REPORT SUMMARY

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LINCOLN TUNNEL EXCLUSIVE BUS LANE CONNECTED AUTOMATED BUS PROOF-OF-CONCEPT DEMONSTRATION PROJECT

Background

The Port Authority of New York and New Jersey (PANYNJ) established a strategic partnership with the Federal Transit Administration (FTA) and regional stakeholders NJ TRANSIT and New Jersey Department of Transportation (NJDOT) to implement a Society of Automotive Engineers (SAE) designated Level 3 (L3) connected automated bus (CAB) proof of concept (POC) demonstration project. The POC demonstrated the effects of connectivity and SAE L3 automation on the Lincoln Tunnel exclusive bus lane (XBL) to determine what improvements on safety and throughput could be achieved with the application of technology on buses. Three decommissioned NJ TRANSIT MCI Coach D-45 buses were retrofitted with L3 braking and steering and throttle control capability to enable (a) automated lane keeping, (b) Cooperative Adaptive Cruise Control (CACC), and (c) automated merging. The final report summarizes the POC's approach, test results, the perspective of the CAB operator, simulation modeling findings, and lessons learned.

Operational since 1970, the XBL is a 2.5-mile contraflow lane, using a westbound (New Jersey–bound) lane along NJ Route 495 to carry interstate buses eastbound (New York–bound) to the Lincoln Tunnel and the Midtown Bus Terminal in New York City. The XBL is the most productive highway lane in the nation carrying more than 1,850 buses and 70,000 bus passengers on the single-lane operation between 6:00 and 10:00 a.m. PANYNJ studies have found the XBL is beyond its peak hour capacity and has grown its passenger carrying capacity only by accommodating fully loaded buses and spreading demand beyond the peak hours to larger portions of the four-hour operation.

Objectives

Recognizing the constraints in its ability to physically alter the geometry of the existing XBL in an already built-up urban environment, PANYNJ looked to emerging technologies to determine how to achieve its goals of improving safety and increasing throughput. The long-term objectives for equipping the XBL buses with connected and automated vehicle (CAV) technology are to:

- Improve travel time reliability by reducing average peak hour delay by 10 minutes due to reduced incidents and breakdowns and increased throughput on the XBL.
- Decrease headway to 4.5 seconds or less to support an increase in XBL throughput by 30% from the current 650 buses/hour to 840 buses/hour, effectively adding 10,000 peak-hour passengers to the 32,500 currently served.
- Eliminate delineator strikes in the contraflow XBL, thereby reducing the frequency of XBL closures due to delineators being taken out of service and having to be reset.
- Increase the productivity of buses entering the contraflow XBL at its western end (the teardrop) by improving bus merging.

- Improve traffic safety on the XBL with a goal of zero collisions through connected and automated bus technology.
- Reduce emissions and improve fuel efficiency due to reduced incidents and stop-and-go traffic.

Findings and Conclusions

The demonstration project successfully tested and demonstrated effective technology solutions to enhance the safety, reliability, and effective capacity of the XBL by showing that retrofitted buses were able to safely merge, maintain headway, and keep within the lane, all while allowing the operator to switch between automated driving system (ADS) and manual modes as needed.

A qualitative assessment was undertaken to determine the CAB operator's response to and overall perceptions of the technology's effectiveness in the areas of manual and automated initiation and disengagement of L3 braking, steering and throttle, ease of use, understanding the information presented, whether L3 autonomy was helpful in general, and risk. The responses were generally positive, and the operators believe the ADS technology would be helpful in time; however, they noted it's too soon to put it into revenue service.

Simulation modeling found increases in passenger throughput and reductions in average headways, delay and fuel savings, emission reductions, and crash reductions between the 2016 existing peak hour throughout of 650 buses per hour and the 2040 future demand of 840 buses per hour.

While the demonstration was a success, lessons to be learned and conclusions to share with others in the transit industry considering retrofitting buses to provide ADS include:

- Refining the approach to obstacle detection
- Refining the approach to automated lane keeping
- Calibration takes time
- Reflectivity can present challenges to ADS technology
- Know the limitations of the selected technology
- Spend time to calibrate ADS in the operational design domain
- The age of the bus matters

Benefits

The XBL POC Demonstration Project offered a unique opportunity to demonstrate the benefits of bus fleet automation within a heavily utilized highway transit lane. Even though only a few vehicles were automated, it is envisioned that this demonstration will drive a technology deployment strategy for equipping vehicles using the XBL with connected and other automation technologies.

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Project Information

This research project was conducted by the Port Authority of New York and New Jersey. For more information, contact FTA Project Manager Steven Mortensen at (202) 493-0459 or Steven.Mortensen@dot.gov.

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