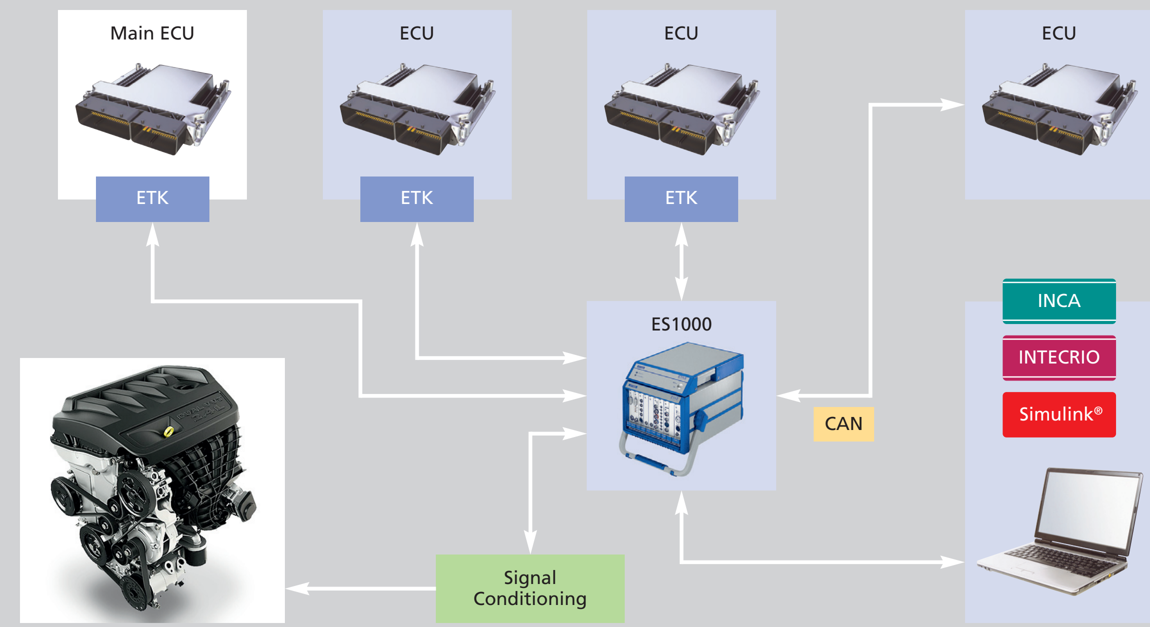
Powerful ETAS Tools Prove Efficiency

Rapid prototyping speeds up the development of advanced engine control strategies

The increased mandate on fuel economy is driving automotive companies to innovate a variety of solutions against stringent deadlines. This pushes up development costs and leads to greater complexity. Accordingly, many technology evaluations and proofs of concept demand quick setup and efficiency, while keeping cost and complexity in mind.



System setup for multiple ECU bypass

Chrysler Group LLC chose ETAS rapid prototyping technology as their solution. The proposed methodology led to the fast and successful development and verification of control algorithms in a real-time environment without the presence of the final ECU hardware. It also helped with evaluating engine technologies very early in the development cycle. For Chrysler, the ETAS tool chain provides an adequate platform for a development environment that will be adopted in similar future projects. The advanced powertrain development group at Chrysler was asked to integrate several new technologies simultaneously. The primary goal was to evaluate the controls aspects and proof of concept rather than to develop a new engine control unit (ECU). The high-level architecture requires high-speed communication between the main engine controller and two other ECUs (see Figure).

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Improving combustion controls relied on a fundamental understanding of the combustion process supported with data gathering from running engines and using it in the design of the control system. Capturing such data during cylinder events made it necessary to add a number of passive and smart sensors onto the existing powertrain system. Moreover, new actuators and solenoids were necessary to provide more degrees of freedom to the control system. To accommodate such an architecture, several algorithms were needed in addition to control systems from existing engine platforms. ETAS rapid prototyping technology was chosen to integrate newly created control solutions with the existing ECU. The ETAS solution included the software (ETAS INTECRIO, ETAS INCA), hardware (ETAS ES1000 system), and communication aspects of the system (ETAS ETK, CAN).

Hardware system

To interface with a large number of I/Os, the ES1000 system was a suitable match. Configured to the specific application on hand, the ES1000 provided access to several digital and analog input channels. These channels were used to acquire sensor measurements at high sampling rates. The measurements were then used to close the feedback control loop and for monitoring. The ES1000 provided drivers for additional actuators and solenoids to facilitate the task. A new external custom-built conditioning circuit with power electronics was designed to acquire and drive I/O signals. The ES1000 system also includes a controller card with a so-called 'simulation controller' on board, which can run models in real time and facilitate interaction with external peripherals.

Communication

The main driver for selecting the ES1000 system solution was the need for a high-speed communication interface that allows data exchange among multiple ECUs at a rate faster than cylinder events. In this case, the best solution was the ES1000 system with multiple ETK cards. Here, each card could act as a communication channel with the main controller card playing the role of the gateway. Each ECU on the network was equipped with an ETK that allows it to communicate with the ETK card on the ES1000 system over a 100 MB/s Ethernet wire. The ES1000 system also had a CAN card with four channels that could be used to potentially add four more ECUs to the network at lower speeds.

Software system

The software system was divided into three main components. One task was to develop new control strategies using a modeling tool such as Simulink®. Since the controls engineers' main focus was the strategy, it was sufficient to create the models in floating point, while taking into consideration fixed-point structure for future portability. The second task was to implement an infrastructure in the main ECU to allow bypass communication with the ES1000 system. The software infrastructure included ETK bypass drivers to allow data exchange between bypass hooks of the ECU software and a model running on a simulation controller of the ES1000 system. The same procedure was repeated for each ECU with ETK interface to be able to utilize the ETK bypass method. The third task was to integrate the hardware, software, and communications together. This was done using INTECRIO software. INTECRIO allows a direct connection of multiple I/Os on the ES1000 system hardware to the I/Os of the software models. The output from INTECRIO is then ported to a measurement and calibration tool such as INCA to be used for testing.

ETAS provides two methods of interaction with the ES1000 system to run tests, the INTECRIO or INCA experiment environments. In this case, INCA was chosen because it is currently used by Chrysler as a calibration tool. The main advantage of INCA was the ability to capture data from all ECUs, sensors, actuators, and solenoids simultaneously and synchronized in time.

ETAS Solution

Deployment of a powerful rapid prototyping environment consisting of INTECRIO and INCA in conjunction with an ES1000 system creates many possibilities for rapid prototyping development, testing, and validation across various project platforms.
Such possibilities were extended from bench, to engine dyno, to vehicle setups with minimal effort.