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Abstract

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Modern Vehicle Architectures

Advanced Embedded Systems

# Introduction

Since the first modern automobiles produced by Karl Benz and Henry Ford, the automotive industry underwent continuous growth and development, becoming one of the largest industries worldwide. One of the most important drivers of the automotive industry is the constantly increasing demand for functionality, comfort, safety and performance inside the vehicle, matched to the rapid development of electronics and software technologies (Navet & Simonot-Lion, 2009). During the last decades more and more functions of the vehicle moved away from mechanical and hydraulically technologies and adopted electronic counterparts. Examples of such functions are the steering, transmission and wipers. Moreover, new functions were added to the vehicle once certain embedded technologies became available, such as the electronic break system and the electronic stability control. In the same time, governmental regulations reading transportation safety and pollution led to the advancement of specific technologies aimed towards low power consumption and environmentally friendly vehicles. All these factors contributed to the development of embedded systems and software technologies for the automotive industry.

## Early stages

Initial vehicle architectures comprised a relatively small number of

## Current development

Vehicle became complex distributed embedded systems consisting in a large numbers of sensors, actuators and processing units. Each functions of the vehicle is typically distributed across electronic control units (ECUs). The number of ECUs in a vehicle was also subject to growth, averaging in current vehicle architectures to around sixty (Navet & Simonot-Lion, Trends in Automotive Communication Systems, 2009). Each of those ECUs performs a very specific task and needs to exchange data with other ECUs. In the early stages of vehicle architectures data was transferred between ECUs using interconnections (i.e. each ECU was connected to all other ECUs with which communication was needed). However, it is not difficult to prove that this method does not scale with an increasing number of ECUs. Moreover, the data exchange demand increased as well since more and more functions required inputs from different parts of the vehicle. For example, modern vehicles employ dynamic volume control of the media player with respect to the vehicle speed. The volume control and the vehicle speed reading are implemented in different ECUs, thus data exchange is required.

## Future trends

Latest trends in the automotive industry support even more demanding requirements such as vehicle communication with the external world. Most notable examples are internet connectivity, vehicle-to-infrastructure and vehicle-to-vehicle capabilities. Such requirements add constraints to the vehicle architecture and communication systems and often require a change in paradigm in order to be feasible.

# Vehicle functional domains

# Architectures

## Gateway architecture

## Domain controlled architecture

# Communication systems