Getting There Faster: TargetLink at Conti Temic

- TargetLink for complex control functions
- Documentation always up-to-date
- Increased clarity through model-based development

The electronics of diesel injection systems interact with electromagnetically controlled injection nozzles. This imposes tough demands on the electronics, which have to improve injection and combustion processes and considerably reduce fuel consumption and exhaust emissions. Conti Temic is developing an electronic control unit (ECU) for diesel engines that will meet these demands for use in DaimlerChrysler's commercial vehicles. The project is being implemented using model-based function specification and automatic production code generation with dSPACE's TargetLink. This makes it easier to produce well-organized specifications for complex engine control functions and implement them in ECU code.

Engine Control Requirements

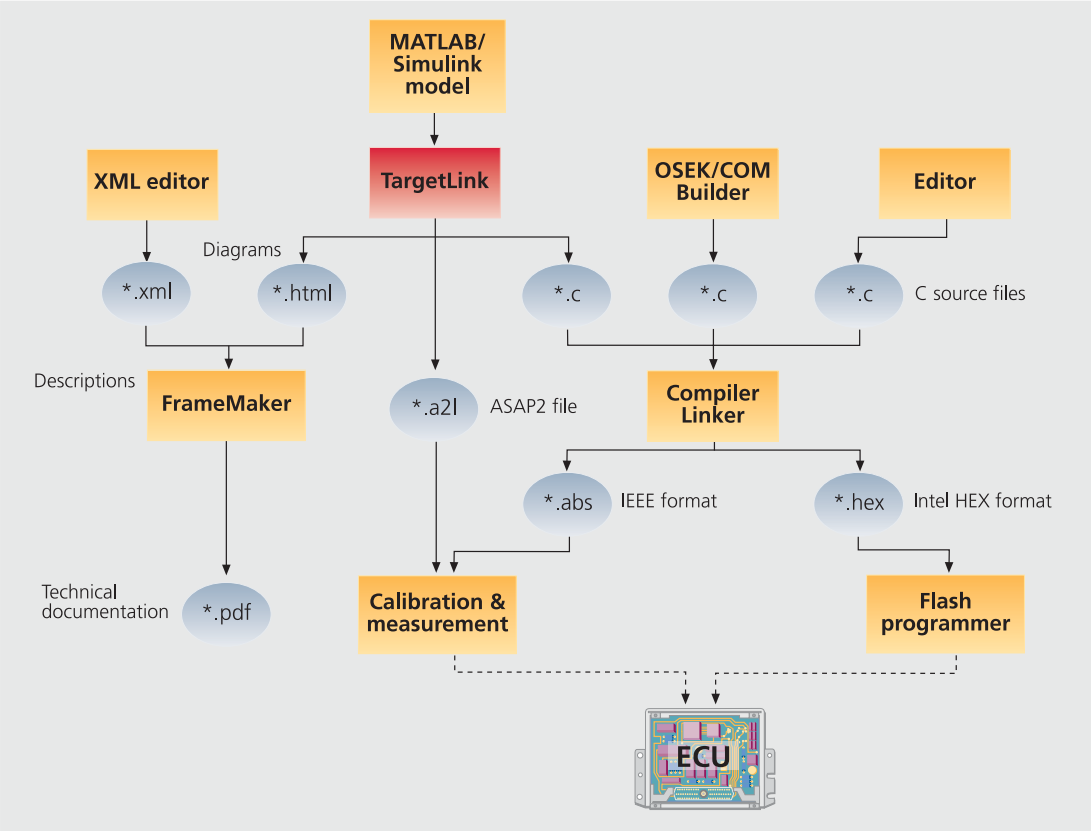
One of the key tasks of engine control is the fast availability of the torque required by the driver's gas pedal input. Further requirements are to cut fuel consumption while at the same time achieving a high level of utilization and efficiency, and to comply with compulsory exhaust limits such as the EURO/EPA exhaust standards. In addition, the engine needs to be protected against overload in all operating states, for example, when the vehicle is starting, cruising or running at full speed.

Onboard diagnostics monitor all the components involved in the exhaust system and help to detect hardware faults such as defective sensors. The faults are read out via a standardized interface, so that garages can perform the relevant repairs.

Software Architecture at Conti Temic

The software architecture is based on the standard embedded systems layer model. The lowest layer is the microcontroller core, which contains all software components that are specific to the processor and other hardware. It includes an OSEK operating system, BIOS and hardware-related communication routines for the CAN bus and K-line. The microcontroller core also contains functions that control data exchange between it and the Real-Time Interface above it. This

