

FROM NAPKIN SKETCHES TO PRODUCTION SOFTWARE

[Space Storms Hunter]
Software Made
With the Papyrus
Open Source Tool
to be Launched
Aboard a French
CNES Satellite

The Business

Spacebel is a software engineering company that has grown in the space market to become a trusted developer of advanced IT solutions and a provider of related IT services.

The Challenge

In the context of the development of the French satellite TARANIS (CNES), Spacebel selected open source solutions for the modelling and development of on-board software of the main spacecraft payload.

The Solution

Eclipse Papyrus was selected as the modelling tool because of its powerful customization capabilities and its compliance with the UML standard.

The Benefits

The open source environment enabled Spacebel to cover the complete development chain, from modelling to code generation.



The Business & The Challenge

«Switching to open source solutions»

[Taranis satellite Illustration - Blue Jet TARANIS (Tool for the Analysis of RAdiations from lightNIngs and Sprites) is a microsatellite project from the Myriad CNES program dedicated to the study of transfers of energy impulses between the Earth's atmosphere and the space environment, which occur above stormy regions]
© CNES/ill./SATTler Oliver, 2012

The Business

Spacebel serves space agencies, government departments, major aerospace companies, European institutions, as well as the commercial market. Spacebel delivers on-board control and data handling software, simulation infrastructure and models, satellites and mission control centers, as well as Earth observation services provisioning infrastructures. Spacebel designs, develops, and implements custom software systems for the space industry. The company can assume major responsibilities in the development of software systems, starting from the initial specification phases and extending through to commissioning and final acceptance.

The Challenge

Developers and architects at Spacebel typically use modelling methods and technologies to architect and develop complex systems. These methods were exclusively based on the UML industry standard and commercial toolsets. Recent R&D efforts around Eclipse technologies have encouraged Spacebel to switch to open source solutions. The company selected the Eclipse Papyrus tool to model complex critical system software. Specifically, the challenge was to develop the on-board software for the main payload of the French satellite TARANIS (CNES). Development and design of this software served as a pilot project at Spacebel for deploying open source solutions based on the Eclipse tool chain.

The software of the TARANIS payload was written in the C language and compiled with a custom cross-compiler for the IP-Core 8051 (the main processor of the payload). Due to its unique instruction set and memory

mapping, the C source code could not fully conform to the ANSI standard. Many of the requisite target-specific language constructs were not supported by commercial tools.

In addition to the source code and the software, documentation is an important requirement in the aerospace industry. Numerous documents must be produced for the project reviews and the final acceptance of the software for flight. For instance, the detailed documentation of the code, the detailed design, and the system specifications must be provided. The diagrams and the descriptions of the architecture are thus key to pass quality and other critical design reviews. Consequently, both the model and the generated documentation are essential for the success of a project. In the context of mandatory software standards for space systems, the quality of the source code and the definition of the various models are primary concerns.

The Solution

« High potential
for customization »

Spacebel selected Eclipse Papyrus as its modelling tool because of its customization capabilities and strong compliance to the UML standard. In addition, for the specific needs of the project, several UML profiles were defined using Papyrus. This allowed specialization of the general-purpose UML language to suit the needs of the target-specific processor.

Thanks to this combination of the UML standard, UML profiles, and Papyrus, Spacebel's architects were able to

[" The development of the TARANIS on-board software and the project itself clearly demonstrated the benefits of using Eclipse Papyrus as modelling tool. "]

JOHAN HARDY (SOFTWARE ENGINEER) - SPACEBEL

adjust UML to the specific semantics of the project. In addition, by exploiting the infrastructure of Papyrus and its extensibility features, the profiles were packaged as modular Eclipse plugins that were fully integrated into the development environment: the views, the menus, the diagrams and the

overall user interface were customised for these specific profiles, thereby greatly simplifying the modeling task. Since Papyrus is based on Eclipse technologies, Spacebel used the model-to-text (M2T) transformations available in Eclipse to automatically generate the code and the documentation.

[Spacebel's developer using Papyrus open source tool.]
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The Benefits

«The Papyrus tool has proven its flexibility»

[Integration activity around payload and platform from satellite Taranis, in Pronaos' CST clean room.]
© CNES/GRIMAULT Emmanuel, 2014.



[" Given the success of this pilot project, the Eclipse and Papyrus based toolchain is now being deployed on most embedded-C projects at Spacebel. "]

ARNAUD BOURDOUX (PROJECT MANAGER) - SPACEBEL

The combined Papyrus and Eclipse toolchain enabled very fast turnaround in terms of toolchain maintenance and adaptations. Since the target processor was non-standard, it was anticipated that many target-specific language constructs would not be supported by the commercial tools that were used in past projects. Thanks to a highly customizable open source environment, it was possible to create extensions that directly capture these technology-specific aspects and translate them automatically into code that executes correctly on the target platform.

CNES, who subcontracted this development work, is now considering transferring responsibility for the maintenance phase to Spacebel. This requires that the software development environment itself be a deliverable in addition to the software. In this approach, the open source environment has the dual advantage of not requiring the purchase of potentially expensive licences, and of having available an active community which can contribute with improvements and error fixing.

Given that this was the first project to use this approach, there were multiple

situations where the environment had to be adapted to the specific needs of the application.

In most of the cases, only a few hours passed between the reporting of a problem to the time when a fix was made available. This is something that would be practically infeasible with a commercial tool. And, although the need for such adjustments is usually less likely with a mature commercial tool, knowing that progress-blocking issues related to the development environment can be resolved within days, is one less risk factor for a project.

The Bottom Line

The completed flight software version has been delivered to CNES and is currently undergoing testing (the launch is scheduled at Kourou in 2018). The quality of the code and the documentation produced by this process was at least as good as that produced in the past using commercial tools and their associated processes.

Moreover, Spacebel was able to improve maintenance response times while simultaneously reducing cost.

PAPYRUS CASE STUDY SERIES



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About List (www-list.cea.fr) : One of three institutes which comprise CEA Tech (CEA Technological Research Division), the List institute is committed to technological innovation in digital systems. Its R&D activities - driven by major economic, societal and industrial challenges - encompass four main themes : advanced manufacturing ; embedded systems ; ambient intelligence ; and healthcare, including radiotherapy and imaging technologies.

About Papyrus (www.eclipse.org/papyrus) : Papyrus is an Eclipse project led by List (contact : Sébastien Gérard at sebastien.gerard@cea.fr). Papyrus is also labelled as a solution of the Eclipse industrial working group Polarsys (<https://www.polarsys.org/solutions/papyrus>). Papyrus supports model-driven approaches by providing a standards-based modeling tool that supports, out of the box, both the UML and the SysML international industry standards from the OMG. In addition, Papyrus provides very advanced support for custom UML profiles that specialize UML, which enables users to define and implement their own domain- and project-specific modeling tools and languages (DSMLs). The user interface of Papyrus is highly configurable to support a broad spectrum of user-specific domains and concerns.