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Airbus DS NL – AIM GmbH: Technical White Paper

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MIL1553 Support in the ADSN EGSE Product Line

Introduction

The EGSEs developed by Airbus Defence and Space Netherlands B.V. (Airbus DS NL) are based on a modular architecture, called ESPRiT (EGSE and Simulation PRoducTs). ESPRiT offers reusable hardware and software components that are combined to meet the needs of a specific project. This ensures a high-level of flexibility to meet customer specifications, while maximally exploiting re-use of proven technology. The core components that are used are very frequently commercial of the shelf (COTS) subsystems. Such equipment is electrically integrated in standard cabinets, with external connectors (often providing the necessary flight protection). Besides analogue and digital I/O, the ESPRiT equipment has successfully integrated several higher-level protocols such as SpaceWire, CANbus, RS422 and the MIL-STD-1553B.

For MIL-STD-1553B support, (Airbus DS NL) often relies on the hardware and software developed and manufactured by AIM. This article describes two use cases of the AIM equipment in the ESPRiT product line.

System Architecture and Overview

The Assembly, Integration and Test (AIT) of satellites often rely on Specialized Check-Out Equipment (SCOE) which are able to simulate missing equipment and the dynamics and environment of the S/C. Such Simulator Front-Ends (SIM-FE) provide a remote-control interface to the Central Check-Out System (CCS) and host a Real-Time Simulator (RTS), which propagates the satellite attitude and orbit position, and calculates from the acquired control commands and the measured actuator outputs, the emulation and stimulation data covering all mission phases. The SIM-FE detects the actuator actions, generated by the S/C, and distributes the emulation and stimulation data, generated by the RTS, via the SIM-FE interfaces (I/F) to the spacecraft (S/C) hardware.

As part of the EuroSim consortium, Airbus DS NL has co-developed a COTS RTS simulator kernel (EuroSim). This product provides an extensive set of tools for the complete simulation life cycle. It contains all functionality needed to develop, integrate, execute and post process real-time simulators, with assistance of an elaborate set of graphical user interfaces. Furthermore, EuroSim provides proven hard real-time performance. Jitter and latencies on model execution are in the sub-milliseconds range.

The ESPRiT SIM-FE allows a range of simulator kernels to be integrated in a SCOE. In one configuration, the ESPRiT SIM-FE integrates a EuroSim based RTS, combined with support for a range of configurable analog and digital I/O. As part of its default setup, EuroSim provides MIL1553 support with extensive monitoring, recording and error injection capabilities through AIM APE1553-x PCIe cards. Key in this setup is direct access of EuroSim to the AIM hardware through the Board Software Package (BSP) which is shipped with the APE-1553-x cards. Figure 1 shows the ESPRiT software layers, the EuroSim simulator and the BSP in context.

cmp EuroSIm FE Configuration:

