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EADS Astrium

SuccessStory

Zeligsoft CE plays strategic role in EADS Astrium's Skynet 5 Paradigm Modem System project

EADS Astrium, a wholly owned subsidiary of EADS, is a global space industry leader, with world-class expertise and extensive prime contractorship experience across all sectors of the space business. EADS Astrium's capabilities include a complete range of launch capabilities, orbital systems and manned space activities, satellite systems, and equipment for a vast range of civil and military applications.

When faced with the challenge of developing a Software Defined Radio (SDR) using the Software Communications Architecture (SCA) component-based framework, EADS Astrium looked to Zeligsoft to equip them with the tools and professional services needed for project success.

EADS Astrium and the SDR/SCA Environment

The US DoD program is pioneering the use of reprogrammable Software Defined Radios (SDRs) through the Joint Tactical Radio System (JTRS) program. This program projects a vision of upgradeable radios that can be quickly reconfigured in many different modes to provide the flexible communication needs required for "net-centric warfare".

Central in this program is the JTRS Software Communications Architecture (SCA), the framework standard that both the reprogrammable radio environment and the radio applications (downloadable entities) have to adhere to. The most prominent programs in this area are the Ground Mobile Radio and the Handheld, Mobile and Small form factor projects ongoing in the US right now.

Projects in Europe are also underway in an effort to gain experience with this new technology for the benefit of European countries. WINTSEC and ESSOR are two of the European projects ongoing right now. Beyond these, many of the member states have been working on demonstrator projects.

Largely behind closed doors, EADS Astrium has been actively working with the JTRS SCA since 2001 through two demonstrator programs and now in a large scale production program. The Skynet 5 Paradigm Modem System (PMS), developed by EADS Astrium in Portsmouth UK, will carry protected and un-protected MILSATCOM traffic for UK armed forces. It has already completed a successful sea trial and will enter service later in 2007.

The PMS has been built from the ground up using the SCA's open elements. In common with other large aerospace companies on the leading edge of this technology, EADS Astrium has developed its own SCA Core Framework (CF), which is now in line with version 2.2.2 of the SCA standard.

Over the last 3 years, EADS Astrium has been an active user of Zeligsoft CE and its tool chain comprising other best-in-class tools. Zeligsoft has provided tooling, training and mentoring to EADS Astrium during the course of the project.

"With their deep expertise in software engineering, model driven development and the Software Communications Architecture, Zeligsoft's professional services team provided high quality training and mentoring to our group, leaving us better equipped to carry out a successful project."

— Mark Bowyer, Consultant Engineer, EADS Astrium

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The Skynet 5 Paradigm Modem System

The Skynet 5 Paradigm Modem System is designed to carry protected and un-protected MILSATCOM traffic for the three branches of the British Armed Forces. Over-capacity on the satellites can be shared with other countries in NATO.

The physical Paradigm Modem platform is built from a large number of General Purpose Processors (GPPs) (all of which are 1GHz Pentium M) and Xilinx Virtex II Field Programmable Gate Arrays (FPGAs) partitioned across many modules and performing various control, security, traffic and waveform functions:

- Restricted Control Processor (RCP)
- COMSEC TRANSEC Module (CTM)
- Guard TRANSEC Post Processor (gTPP)
- Traffic Interfaces (x 2) (TIF)
- Burst Mode Processors (x 4) (BMP)

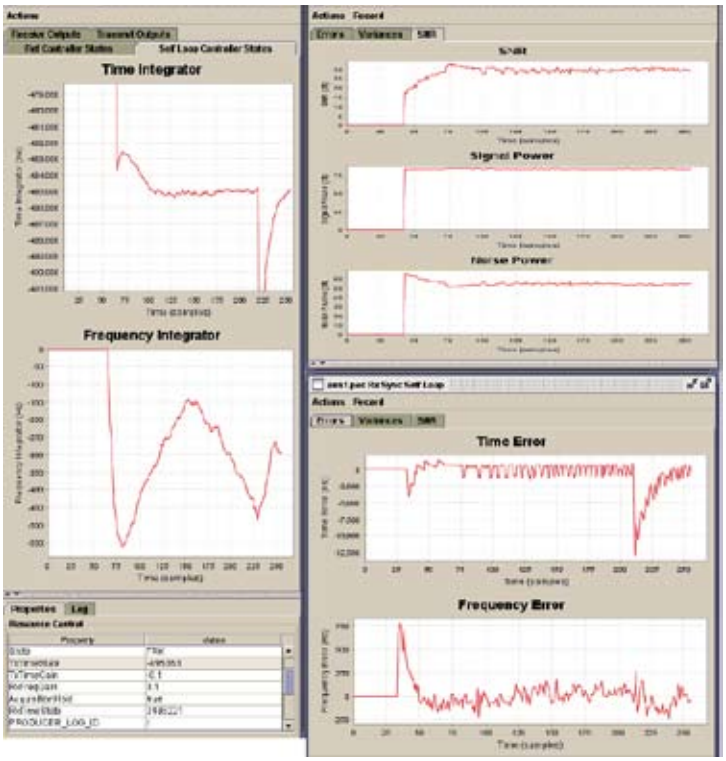
Skynet 5 Paradigm Modem System

A flexible core executable (CoreDevice) device has been developed that can run C/C++ processes directly on the host operating system or many JAVA processes efficiently inside a single JAVA virtual machine — the Multi-Virtual Machine (MVM). Thus the system can support an efficient mix of Java and C++ components inside SCA applications.

