case study

# dSPACE:

## ASAM MCD-1 XCP (FlexRay) protocol for function prototyping and ECU testing


### SUMMARY

Challenge: The FlexRay bus is being used in more and more ECU projects. To master increasing complexity and the workload involved in developing and testing ECU software, communication interfaces between ECUs and simulation platforms are required. Considerable simplifications and savings can be achieved by standardized protocols.

Solution: The ASAM MCD-1 protocol (XCP on FlexRay) in connection with the ASAM MCD-2 description files (FIBEX, A2L) establishes a basis for the interoperability of ECUs and off-the-shelf products. Utilizing these standards, the RTI Bypass Blockset from dSPACE makes it possible to develop and test ECU software on real-time simulation platforms, with data exchange and synchronization to the ECU being performed via XCP on FlexRay.

Key Benefits: Using XCP on FlexRay on ECUs allows dSPACE customers to prototype software-based functions in a minimum of time. In addition, data from hardware-in-the-loop (HIL) simulation and ECUs can be precisely correlated according to a common time base, resulting in enhanced test quality.


### SITUATION

Due to the complexity of modern ECUs and the narrow time window for development, it rarely happens that all the software functions for new ECU generations are developed from scratch. Usually, existing code is simply adapted or extended. A method that is being used in this context by control engineers at OEMs and Tier 1 suppliers is external bypassing, in which only new functions or functions that need to be modified are prototyped on a real-time simulation platform. Input and output variables of these functions are exchanged via dedicated ECU interfaces, and the calculation is synchronized with the ECU. Due to cost issues it is often desirable to use existing bus interfaces and the existing ECU harness for this.

HIL tests are becoming more and more challenging. ECU internal variables need to be measured and stimulated flexibly in correlation with the real-time simulation. This requires a direct communication interface between HIL platforms and production ECUs.

### CHALLENGES

Function development is typically done graphically by means of block diagrams and state charts, and the associated model code is implemented automatically on the prototyping platform. Fast iteration cycles are essential, and control engineers do not have to worry about ECU interface or software implementation issues. In contrast, setting up a bypass scenario via XCP on FlexRay requires a certain level of FlexRay know-how and information on the communication schedule.

During ECU testing, different test scenarios have to be run with different ECU software versions. With respect to the simulation platform, the challenge was to automatically reconfigure, during run time, the variables to be read from and written to the ECU via XCP on FlexRay.

### SUCCESS STRATEGY

The RTI Bypass Blockset makes it possible to prototype ECU functions on dSPACE real-time simulation platforms using the existing FlexRay interface of the ECU and the XCP slots in the communication cycle. Data is acquired via XCP service calls at defined positions in the ECU code and transmitted to the simulation platform. New functions are calculated on this platform and function outputs are returned to the ECU. The A2L file contains all ECU variables to be measured and stimulated, and data exchange is configured by means of the RTI Bypass Blockset. Up to four ECUs can be addressed in parallel via the same FlexRay bus. Intuitive

configuration dialogs enable users to select the XCP slots which are to be used for communication with the individual ECU.
Typically, dedicated XCP service calls remain in the ECU production code for test purposes. These service calls also serve for monitoring ECU variables task-synchronously during HIL tests. Depending on the individual test case, the XCP on FlexRay communication is adapted without recompiling the simulation model.

## CHALLENGES DURING THE PROJECT

In function bypassing, data has to be exchanged at defined points in time and often within the same FlexRay communication cycle. This requires detailed knowledge of the ECU task and FlexRay schedule. To facilitate the configuration, the RTI Bypass Blockset allows XCP slots to be selected automatically.
In addition, the FlexRay schedule may only allow XCP slots in the dynamic segment of the FlexRay communication cycle. In this case, the input and output data of bypass functions can be transmitted with communication cycle delay.

## BUSINESS BENEFITS

XCP on FlexRay provides an improved bandwidth and, depending on the FlexRay schedule, reduced communication latencies compared to CCP and XCP on CAN.
For function prototyping, time and cost savings can be achieved by using the existing XCP on FlexRay implementation in the ECU. No extra hardware interfaces are required and the existing ECU harness is reused.
Regarding HIL simulation, the integrated XCP communication interface to ECUs allows the overall quality of ECU tests to be improved. Simulation data and ECU internal data can be captured time-synchronously and correlated precisely.

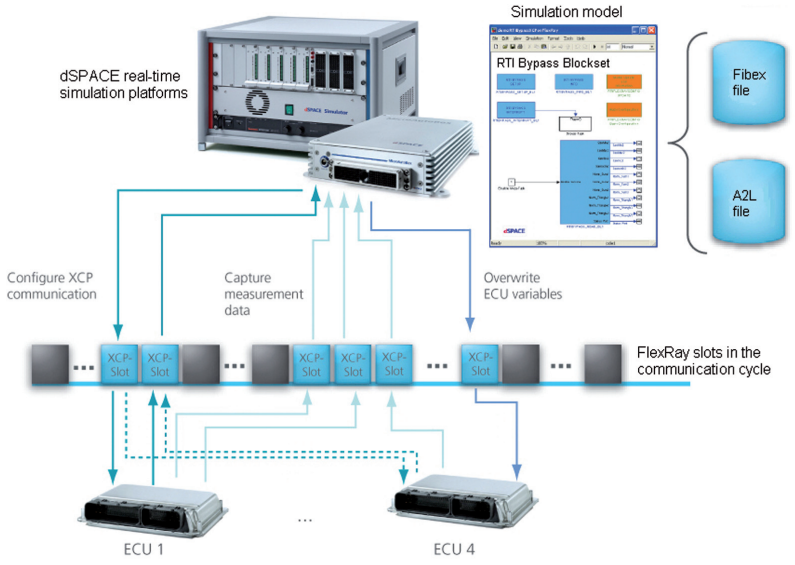


Figure 1: XCP on FlexRay interface of dSPACE real-time simulation platforms