SPARC – Comprehensive Testing Platform for Redundancy System

By Dr. Wolfgang Eismann and Petra Rehberger, ETAS

EU-sponsored project aims at improving vehicle safety

Coordinated by DaimlerChrysler AG, the SPARC project (Secure Propulsion using Advanced Redundant Control) unites European vehicle manufacturers, automotive suppliers, and research centers in an effort to achieve significant improvements in the traffic safety of vehicles through the deployment of intelligent X-by-Wire systems in the powertrain. Contributing as a cooperation partner, ETAS supports the project's integration and test phases with a real-time test environment.

For the period between 2004 and 2010, the European Union has declared the goal of reducing the number of fatal accidents on the roadways of Europe by 50 percent. To achieve this goal, the intent is to pursue political avenues with a view to standardizing the highway traffic statutes in the individual member countries on the one hand, and to render technological assistance to motorists on the other.

Investigative findings prove that 95 percent of accidents are caused by the vehicle operators themselves (source: EU-project PEIT). It therefore stands to reason that there is a need for the development of intelligent vehicles capable of assisting the driver with regard to accident prevention. To this end, the cooperation partners of the SPARC project have accepted the challenge to deploy and further advance existing driver assistance systems, and to develop suitable new technologies. The specific project objective is the development of an accident prevention system capable of evaluating the probability of driver error, supporting the driver in critical situations (e. g., microsleep, false reaction) and – in the absence of suitable human responses – initiating corrective intervention in vehicle control (Figure 1).

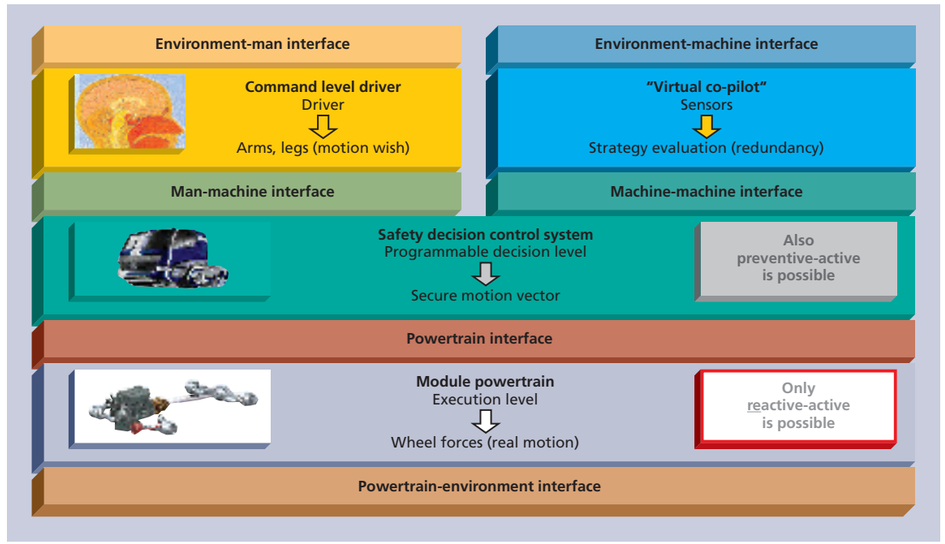

Figure 1:
Virtual co-pilot as assistance system.
Source:
AAET Conference 2005, Brunswick.

