ATZ Elektronik

E/E architecture for battery electric vehicles
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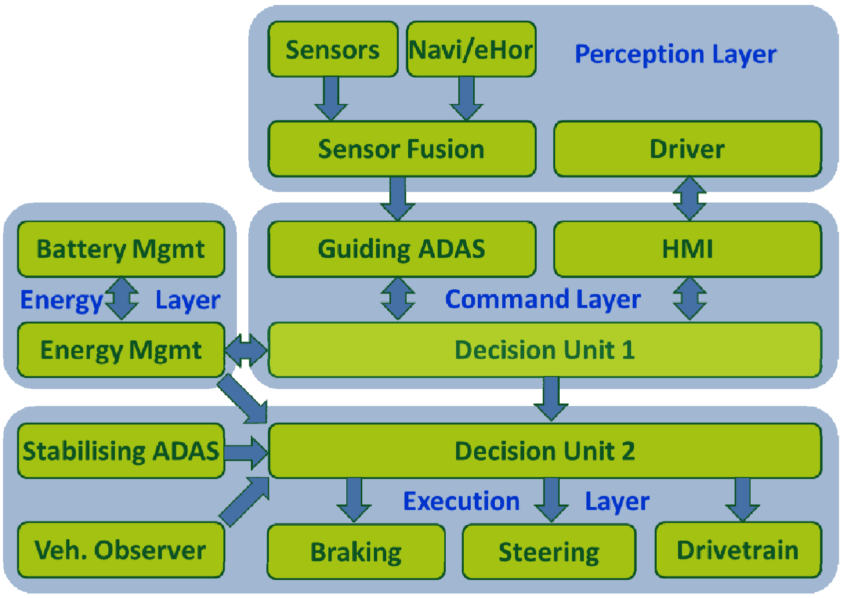
E/E architecture

The E/E architecture of a vehicle can be divided into the functional and the physical architecture. The latter comprises the entity of control units, the topology of the bus network and the wiring harness, i.e. the hardware to distribute signals and power. To keep these networks lean a comprehensiveanalysis of vehicle functions is essential as all these functions need sensors, interfaces to other functions, a power supply and a control unit for the corresponding algorithm. Knowing the functions in detail a functional architecture can be set up which considers the specific requirements of the vehicle. In the case of eFuture these are maximum energy efficiency at the highest level of operational safety.

The functional architecture's upper level is shown in Figure 1. A layer model with the classical command and execution layer as the main axis for driving has been chosen. The perception layer combines all environmental information via the driver and the exteroceptive sensors including navigation and eHorizon.In parallel, the energy layer accomplishes the control of the energy flows and the assignment of reserves for the domains driving, comfort and safety. This is a dynamical process depending on the driving situation and on the driver's wish. The communication between energy layer and execution layer is essential for safe and efficient driving as the stability functions (ABS, ESC, torque vectoring) need to feedback their status and energy/power needs.



Top level functional architecture of the eFuture vehicle. ADAS stands for Advanced Driver Assistance Systems, HMI is the abbreviation for Human-Machine-Interface

To cope with the functional complexity the concept of dedicated decision units is followed which are designed as state machines and serve as the central intelligence of the functional concept. The decision units collect the requestsand demands of the preceding functions and decide according to criteria of safety and efficiency which action should be taken in the actual situation.In the example of motorway driving different requirements to the vehicle can arise: while the adaptive cruise control (ACC) requests a braking action upon approaching the leading vehicle, the driver might want to overtake and steers accordingly. In the case the indicator has not been used, the lane keeping assistance system (LKAS) would revise the steering command. This operation together with the ACC braking could lead to an unwanted trajectory and possibly to a derogation of the driving stability.

For single operating functions contradicting actions can only be avoided if every function has its own situation assessment and appropriate decision logic. The decision unit provides this functionality as a central function to all connected functions thus reducing their complexity and their cycle time.

The example reveals an additional advantage of the concept. The transition between different assistance functions and driving states is accomplished by simple rules. The behaviour in the threshold region of longitudinal to lateral dynamics will be balanced individually in order to avoid dangerous and contradicting actions from different functions. The same holds for the transition from automated to manual driving where discontinuities could lead to undesirable driving behaviour.

For normal driving scenarios where the vehicle is in a stable driving state, the decision will lead to the most efficient driving state. As long as the driver does not contradict or the vehicle does not reach an unsafe state, the choice will always lead to maximise the range, thus, to “green” driving. This principle is promoted by the use of the central decision as there is no functional path in parallel.

To reduce the complexity of the decision unit it is split between the command and the execution layer. The decision unit 1 in the command layer is responsible for the mediation between the guiding assistance systems (ACC, LKAS, emergency brake assist), the driver, and the input from the energy management system. The decision, which trajectory should be followed, will be passed to the decision unit 2, located in the execution layer. This function assesses the received requests to the electric machines (acceleration or recuperation), to the hydraulic brakes, and to the steering system with respect to the actual driving state and extrapolates the implications of this manoeuvre. In the case of an undesirable behaviour (e.g. oversteering), the decision unit hands over the control to the corresponding assistance function (here ESC).