

Residual Bus Simulation in Test Bed Use

Volkswagen had been looking for a new concept of how to use residual bus simulation within the test beds of their engine development. The present residual bus simulation has been an integral part of the current test bed automation system (AuSy) and therefore it is usable only to a limited extent. As all test beds have a CAN bus architecture available, a gateway solution was required. Goepel maps out the path towards a modular solution, which avoids proprietary concepts and relies on open standards, tools and interfaces.

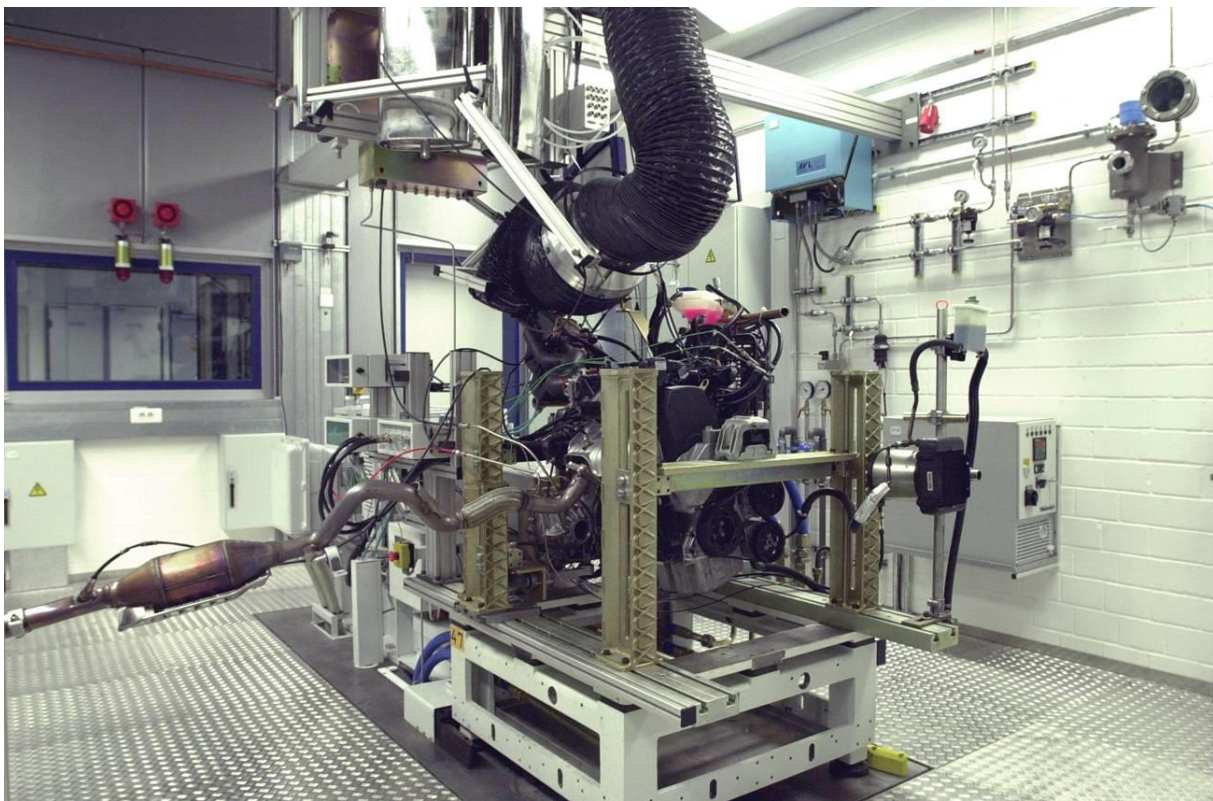


Image 1: Aggregate test bed at Volkswagen AG (source: Volkswagen)

Requirements

The new solution for residual bus simulations (RBS) should not only rely on CAN bus but also support LIN/FlexRay bus systems. In addition, analogue and digital I/O, an integrated tool chain as well as the possibility of integrating own user codes and functional blocks have been required. Here, the approach of “parameterisation instead of programming” was of primary importance. The variable part of the residual bus simulation should be creatable and adaptable by configuration and parameterisation using a standard tool.