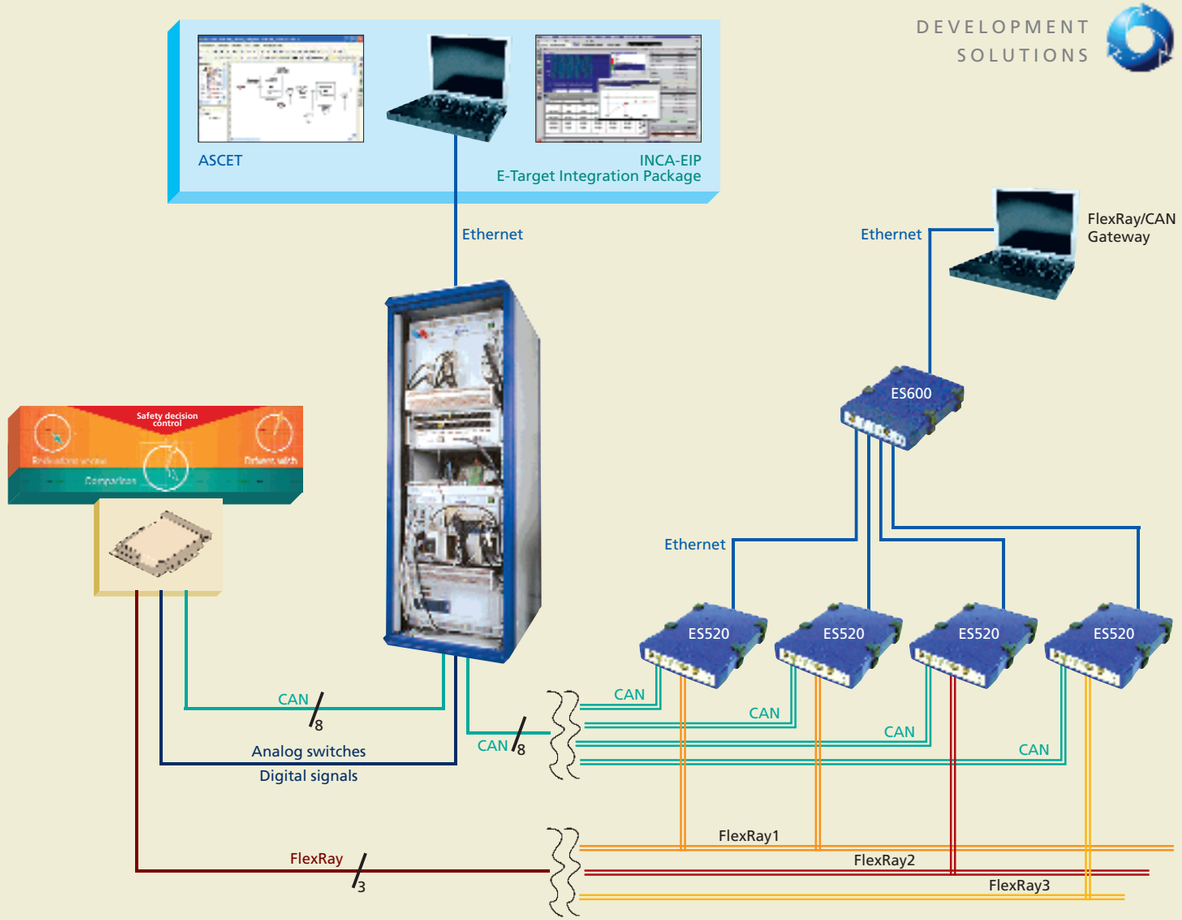

Figure 2:
Setup test system.

As one of the SPARC cooperation partners, the Department of Airborne Systems Engineering (ILS) of the University of Stuttgart is charged with providing the architecture for the overall system and establishing the specifications for the ECU of the central redundant control platform in the cockpit. The monitoring of the overall system is done by means of a redundancy management software (fault recognition, management of redundant resources, reconfiguration in case of error, etc.). The ILS enriches the project with its valuable expertise gained in by-Wire projects in its specialty fields of avionics and auto industry (www.sparc-eu.net).
Due to its dual-duplex redundancy architecture with four duplex units, the central control system is equipped with redundancy management.
It contains the coordination functions handling vehicle control through access to all vehicle data and functions. The coordination functions are supplied in the form of software modules by approximately ten teams of developers working for a variety of suppliers. The modules are then converged on the redundant control unit platform and prepared for deployment in the real-world vehicle.

The SPARC project pursues new avenues not only with the dual-duplex redundancy architecture but also with respect to communications. Since the options available with the present CAN technology have largely been exploited – the technology cannot handle the high data transfer rate and data security – FlexRay busses are used for data communications between sensors and actuators, and for communication with the Electronic Stability Program, GPS navigation, Man-Machine Interface, and Camera subsystems, etc. Eight separate CAN busses handle measuring and calibration-specific access between testing system and control computers (Figure 2).

Abbreviations:

APP:	Application Processor
PIT:	Platform Integration Tool
RMP:	Redundancy Management Processor
EBS:	Electronic Braking System
MMI:	Man-Machine Interface
ESP:	Electronic Stability Program
GPS:	Global Positioning System
CCP:	CAN Calibration Protocol
SPARC:	Secure Propulsion using Advanced Redundant Control
PEIT:	Powertrain Equipped with Intelligent Technologies

For testing the overall system and its individual modules, the Department of Airborne Systems Engineering (ILS) requires a system capable of conducting, verifying, and validating the software integration, real-time tests, rapid prototyping incl. data manipulation, fault simulation, and recording of measurements. The ETAS Engineering Team undertook the task of designing and developing this comprehensive testing system named PIT (Platform Integration Tool) jointly with the ILS. The PIT consists of software and hardware components, with the software divided into the three areas of protocol, simulation, and test instrumentation.