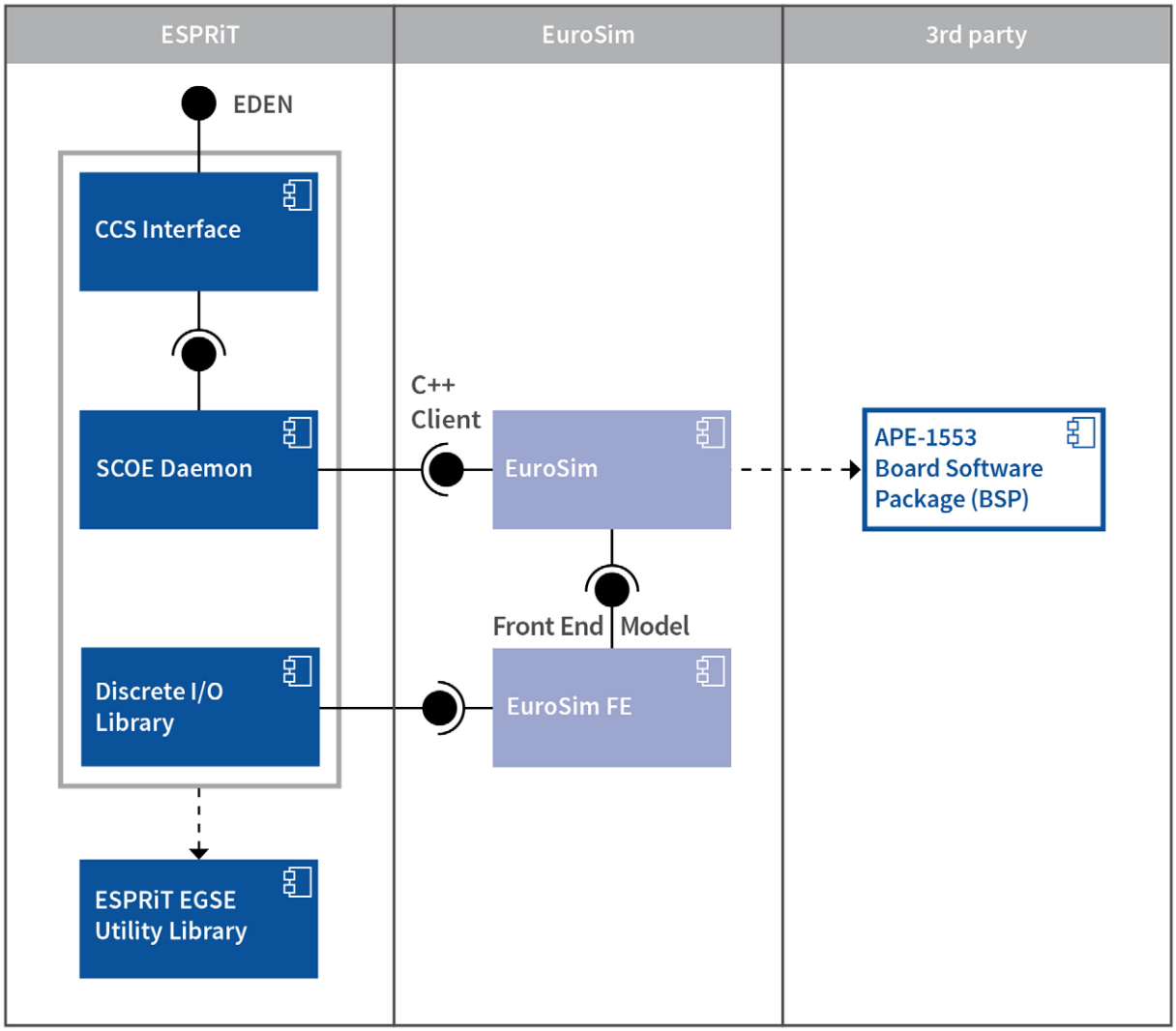

Figure 1: The ESPRiT SIM Front End software layers. EuroSim provides hard real-time simulations with MIL-1553 support through direct access of the BSP. The ESPRiT Daemon exposes this functionality to the CCS through standardized I/F.

The Model Development Environment (MDE) offered in EuroSim contains a Model Reuse Architecture (MRA), which allows a modular approach to modeling the I/O and functionality of equipment. Figure 2 illustrates this architecture.

