

# Human-centric automated driving for intersection crossing

## C-ITS control application for public transport

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The prospect of CCAM (cooperative connected automated mobility) includes providing all-inclusive transport of people by offering shared vehicles for public transport. The key target for attracting passengers is an increased service level and improved comfort to give confidence to the occupants during their travel. The European SHOW project is aimed to demonstrate automated public transport to citizens in a dozen European Member States in order to increase the interest for widespread deployment of CCAM in public transport services. One of the locations is the Brainport region in The Netherlands, which encompasses various cities including the City of Eindhoven which has a wide network of dedicated bus lanes. Brainport is also the host of many Automotive companies, high tech industries, research centers and academia. The first initiative on automated public transport concerns the Phileas bus (see Figure 1) was initiated in 1998, resulting in an operational on-road service launched in the mid-2000 with automated steering functionality to support in-lane driving and docking at bus stops by utilizing a trace of magnets in the road.

Since then, there has been significant developments in the use of communication technologies for traffic management and traffic safety improvements, which have been standardized within the C-ITS platform.

The Netherlands has been represented in the C-ITS platform by various organizations (including TNO), that have had direct access to the standards that have been developed. As a result, the deployment of C-ITS systems and services is executed at a national level, with Brainport as a frontrunner region.

The presence of C-ITS equipped intersections in the Brainport has been the enabler for developing technology for crossing intersections with automated driving at normal operational speeds of busses. This topic is addressed in this paper as well as the user evaluation.



Figure 1: Phileas bus



Figure 2: User testing

The automated driving functionality for intersection crossing has been tested with a group of users, where various scenarios with traffic lights and a (dummy) VRU were created at a proving ground. The focus has been the speed adjustment for different scenarios with an approach speed of 50 km/h. The speed adjustment has been made according to four states in a tactical control layer.

The users were passengers in the vehicle that have been answering surveys after each test run and have been interviewed after completion of the whole test session. The results of user assessment are presented and discussed, including some review of recorded vehicle motions in relation to the states of the tactical control layer.

The traffic light scenarios concern a different timing of braking in response to the traffic phase turning yellow and red. The results suggest that users feel more confident when the automated vehicle is acting similar to human driving. The tests with VRU are more focused on repetition of scenarios and assessing how users adjust to the automated driving when they experience it more than once.

Based on the results, recommendations are made for further studies into the speed adaptation profile and setup of testing with VRU.