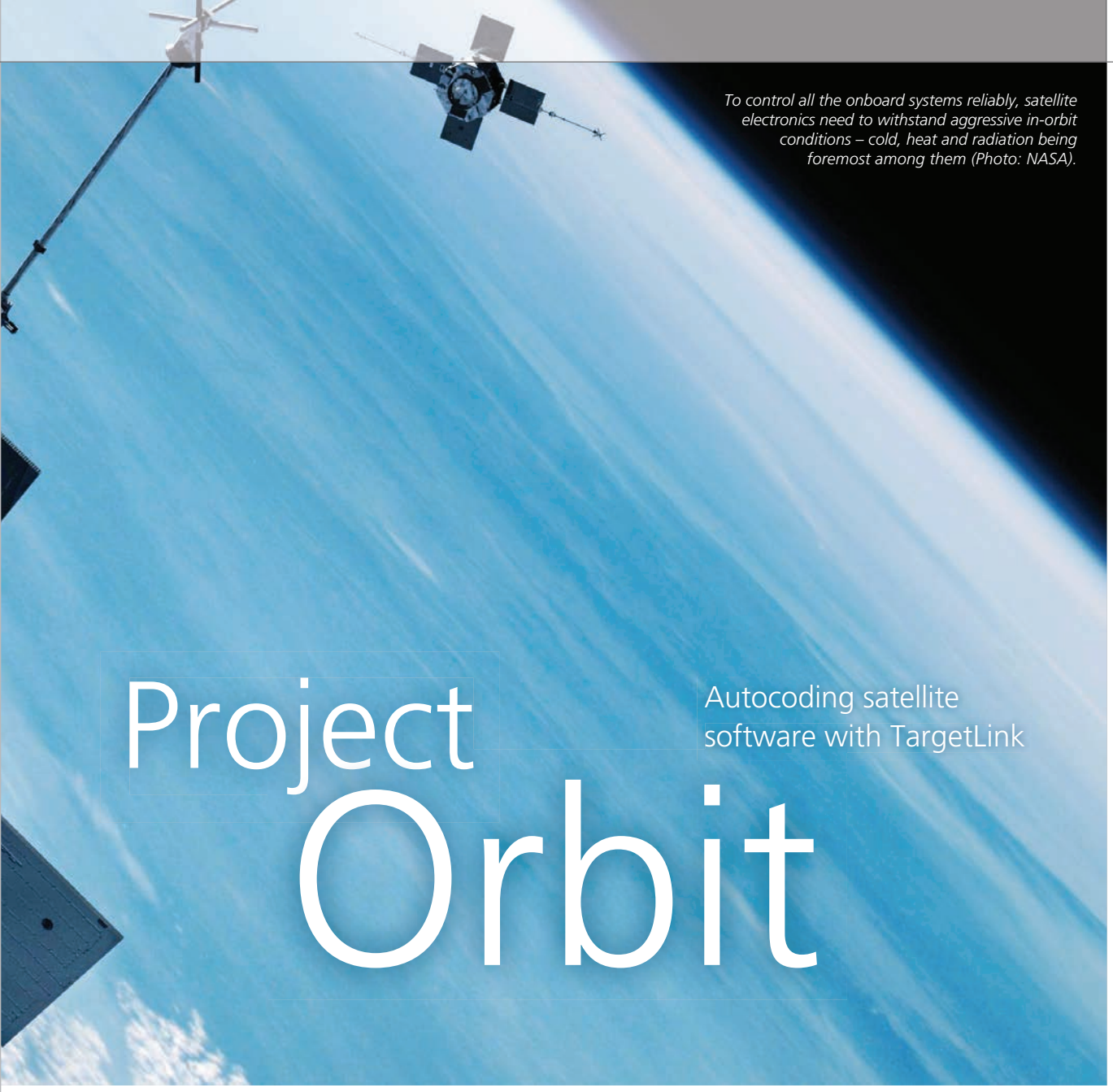
Satellite computers have to handle a whole range of monitoring and control tasks. Thales Alenia Space have integrated dSPACE's production code generator TargetLink into the development process for their complex onboard computer software. The approach has already proved beneficial in two projects.

### Earth Orbit: A Harsh Environment

Despite its emptiness, space is an extremely hostile environment for electronic components. Satellite electronics must not only endure extreme temperature differences of approx. 300 °C between the sun and the shade, but also face constant bombardment by charged solar wind particles and other cosmic radiation. Being hit by pieces of space junk is yet another danger that has been growing over the years. Satellites in low earth orbit additionally suffer friction from atmospheric particles, even at an altitude of 200 km, and this slows them down. All these influences demand the meticulous monitoring and



*To control all the onboard systems reliably, satellite electronics need to withstand aggressive in-orbit conditions – cold, heat and radiation being foremost among them (Photo: NASA).*

# Project Orbit

## Autocoding satellite software with TargetLink

control of all onboard systems. The attitude orbit control system (AOCS) plays a central role, ensuring that the satellite stays on orbit and pointing it in the right direction.