In a formal selection procedure, which included several competitors and their currently available products, the respective turnaround times have been measured. Finally, the stand-alone box-solution

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and its Ethernet connection with the test bed automation system have been preferred. In the end, the advantages of the box-type unit, its ability to be run independently of the automation system AuSy, were convincing. And the possibility to install it close to the test object has cut down cabling effort and required cable lengths.

Hardware and software from a single source

The decision was ultimately made for the basicCAN61plus module of the series 61 controller family from GOPEL electronic. The chosen configuration of this box offers three CAN bus ports (2 x motor CAN, 1 x AuSy CAN), a LIN interface (accessories), two FlexRay interfaces, six analogue and eight digital inputs/outputs each. Furthermore, the box features a powerful 600 MHz PowerPC CPU to run the residual bus simulation, a Gigabit Ethernet interface and a USB 2.0 port. A “terminal 15” relais has also been integrated in the box.



Image 2: GOPEL electronic RBS box (basicCAN61PLUS)

To create the residual bus simulation Volkswagen used GOPEL electronic's Net2Run software package. The software enables users to create an executable, static residual bus simulation within a few minutes. Therefore, the required information will be imported from on-board network databases like DBC-, LDF- or FIBEX-databases and the control units to be simulated, with their respective messages, can be selected. Checksum calculations, message counters, as well as the required LIN and FlexRay send schedules are configured automatically. The same holds for PDU multiplexers, the entire PDU triggering and the FlexRay update bit handling. Finally, the user only needs to select those signals, which should be accessible in the RBS programme at runtime. Then the RBS file will be generated and can be stored in the RBS box. There, the RBS programme will load the file and run it. Alternatively, the residual bus simulation can be started directly from within the Net2Run software.

Residual bus simulation – a modular approach

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To be able to control the residual bus simulation via the AuSy CAN interface, GOPEL electronic's RBS box must be configured as gateway. This can be done using the gateway editor in Net2Run. The signals to be transmitted are mapped in a routing table. If applicable, additional scaling factors or offsets are added. This information too will be stored in the RBS file.

To be able to run the RBS box independently of any PC or the AuSy, an RBS programme (user code) is required for the box. It is a small C or C++ programme, which uses GOPEL API functions to access GOPEL electronic hardware and the respective firmware functions. Volkswagen uses RBS programmes with switchable versions for e.g. manual or automatic gearboxes. A simple RBS programme initialises all interfaces and activates/deactivates termination resistors as required. Then the RBS file is loaded and the residual bus simulation gets started. As soon as valid messages from the motor control unit are recognised, the RBS programme starts the Tx-PDU groups of the residual bus simulation and stops them accordingly, when the motor no longer sends any information. In addition, an RBS programme can control analogue and digital I/Os and may contain signal-based models or functions for dynamic residual bus simulation. These functions can be grouped together in libraries to be re-used in different RBS programmes.

As a tool for creating on-board RBS programmes, Volkswagen relies on Net2Run-IDE from GOPEL electronic. This Eclipse based development environment contains all necessary components to create and debug C and C++ programmes for the RBS box. Programmes in the RSB box are running under the QNX real-time operating system. All functions, which are required for residual bus simulation, are included in the GOPEL API and can also be used under Windows. Aside from standard C libraries, users can benefit from numerous, mostly POSIX compatible, QNX libraries.