The Paradigm Modem functionality is built up of many smaller SCA applications. For example, the Tx and Rx sides of a particular waveform are considered as separate applications.

At present the modem supports two major waveforms: FDMA and PMPW. The FDMA waveform is un-protected conforming to MIL-STD-188-165 and provides data rates to 8Mbps. The Paradigm Modem Protected Waveform (PMPW) is an Orthogonal Frequency Hopped Multi-Frequency TDMA waveform with 3 mutually orthogonal classes spanning a range of data rates (75bps – 64kbps – 2560kbps) and robustness levels (higher – medium – lower).

The PM waveforms make extensive use of the SCA Event Service that provides loosely coupled publish-subscribe connectivity between various management and waveform components. A diagnostic GUI can log and plot activity on the event channels in a non-invasive manner. A screen capture example from the diagnostic GUI is shown below.



Diagnostic GUI

The JTRS SCA provides consistent mechanisms to break down modem functionality into coarse grained components and provides standardized mechanisms for many design patterns that programmers would otherwise invent for themselves.

Much of the real time waveform functionality is partitioned between firmware in FPGAs and soft, real-time processes running on GPPs, but outside the SCA and controlled by SCA adapters (management resources). More recent developments in the SCA, like CP289, with corresponding features in Zeligsoft CE, will allow the SCA modeling description of future waveforms to be finer grained and extend down to "hard real time" functionality inside FPGA's and "soft real time" functionality compartmentalised in high priority GPP processes.

EADS Astrium is developing a single channel, low cost variant of the Paradigm Modem called the LC1000. FDMA components developed for the PMS are used with little modification on the LC1000, which integrates functions of the RCP and BMP modules onto a single processor.

Developing the PMS with Zeligsoft CE

Zeligsoft was involved early in the development of the PMS and provided SCA training to the EADS Astrium engineers. These engineers already possessed expertise in embedded systems and development of software defined radio functionality.

EADS Astrium engineers worked with the support of Zeligsoft's professional services team to develop the SCA architecture for the EADS Astrium SDR platforms and applications. Zeligsoft's wider knowledge of SCA best practices has enabled EADS Astrium to optimise its development process in addition to making full use of the Zeligsoft SDR/SCA development environment.

During the project Zeligsoft CE was used to visually represent all the artifacts and to model how the application would fit with the platform. Zeligsoft CE provided SCA guidance through its user-friendly GUI as well as through its comprehensive validation capability. CE was used throughout the project to ensure that the radio complied with the SCA specification. EADS Astrium's model was used to generate SCA artifacts, specifically, correct-by-construction XML descriptor files for the SCA applications as well as for the devices and nodes making up the SCA platform. This function saved developers from having to author the files manually — a tedious, time consuming and error-prone task. By allowing Zeligsoft to look after the SCA aspects of the radio, EADS Astrium was free to focus on what they do best: radio development.

> "EADS Astrium is applying the open elements of the JTRS SCA in its current SATCOM modem products. The visual modelling and automated generation of XML to describe hardware platform and software/waveform applications is greatly simplified by the use of the Zeligsoft CE tool chain."
>
> — *Taj Sturman, Communication Systems Engineer, EADS Astrium*

The diagrams below provide insight into the SCA representation of the PMS platform and one of the waveforms it runs.

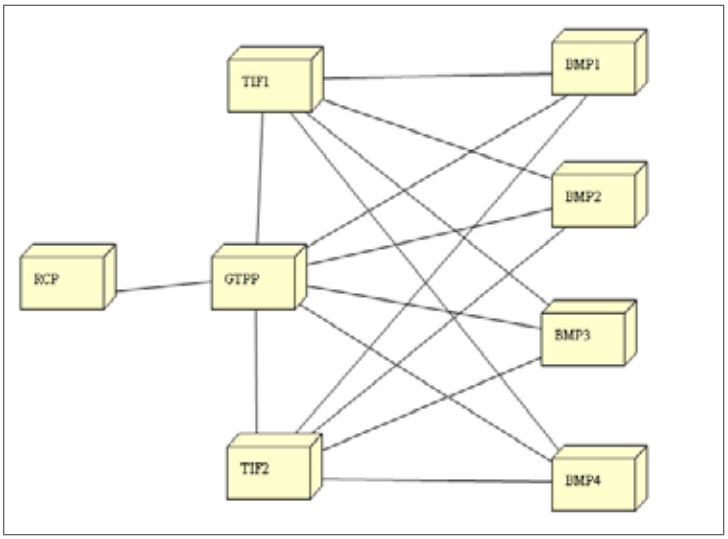


Figure 1: PMS Platform

The platform model in CE provides an overview of all the SCA nodes that are available to execute components. Figure 1 shows the Restricted Control Processor (RCP), the Guard, TIFs and BMPs.

