Background on Automated Guided Vehicle (AVG) Technology (Guided Bus)

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AGV systems were first introduced in the 1960s for industrial applications for warehouses and loading docks. It was not introduced into a transit application until the late 1990s, and testing of the system began in 2000. In 2004 the first passenger carrying system using APTS buses and the FROG guidance technology is the Eindhoven (The Netherlands) system.

AGV Technology

The FROG (Fee Ranging On Grid) guidance system has on each vehicle has an on-board computer which stores an electronic map of the area in which the vehicle is required to operate. Using this map, the vehicle is able to plan its route to drive from point A to point B. The vehicle's starting position is known. As soon as the vehicle starts to move, it measures the distance traveled by means of encoders that count the number of wheel revolutions. Magnets embedded in the travel lane and detected by a magnet sensor array on the vehicle, which provides the targets which the on-board computer uses to guide the vehicle within the lane.

The vehicle is able to determine its own route because each vehicle has its own driving computer and positioning system. Regulation of route planning and the vehicle's interaction with other FROG vehicles and normal road traffic is taken care of by a supervisory computer control system called SuperFROG.

To date the Eindhoven system has not been certified for automatic running, however APTS plans to acquire certification in Europe in 2009. It is unknown if APTS will seek certification in the US.

Discussion

The FROG guidance system as described is a very complex communication based train control (CBTC) system that is still experimental. The control system must be able to vitally control vehicle speed, safe separation from vehicles or other obstructions ahead, and determining safe stopping distance based upon speed, grade and traction. In the rail industry there are proven CBTC systems, but they are products of well established train control firms with a long history of rail signaling that use system architecture very dissimilar from APTS/FROG.

CBTC bring unique challenges that include:

- Vital software of the on-board and stationary computer software must undergo rigorous safety analysis, identifying each safety case and its fail safe resolution.

This includes Failure Mode Effect Analysis (FMEA) and Failure Mode Effects and Critical Analysis (FMECA).

- The use of radio signals to transit vital operating instructions must be able to encrypt messages and prevent accidental and malicious interference.
- The system architecture must be a deal with “silent vehicle”, that a vehicle that can not communicate with the central computer. This is a very hazardous condition where control cars may over-run non-controlled vehicles. FROG experienced such a failure in 2005, when two vehicles collided at the Rotterdam ParkShuttle system that was controlled use FROG technology.
- Initiating vehicles as they enter the control area is a vital step in tracking the vehicle through the on-board computer. If a vehicle was to weave out of its lane and forced to stop, how it will re-initialize to move or will the entire control system is disabled until all the vehicles are again in control mode.
- SWSR has a fixed guideway to guide and steer the vehicle. APTS by design must account for a bus intruding into on-coming lanes, adding further complexities to the safety analysis.

These are just a few of scores of safety cases that must be analyzed and resolved prior to a new control system being approved for revenue service. There is no guarantee that FROG’s unique system architecture will satisfy the demanding FTA requirements for safety certification. Others have failed in their attempt to prove their unique control system is safe in control fast moving trains, at frequent headways, with thousands of passengers.

Conclusion:

Vital control system for transit is extremely complex. The information material provided by APTS did not adequately address the automatic control requirements of the RFI. In fact, their experience is very limited, having no system in operation that remotely compares to what is needed for Honolulu. In careful review of public information available it clearly implies that the bus operator is vital in assuring safe operation, obviously substituting human intervention for adequate automatic control system.

Safety is paramount in any transit system design. It is not in the best interest of a public entity to risk the safety of its citizens with an unproven experimental control system. APTS and its supporters should not make claims for automatic operation until its system is proven safe by industry and regulatory standards.