### Tough Conditions for Satellite Software

The aggressive outer space environment is a tough challenge to the reliability of satellite software, and developing and maintaining it are hard tasks.

- Onboard computers have low performance compared with other modern computers. This is because the hardware has to be 'radiation-hard', a property found only in less densely packed microchips, whose performance is correspondingly weak. CPUs with a low clock rate (20 MHz) and only little memory (4 MB RAM) are typical.
- Because the satellite is not physically accessible in space, it has to be remote-maintained (patches are transmitted by radio).
- The software has to manage numerous different onboard interfaces, and also maintain the link to the ground station. This complex data flow necessitates a finely coordinated architecture.

### Good Reasons for Autocoding

At the start of the millennium, the drawbacks of the traditional hand-

> "The evaluation of several code generators showed that TargetLink from dSPACE is the best match for our requirements."
>
> *Arnaud Dupuy, Thales Alenia Space*

## About Thales Alenia Space

Thales Alenia Space is a joint venture between Thales and Finmeccanica that in its current form was created in 2007. The company specializes in developing satellites for telecommunications, navigation and observation. A total of 7,500 employees work for Thales Alenia Space in France, Italy, Spain, Belgium and Germany. The company headquarters are in Cannes, France.

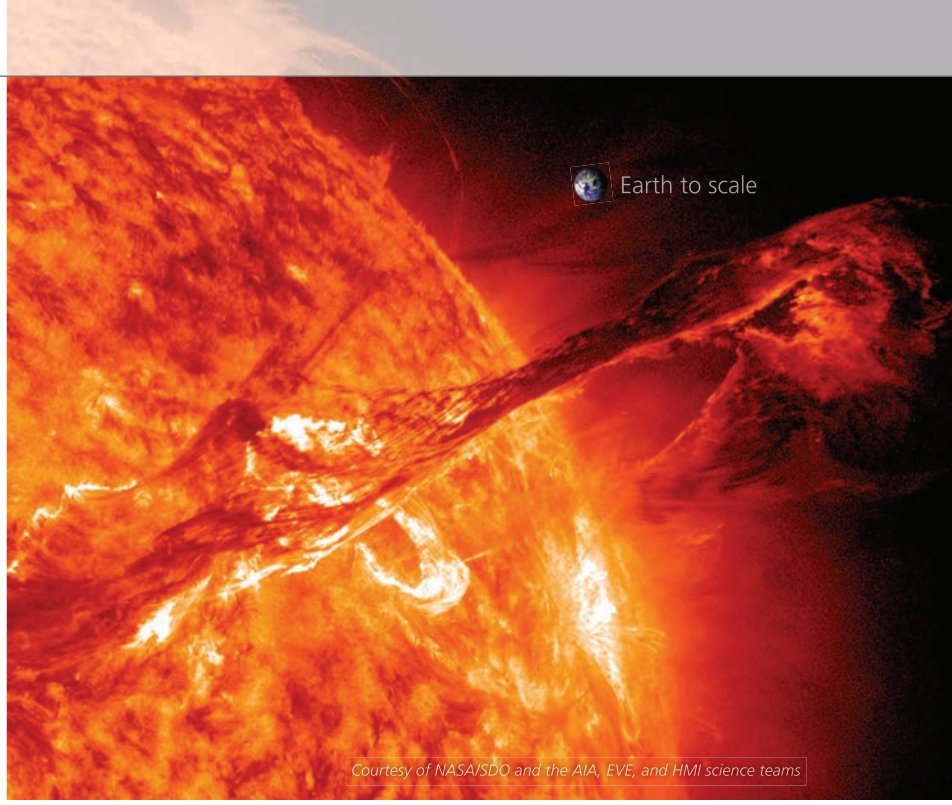



*Figure 1: One cause of disruption in satellite electronics is solar flares that hurl charged particles as far as the Earth (the photo shows a large flare that occurred on August 31, 2012).*

coding of satellite software were becoming obvious (it was difficult to retrieve information from earlier projects, to perform software maintenance, and so on). Thales Alenia Space therefore started evaluating software tools for automatic code generation in 2004. The goal was a process where different development teams could exchange information in a defined, unambiguous format. At the same time, responsibilities for function development and software development had to be clearly separated. This led to the decision to use model-based development with Simulink® in conjunction with an automatic code generator.