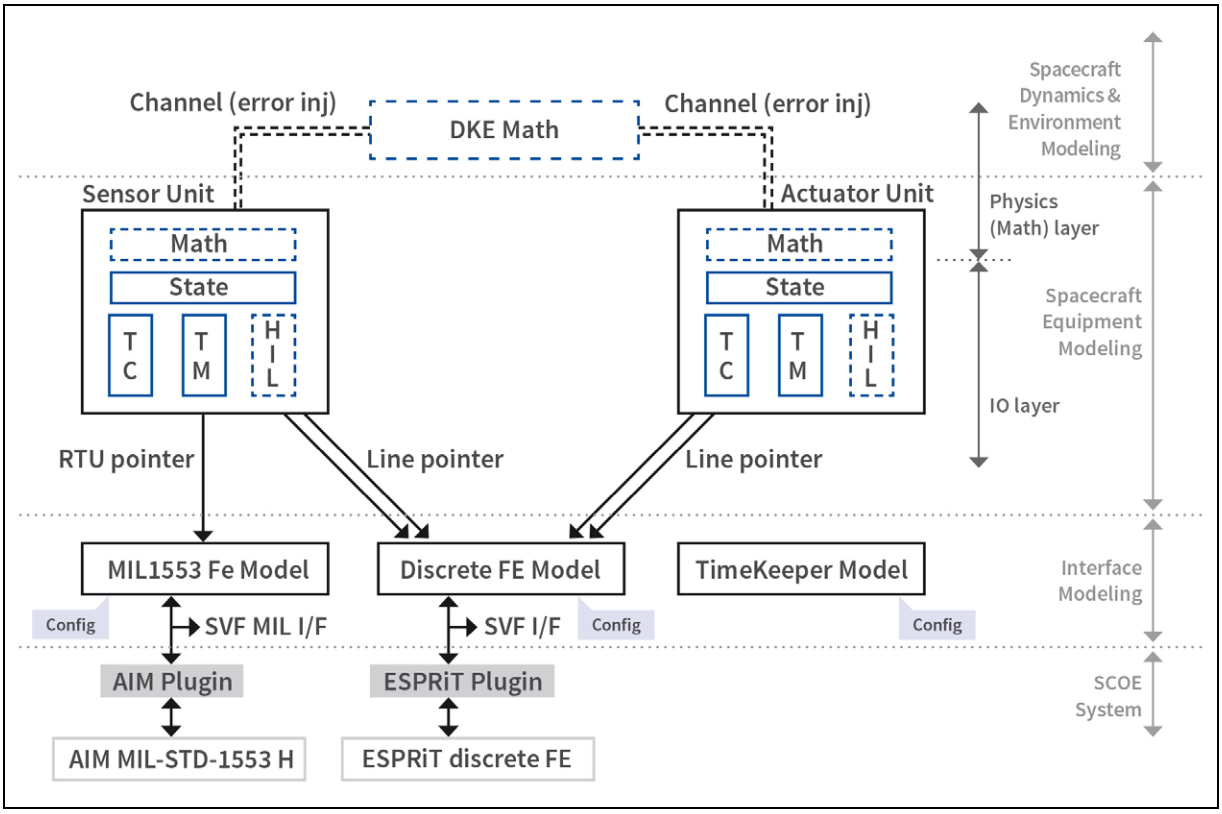

Figure 2: The EuroSim Model Reuse Architecture (MRA).

Equipment such as sensors and actuators are captured by a model with a math layer and I/O layer. The math layer typically obscures the signals through bias, error injections and (nonlinear) transformation. The I/O layer provides access to the actual data protocols, which are highly dependent on the brand and type of the equipment. These I/O layer models are based on ICDs provided by the equipment supplier.

As shown in Figure 2, the I/O equipment models have direct access to the MIL1553 FE model, which in its turns communicates through the AIM BSP to the APE1553-x hardware. This allows the user to implement higher level protocols on top the MIL layer in the real-time models and accurately represent the behavior of the equipment, while maintaining an abstraction layer for reusability.

In the previous scenario, EuroSim provides access to the BSP and the underlying MIL1553 hardware. AIM also supplies COTS software which allows to user to access the BSP functionality. This package, PBA.pro™, is based on a highly configurable User Interface with support for python scripting. In this use case, the focus is not on hard real-time simulation, but on open-loop features such as archiving, filtering, BC scenarios, open loop RT simulation etc. An independent software layer (such as PBA.pro™) with proven performance validating the MIL1553 traffic is often utilized to validate and monitor the MIL traffic on a bus. Airbus DS NL uses the AIM APE-1553-X hardware, the BSP and PBA.pro™ in MIL1553 Front End (MIL-1553-FE) setups.

Connection (TCP/IP)

Figure 3 shows the software layers in context.

cmp MIL-STD-1553-FE (Pba.pro)

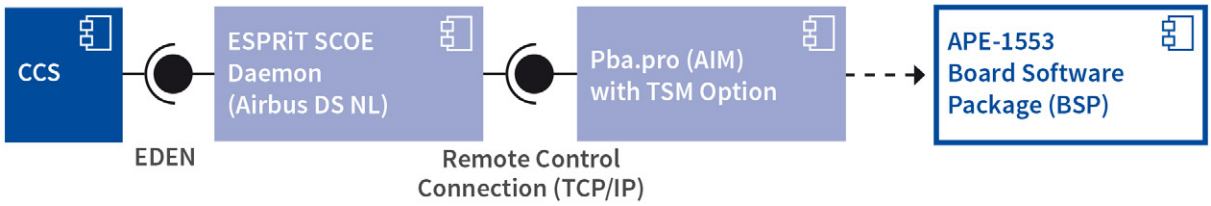

Figure 3: The MIL1553 Front End software layers. All operational functionality provided by PBA.pro™ and the BSP. The ESPRiT Daemon exposes this functionality to the CCS through standardized I/F.

In local mode, the user can directly access and control the MIL traffic from PBA.pro™. In remote mode from the CCS, the user can access similar functionality through a range of open interfaces. In this configuration the user is able to load predefined configurations (created in local mode using PBA.pro™), control the Bus Controller, Remote Terminals and Bus Monitor and stream data towards the CCS. Particularly useful is the access to the run-time variables and modeled parameters in the PBA.pro™ database. This allows the user full control of the created project in PBA.pro™.

