Developing ESP for Com

Pilot project with ASCET-SD at Knorr-Bremse

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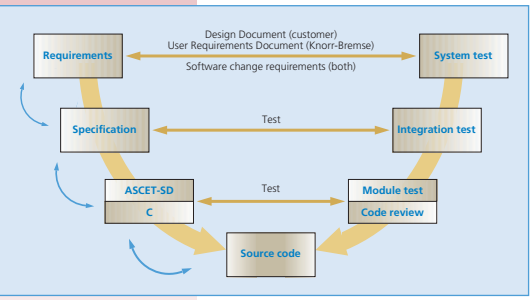
Detlef Zerfowski during his lecture at the Competence Exchange Symposium.

The electronic stability program (ESP) also enables increased driving safety for commercial vehicles in critical driving situations. For this purpose, different load states and vehicle configurations – for example with a trailer or semitrailer – have to be taken into consideration during software development.
Knorr-Bremse used ASCET-SD, the ETAS embedded control development system, in a pilot project for the production development of an ESP system for commercial vehicles.

Increasing software complexity requires the implementation of a specific, organizational framework for the software development process. The V model is exactly this kind of process model: in addition to the actual development steps, it also includes the verification and validation of the software. The development process is divided into several phases. After the specification, there is coarse- and fine-tuning before module implementation is started. Test cases are defined in each phase: these keep the individual development steps to a manageable size for testing.

Validation and verification.



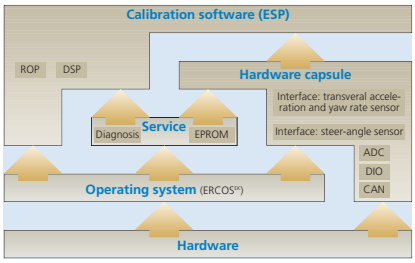
Getting started

Knorr-Bremse took the first step towards a new development process as part of the development of a trailer control module. ASCET-RSF was implemented. The predecessor of the current ASCET-SD is a CASE tool which allowed the graphic specification of the control algorithms to be implemented and also allowed their development.
Automatic code generation was not, however, possible, making manual reimplementation of the functions in C necessary for the target hardware.

In addition to this time-consuming implementation in C, there was another disadvantage: due to functional changes in the implemented C-code, the model in ASCET-RSF was out-of-date in a very short time because no changes could be made.

Knorr-Bremse then decided to use ASCET-SD as part of a pilot project – the production development of an electronic stability program (ESP) for the commercial vehicle sector. A major reason for this decision was the consistency of the development process from specification to production code – available for the very first time. This enables functions to be tested for correct behavior in an early prototype phase by simulation without a specific target hardware having to be available.

Thanks to the permanent further development of the functions within this development system, transition between development tools, which would otherwise lead to a loss of previous implementation information, is no longer necessary. The early simulation of integer implementation (without existing target hardware) makes it possible to take quantization effects into consideration in early development phases.



Software architecture: overview of the different software levels.

mercial Vehicles

Time-consuming, error-prone software changes due to quantization effects in late phases of development which cannot be foreseen are thus avoided. Implementation in ECU code is realized by the automatic code generation of ASCET-SD which considerably reduces development time.

Test procedure

The test phase under "real" conditions plays a special role in software development. As software tests in vehicles are time-consuming, expensive and very difficult to reproduce, Knorr-Bremse constructed a test bench with ASCET-SD. It enables realistic simulation of driving maneuvers under different conditions. A vehicle simulation model developed by Knorr-Bremse is also used on a separate PC. This model allows the specification of different vehicle configurations, environmental influences and driving maneuvers which are visualized in real time in a moving vehicle as a 3D grid model.

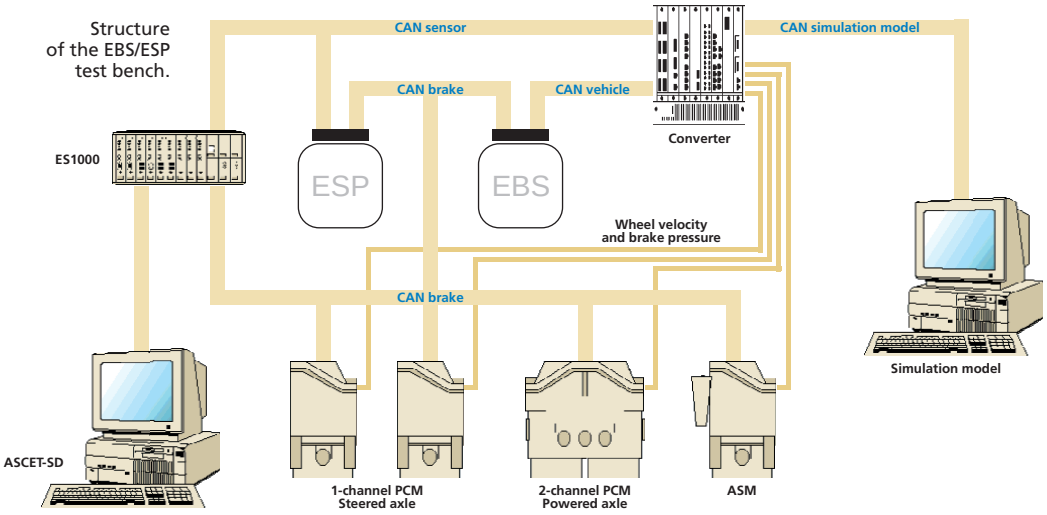
An ES1000 system with ASCET-SD is used on the test bench as part of a "hardware-in-the-loop" concept: this runs selected subfunctions of the ESP software outside the ESP ECU in the experimental hardware (bypass operation). This makes it possible to test ESP functionality – for example in an implementation not yet quantized – in the whole system. The ESP ECU and ES1000 hardware communicate using a CAN interface.

ASCET-SD systems can also be used directly in the vehicle with a hardware-in-the-loop connection. The measure data acquired in real driving maneuvers is then used as a basis for test drives executed on the test bench.

Basis for further developments

On the whole, Knorr-Bremse sees the implementation of ASCET-SD as a way of considerably increasing efficiency and quality in software development for embedded systems. This is also coupled with a corresponding return-on-investment (ROI).

Structure of the EBS/ESP test bench.



The universality of the development process "forces" development to be structured and documentation of the developed functions to be up-to-date. This is guaranteed by the graphic structuring of the function blocks (system documentation) as well as the automatic documentation possibilities. The emphasis is then purely on functionality as detailed knowledge of the target hardware is no longer necessary.

The result is function software which, for the most part, can be reused. The performance of the entire development process, using the experience gained in ESP development, is currently having to prove itself at Knorr-Bremse as part of the development of a new EBS system on different target hardware.

EBS system overview.