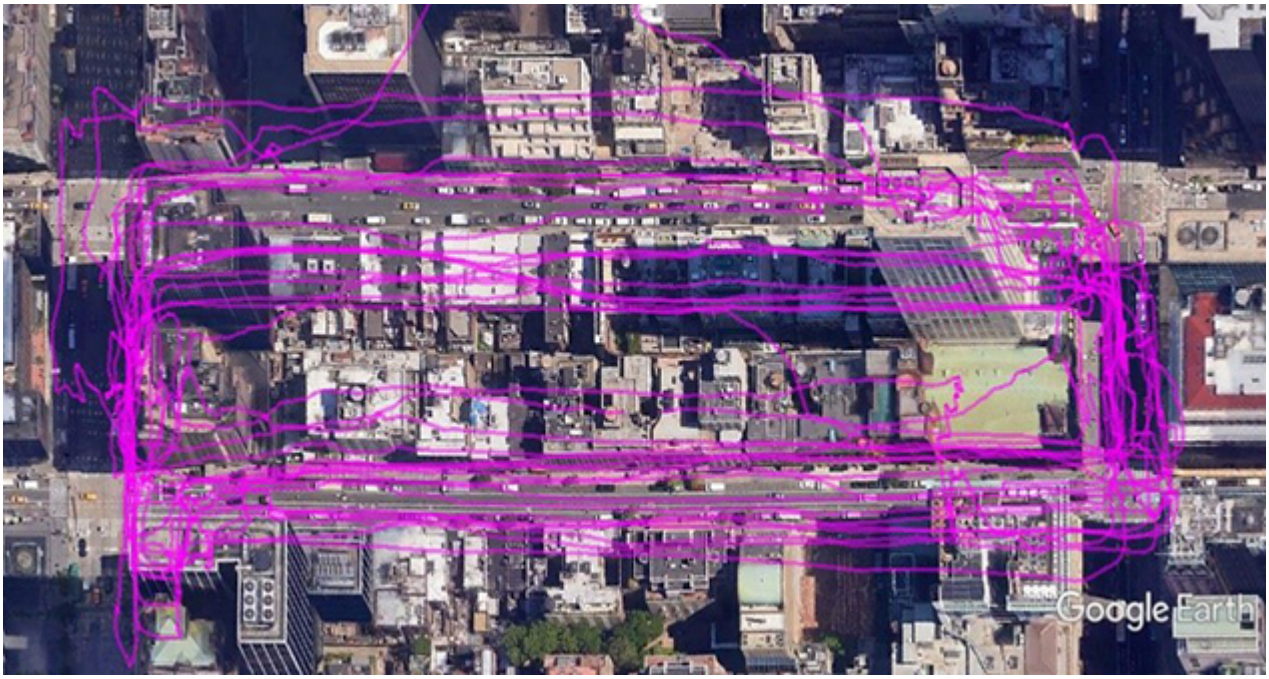

Figure 1 . Example of GNSS Uncorrected Accuracy (Source: Google Earth, edited by NYCDOT)

The NYCDOT CV Pilot team is using an enhanced V2X-locate positioning engine to improve location accuracy. By measuring the time-of-flight from Roadside Units (RSU), additional location information can be fused with the GPS information to reduce the error and improve location estimates.

Figure 2. Example Laser Pointer Attached to Mirror (Source: NYCDOT)

Figure 3. Pavement Marking (Source: NYCDOT)

While testing these technologies, an important consideration became the repeatability of vehicles tracking a path and returning to the same location. This repeatability was addressed using simple laser pointers, tape, and temporary-chalk spray paint (water-soluble). The laser pointers were temporarily attached to the mirrors and bumpers of each vehicle (as shown in Figure 2). With the vehicle at the stop bar, the chalk spray paint was used to mark the laser on the pavement (as shown in Figure 3). This enabled the driver to repeatably align the vehicle at the stop bar each trip around the block when recording the location information. Using this methodology, the NYCDOT CV Pilot team was able to verify the accuracy of the vehicle's location using the time-of-flight information in combination with the GNSS data.

Using this data, the NYCDOT CV Pilot team was able to quantify the location differences between each run, measuring the deviations detected when the vehicle was located at the stop bar. The onboard unit's (OBU)

internal location information was retrieved over several runs with the vehicle located at the same point each time. Figure 4 shows the vehicle path using the laser-pointer method describe above. The circles in Figure 4 indicate the data collected from the vehicles using the laser pointer at the marking location.

Figure 4. Example Runs showing the stop bar measurements (Source: Google Earth, edited by NYCDOT)

NYCDOT's innovative use of beaming lasers generated a precise, repeatable way of verifying the accuracy of the vehicle's location in their efforts to overcome the GPS limitations of the City's urban canyons.