What delivers the PIT in terms of performance?

- Controlled access to all data of the duplex units is possible during system runtime.
- All I/Os are simulated, enabling the overall system to operate as if the physical target system were present.
- Data manipulation and fault stimulation under real-time conditions are possible on the duplex units.
- Data can be recorded in real-time for subsequent processing.
- Client side of protocol is implemented in ASCET.
- Component stimulation.
- Specially designed and developed user interface in INCA.
- Post-Processing/Trace.
- Test execution can be automated.

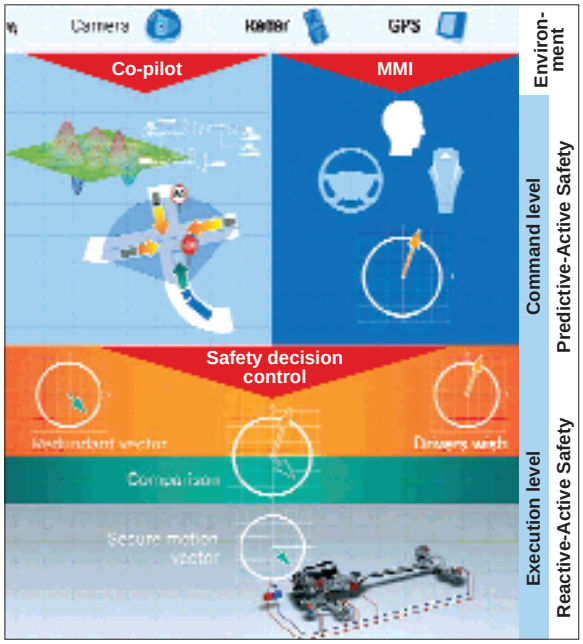

Figure 3: Redundancy system. Source: SPARC brochure, www.sparc-eu.net.

Protocol

The protocol to handle all communications between testing system, application processors (APPs), and redundancy management processors (RMPs) on the control units, is a CAN-based, ILS-proprietary client/server protocol named "SPY" that was implemented in the function and development tool ASCET. In a manner that echoes the CAN Calibration Protocol (CCP), this protocol facilitates the measuring and calibrating of variables via one of the eight CAN busses.

The server runs on the APPs and RMPs, and the client runs on the rapid prototyping hardware of the PIT.

Simulation

The second area – simulation – emulates the I/O characteristics of the – as yet physically absent – component ECUs such as the ESP for executing a rest bus simulation.

Test instrumentation

The third software component concerns the testing instrumentation in INCA. In order to clearly organize the display and handling of the sizeable data volume generated in the course of measuring and monitoring, a special extension was added to INCA. Thus, a mere touch of a button selects the CAN busses to carry the transmitted data. In addition, the number of transmitted CAN messages can be dynamically configured. If required, automated testing is an additional option.

The requirements for the hardware components of the PIT were also quite demanding. To facilitate the testing of all interfaces and functions of the complex redundancy system, the PIT testing system must reliably handle the following interfaces:

- 3 FlexRay busses with 4 FlexRay bus nodes
- 16 CAN interfaces for processor access and converted FlexRay data
- approx. 70 digital signals
- 8 Power node stimulation channels, 0-32 V, < 20 mA (power-on scenarios)
- 4 Power node emulation channels, 0-32 V, < 6 A

One of the consequences of the need to meet these requirements was the further development of available VME boards from the ETAS product portfolio. Initially, handling communications via the new FlexRay bus technology presented a challenge. The recently released ES520 FlexRay and CAN Interface compact module (featuring two FlexRay and two CAN interfaces) provides a solution. It consists of a conversion of FlexRay data to CAN, with subsequent download to the test system. The entire complement of synchronized data processing – i.e., for CAN, FlexRay, digital, PWM, and analog signals – occurs in the PIT. With the platform integration tool, ETAS not only pursues the objective of supplying a test system for the in-lab engineering phase. Instead, the very same test system is intended for initial deployment on both validation vehicles (one a commercial vehicle, the other a small passenger car). Subsequent use in series development, on test benches, and/or in test fleets is expected to provide optimum support for the development of a SPARC-compliant mass-produced vehicle of the future. The attainment of this goal is one of the long-range targets for the ETAS Engineering Team. It will continue to bring to bear its manifold experiences and unique skills on the various phases of software integration, test system design and setup, as well as measuring, calibration, and flash programming of control unit data.

To find out more about the SPARC project (EU funding number IST 507859), visit the website www.sparc-eu.net.