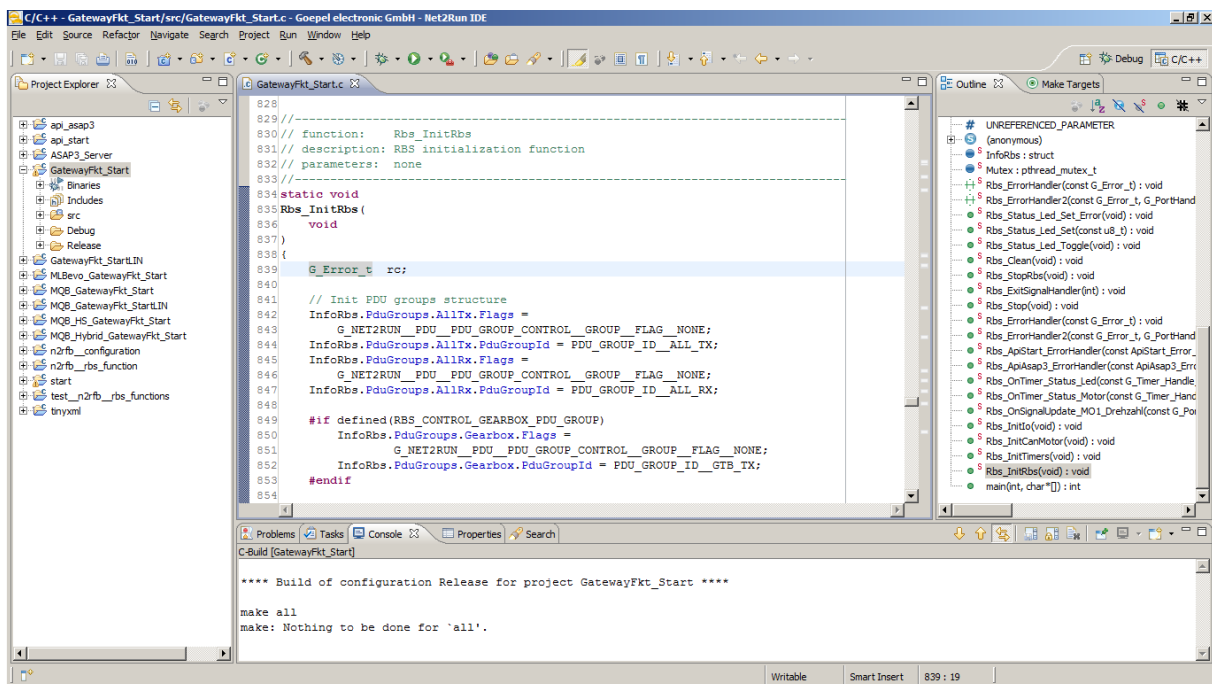


Image 3: Net2Run IDE (Code Perspective)

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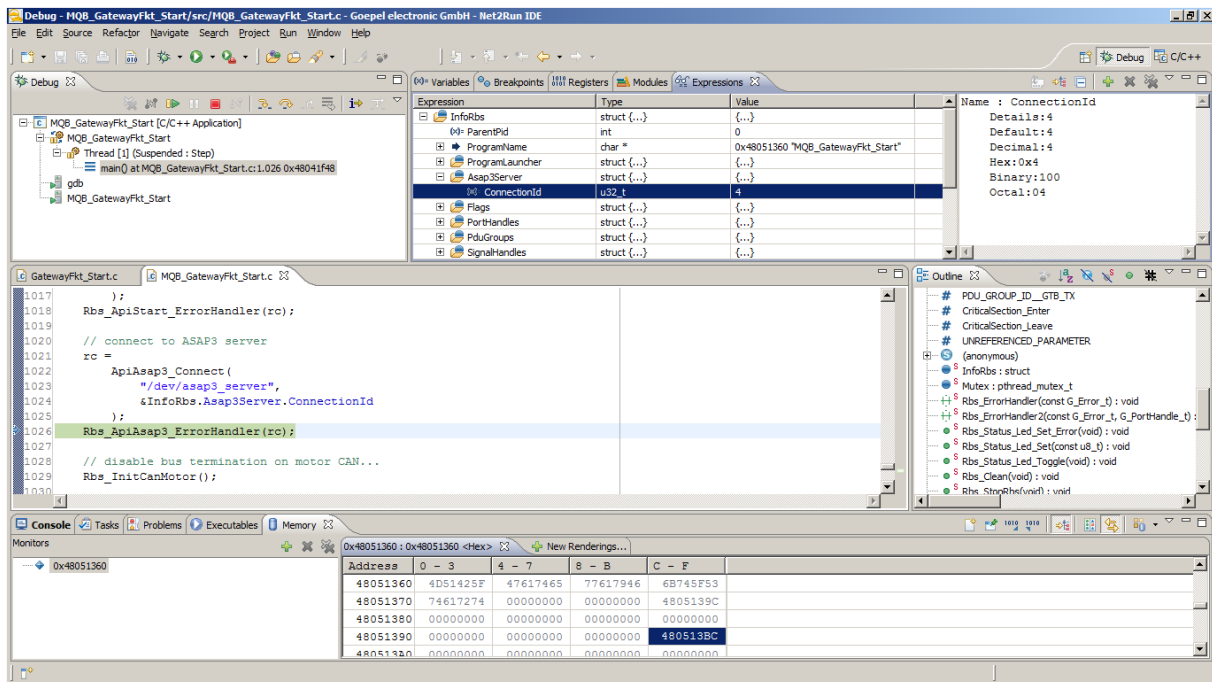


