In the framework of the Konvoi Project, a consortium amongst of RWTH Aachen University institutes, MAN Nutzfahrzeuge AG and Wabco Development GmbH developed four experimental vehicles in order to investigate the effects of electronically coupled commercial vehicles in real traffic. This article describes the system architecture, the development process and the results of the runs in public traffic.
1 INTRODUCTION

Over the coming years, significant increases in individual traffic and road freight transport are expected [1]. In future, reduction of the associated negative effects will become increasingly important. This is the approach taken by the Konvoi concept of forming truck platoons. The electronic coupling of trucks with short distances between them is expected to reduce the drivers’ workload, increase road safety, improve utilisation of the space available on the road and save fuel.

The first vehicle (the leading vehicle) in a platoon of electronically coupled trucks is driven manually; all the other vehicles (the following vehicles) automatically follow the leading vehicle within its lane. Research on the basics of electronic vehicle coupling has already been done in the Path Project [2, 3] and in the Promote Chauffeur I and II Projects [4]. The goal of the Konvoi Project was in particular to investigate the advantages and effects of truck platoons in real traffic. For this reason, four experimental vehicles were developed on the basis of series production vehicles. These experimental vehicles enabled an automated Konvoi platoon to be tested in practice on public roads. Right from the start, freight-forwarding companies, public authorities and a vocational school for professional truck drivers were involved in the development of the system.

2 SYSTEM ARCHITECTURE AND ITS IMPLEMENTATION IN THE TRUCKS

The basis for the design of the Konvoi system was the analysis of the functional requirements for the electronic coupling of vehicles. These are summarised below.

2.1 LONGITUDINAL AND LATERAL CONTROL

All the vehicles within Konvoi must be able to control their distances and their lateral positions in the lane in a reliable and comfortable way. The specified distance must be adjustable, for example during the formation of the Konvoi platoon. Subsequent to coupling, a constant distance of 10 m must be maintained during normal operation. Due to the short distances between the vehicles, the field of vision of the integrated camera is limited, which means that lateral control must be able to operate without any predictive information as to the curvature of the traffic lane.

2.2 DYNAMIC CHANGES TO THE VEHICLE PLATOON IN OPERATION

The system must allow an automatic coupling or decoupling of vehicles during operation. This is initiated by the driver or by the Konvoi system itself in the event of an error.

2.3 INTEGRATION OF THE DRIVER

The Konvoi system must allow the driver to intervene at any time, must execute the driver’s commands and must keep the driver informed of the system status at all times.

2.4 MONITORING THE SYSTEM

Because Konvoi is a safety critical system, there must be continual checks on whether the hard- and software components are functioning. The Konvoi system must inform the driver and take suitable action independently in the event of errors.

The system architecture is depicted in . It shows the interaction of the system’s components with the driver and the vehicle. The driver information system (DIS) is the human-machine-interface and the primary control device for the Konvoi system. In addition, the driver can take control of the vehicle at any time using the vehicle control elements (for example brake pedal, steering wheel etc.). A central element of the Konvoi system is the coordinator module, which specifies the current system status in the vehicle. It represents the superior logical level of longitudinal and lateral control, interprets driver-system-interaction, enables manoeuvres (for example the coupling/decoupling of a vehicle) and specifies the states of the Konvoi system. In order to do this, the coordinator module of each vehicle needs information about the presence of vehicles nearby that are capable of being integrated into the Konvoi system. This information is provided by UMTS-based communication with a central Konvoi organisation server. Furthermore, the organisation server receives the GPS position data from each vehicle via UMTS. This allows the order of the vehicles in the Konvoi formation to be determined, which in turn is transmitted to the coordinator module. During Konvoi operation