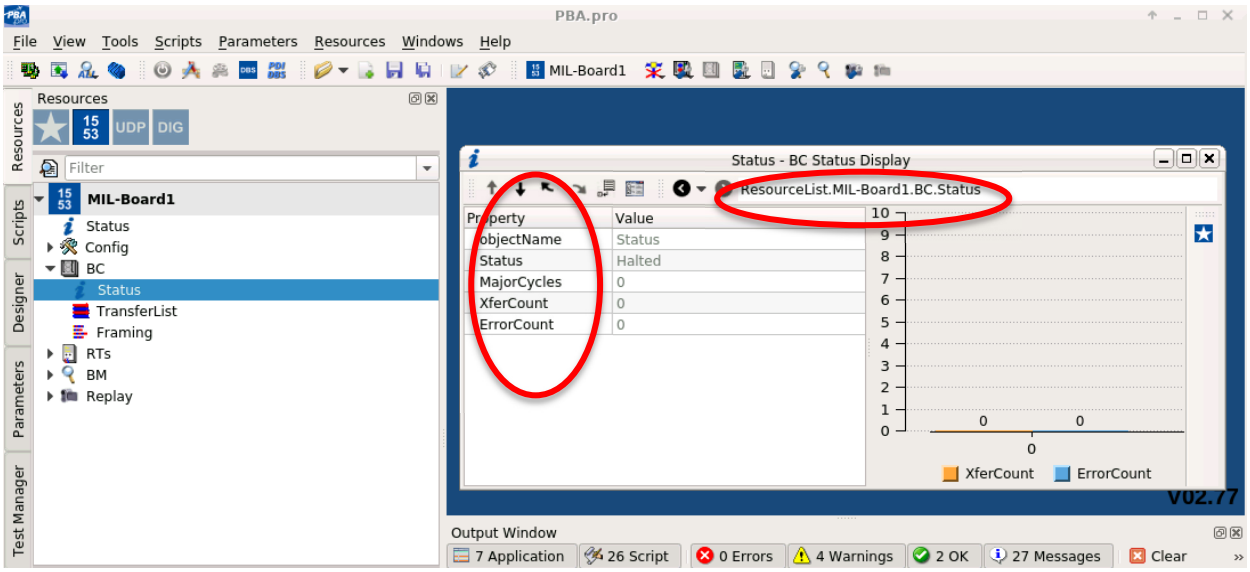

Figure 4: Properties of PBA.pro™ are accessible through the Remote Control connection

PBA.pro Software and MIL-STD-1553 PCIe cards from AIM

PBA.pro is a software platform for Avionics Test and Analysis applications supporting AIM's high performance avionics test and simulation interface modules for MIL-STD-1553B and other databus protocols/networks & 3rd party interfaces.

PBA.pro is modular, scalable and customizable covering a wide range of applications. The PBA.pro software runs on Windows and Linux platforms integrating simulation, monitoring and analysis. It has dedicated GUI support and can be customized via Scripts. PBA.pro for use as a simple Databus Protocol Analyzer up to System Test and Integration tool for handling multiple data buses via single software solution.

The PBA.pro Remote Control Component offers the control of the PBA.pro via a TCP/IP socket connection and an open communication protocol. This can be performed by any TCP/IP capable system, independent from the Controller's operating system. The communication protocol for the PBA.pro Remote Control is derived from the PBA.pro's scripting concept, therefore the Remote Control capability is an integral part of the PBA.pro Test and Script Manager Component which has been integrated in the ADSN MIL1553-FE of Airbus DS NL.

APE1553: PCIe (x1)

Conclusions

The ADSN EGSE product line (ESPRiT) of Airbus DS NL integrates Commercial-of-the-Shelf (COTS) Hardware and Software components for a wide range of SCOEs. The modularity of the design allows tailor made equipment which meets customer specifications. For MIL1553 support in the ESPRiT product line, Airbus DS NL often relies on the hardware and software by AIM. The flexibility of the AIM equipment enables a wide range of application, from simulators to front-ends. The partnership between AIM and Airbus DS NL proved to be a cost effective yet flexible solution, which relies on components with proven performance.

This Technical paper has been a joint venture project and contributions made by Eelco Nederkoorn, Team Leader Engineering at Airbus Defence and Space Netherlands and Douglas Ullah, Sales & Marketing Manager, AIM GmbH, Germany.