Image 4: Net2Run Configurator

RBS programmes are designed to run with various RBS files. However, for different units and bus systems there are accordingly adapted RBS programmes. A distinction is made between CAN and FlexRay control units and power train units with LIN Sub bus for auxiliary components. There is also a functional distinction made between petrol, diesel and hybrid engines. This leads to numerous possible combinations of RBS programmes and RBS files. They are grouped as RBS projects and defined in an XML file. Within this file the RBS project to be automatically loaded during start-up of the RBS box is also defined. For that, the RBS box features a tiny little programme called Program-Launcher. It is run during boot-up of the box and ensures that the selected RBS programme gets started with its associated RBS file. In addition, users can remote-control the Program-Launcher. On the one side, the residual bus simulation can be changed via CAN bus, on the other side this can be done via the GOPEL electronic tool “RBS-Selector”, which runs on a PC. RBS programmes use a FIFO buffer to send current status and error messages to the PC, where they are displayed by “On-Board Monitor Tools”.

In-house automation system for test sequence control

To control the test sequence and to record measured values Volkswagen uses their in-house test stand automation system “VENUS”. Communication takes place via CAN protocol. The automation system sends via the gateway of the RBS box all required parameters and reference variables, which influence the dynamic part of the residual bus simulation using the CAN bus. So even LIN controlled ancillary units and FlexRay control units can be remotely controlled via CAN. Measured values of the individual buses are sent via the gateway to “VENUS”, where they get evaluated. In addition to in-house test beds Volkswagen also uses test beds from external service providers, which use other test

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bed automation systems. Even here, most often a CAN connection can be implemented with very little effort.

Alternatively to CAN communication, Volkswagen and GOPEL electronic have jointly developed an ASAP3 server for the RBS box. It is running on the box as a service and offers easy access to signals of the residual bus simulation. ASAP3 is an ASAM specified protocol for calibration and recording of measured values in control unit software. Numerous calibration tools and test bed automation systems of renowned suppliers and the in-house software VENUS support the ASAP3 standard. The ASAP3 clients connects to the ASAP3 server via a Gigabit Ethernet link and can then access the Tx signals of the residual bus simulation as parameters; Rx signals are regarded measured values. From the A2L file the ASAP3 client can learn, which parameters or measured values are available in the RBS. Therefore Net2Run offers an integrated A2L export function for versions 1.51 and 1.60 of the standard, which exports all signals from the list as parameters (Tx) and measured values (Rx) respectively. To access the signals, the ASAP3 server uses the GOPEL API. The configuration is defined in an XML configuration file, which is read in by the TinyXml parser. Via the API of the programme launcher, users can switch over to run another residual bus simulation using the ASAP3 server. Ethernet communication is based on the POSIX compatible socket I/O library of the QNX operating system.

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