▶ *State-of-the-art ECU technology from Conti Temic for DaimlerChrysler.*



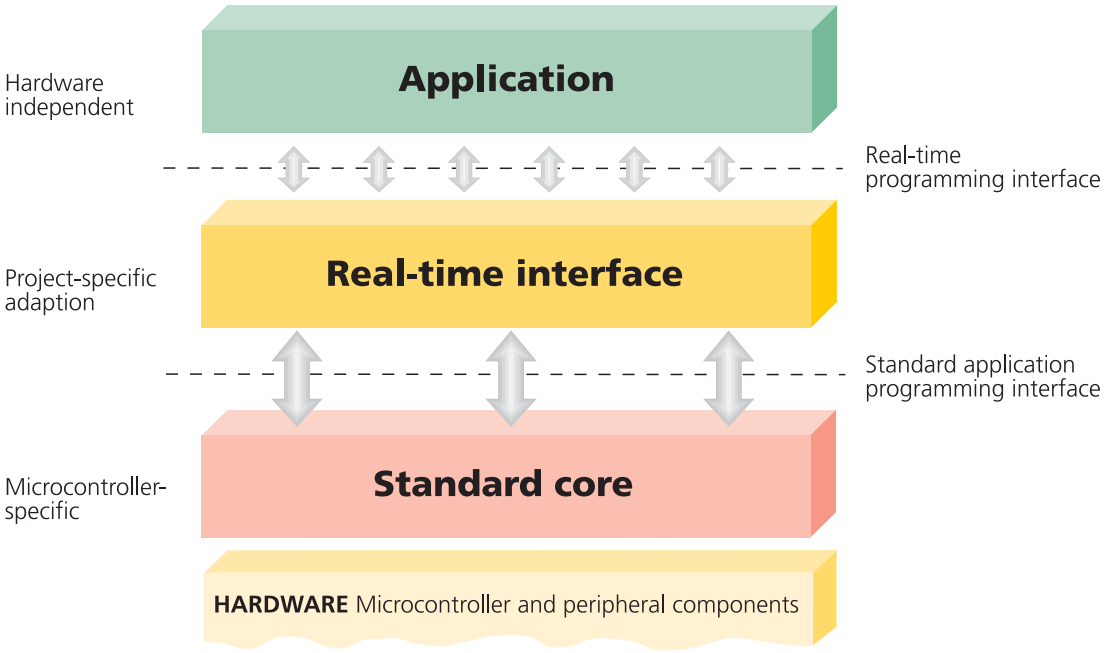
▲ *Software development process at Conti Temic.*

ensures that programming of the software above this interface is largely hardware-independent. The real-time interface is used for project-specific adaptation of the application to the microcontroller core below. It also contains all the routines that have tough real-time requirements and that cannot be implemented as OSEK tasks. Part of the real-time interface was implemented with TargetLink. The top layer, which we call the application layer, contains all the control algorithms for running the engine. These components were entirely designed, simulated and implemented with TargetLink. Overall, 80% of the ECU code was generated by TargetLink.

Software Development Process at Conti Temic

At Conti Temic, we use MATLAB®/Simulink®, the standard simulation tools from The MathWorks, to develop control algorithms. The software is modular, allowing the individual function requirements to be dealt with in separate models. Simulink libraries are also used, so several developers can work on one project in parallel.

Alongside other standard tools, dSPACE's TargetLink plays a major role in our development process. It not only performs production code generation, it also allows efficient verification, by simulation, of the model-based functions that have been developed. First we check functional behavior using floating-point simulation (model-in-the-loop simulation). When we are happy with these results, we compare them with the results of the fixed-point simulation (software-in-the-loop simulation). This is also performed on the developer PC. Any parameterization errors, such as a wrong data type, insufficient quantization, etc., are quickly detected and easily corrected, which saves considerable time otherwise spent debugging on the target hardware in a later phase. The C files generated by TargetLink are perfect in quality, the C code is well commented and optimized for the processor type used in the ECU. Our experience with using TargetLink in the project has also shown that

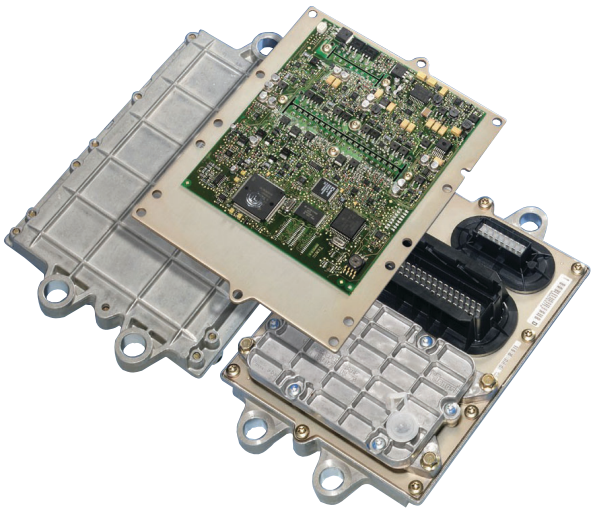


▲ *Model of the software architecture for embedded systems at Conti Temic.*

the functional behavior of a model as verified by PC simulation is always consistent with the behavior on the target hardware.

Another task that TargetLink performs for us is automatic creation of an ECU description file in the standardized ASAP2 file format. We also use TargetLink's options for automatic documentation of the developed models, which dSPACE specifically adapted to our needs.

This ensures that we always have the necessary customer documentation for every model version.



▲ *Developed with innovative tools – the Conti Temic ECU.*

The extreme complexity of the requirements imposed on engine control meant we had to constantly further develop and optimize TargetLink. We did this in close cooperation with dSPACE. The extensive support and competence provided by the TargetLink Support Team was a decisive factor in our success.

Outlook

In January 2003, the engine ECU was tested in a real vehicle, under extreme conditions within the Arctic Circle. Our client's very positive reactions reflect our own experience. Using TargetLink allowed us to achieve an unprecedented test depth, which automatically means that our client has far fewer error messages. We feel that the improved quality and clarity provided by model-based software development are key factors in the endeavor to cut development times despite the growing complexity of projects. These aspects are relevant to almost all automotive electronics projects, so at Conti Automotive Systems, we have defined TargetLink as a mainstream development tool.

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