Each of the nodes in Figure 1 contains a number of processors. Figure 2 shows the internal make-up of the RCP node referenced in Figure 1.

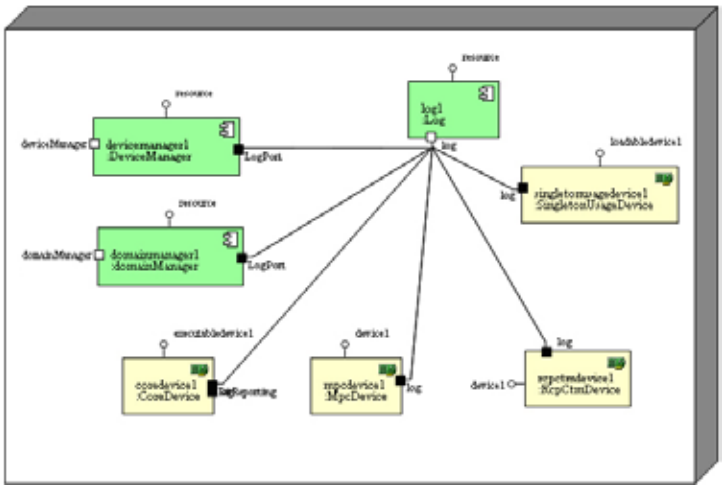


Figure 2: RCP Node

> "EADS Astrium's Paradigm Modem System project is an example of how, with attention to planning, training and tooling at the fore-front of the project, the SCA can be used to promote portability, reduce risk and provide flexible radios in a successful fashion."
>
> — *Mark Hermeling, Director of Applications Engineering, Zeligsoft*

The nodes are used by the SCA DomainManager to execute waveform applications. Figure 3 represents the PMPW management and I/O interfaces. The diagram shows the major components of the waveform as well as external ports, connections to devices, non-SCA FPGA images and adapters for those images.

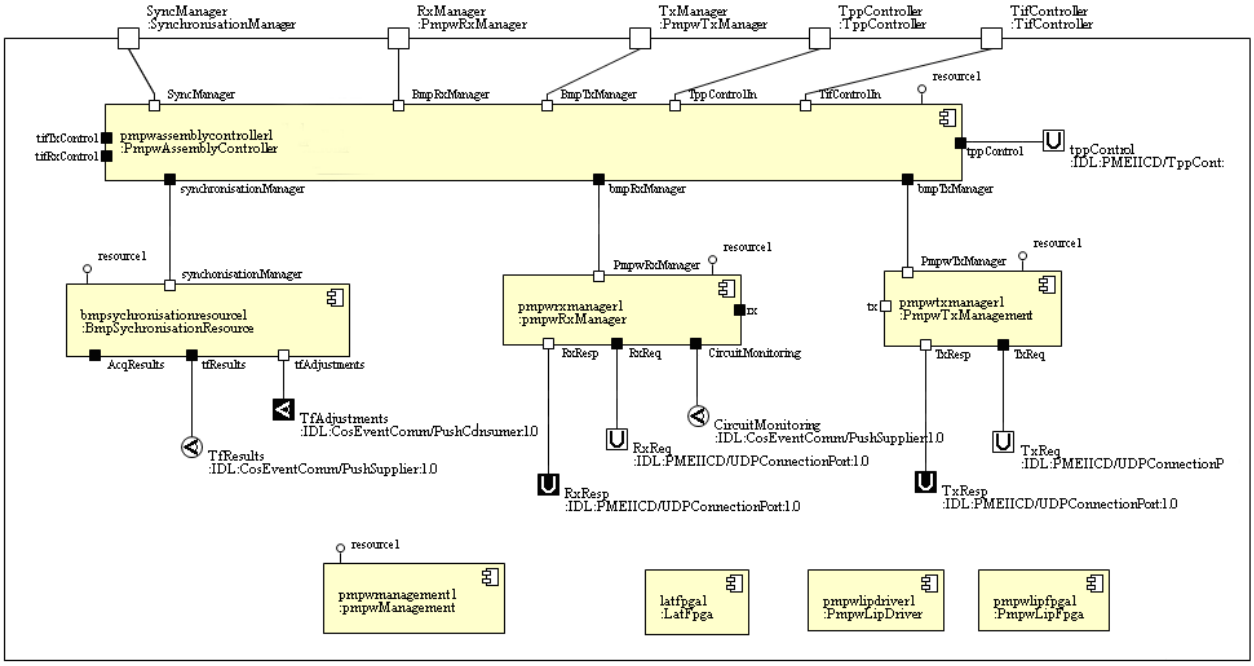


Figure 3: PMPW Management and I/O interfaces

The future of the PMS

EADS Astrium is working on SDR certification with the European Defence Agency (EDA) and is participating in some SDR aspects of the European Union's FP7 program. Having used Zeligsoft CE to support the development of the PMS as an open-standard, flexible, and adaptable radio, EADS Astrium is in a position to strengthen its SDR technology base and to market both platforms and waveforms in European and North American organisations alike.

Mark Bowyer (EADS Astrium) / Mark Hermeling (Zeligsoft).

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