### TargetLink Best in Test

Thales Alenia Space investigated the suitability of several code generators. These had to fulfill several criteria: As well as supporting the workflow, the code generator had to be flexible with regard to naming rules, code structure and function interfaces so that it could be integrated into the existing coding scenario. Other criteria were the readability and reliability of the generated code. The evaluation of several code generators revealed that TargetLink was the best match for Thales Alenia Space's evaluation criteria. TargetLink's rich graphical user interfaces provide intuitive and powerful options, including support for structures, pointers and access functions. Moreover, the separation

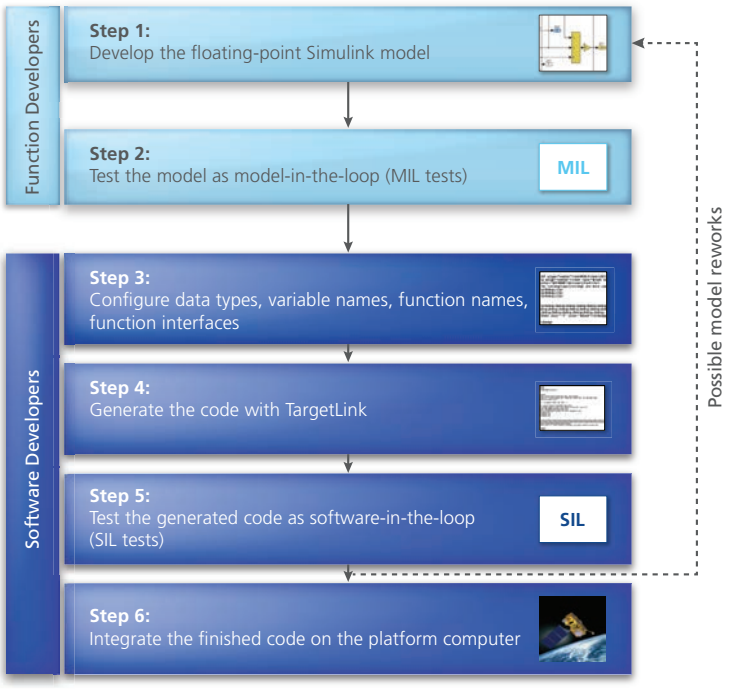



*Figure 2: The clearly structured development process ensures clean separation of responsibilities, an unambiguous flow of information and the complete traceability of all the work steps.*

between Simulink data types for simulation and TargetLink data types for code generation allows round trips between different development teams, such as function developers on one side and software developers on the other, in which both teams can work on the same model.

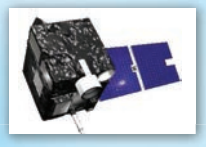
## Streamlined Development Process

The process begins with the function developers developing a floating-point Simulink model, which they test with model-in-the-loop (MIL) tests in the second step (figure 2). Then they pass the model to the software developers, who carry out the third step – configuring the data types, variable names, function names and function interfaces. The fourth step is automatic code generation with TargetLink, followed by software-in-the-loop (SIL) testing in the fifth step. If the result of the SIL test indicates that the model needs reworking, the software developers pass it back to the function developers again. This is where the new process reveals its great strength, because although the model has to go "back to the drawing board", the work already done by the software developers is not lost – thanks to the cleanly defined exchange formats and work steps.
As soon as all the model modifications are completed and the SIL tests have run successfully, the sixth and final step is to integrate the finished code on the platform computer.

## Real-World Success

The first project with TargetLink was the development of software for two infrared Earth observation satellites ("SPIRALE"), which were launched into orbit in 2009 by an Ariane 5. That same year, Thales Alenia Space also decided to use TargetLink for a new project called "Sentinel 3". Sentinel 3 is part of Global Monitoring for Environment and Security (GMES), a mission of the European Space Agency (ESA). Thales Alenia Space has already generated 12,000 lines of code for this. Sentinel 3 will be launched later this year.

### Thales Alenia Space Projects with TargetLink



**Project SPIRALE (two identical twin satellites)**
- Purpose: Observing the Earth in the infrared range
- 5,000 lines of code generated by TargetLink
- Satellites already launched (2009)

**Project SENTINEL 3**
- Purpose: Measuring the temperature of ocean and land surfaces, etc., and the topology of ocean and ice surfaces
- 12,000 lines of code generated by TargetLink
- Launch planned for 2013

*Figure 3: The code generator TargetLink has convincingly demonstrated its advantages in two projects.*

## TargetLink Firmly Established

Model-based design and automatic code generation have since become the established practice at Thales Alenia Space. Using models that can be shared by different teams makes work very efficient. And with TargetLink, the code structure and naming rules can be configured flexibly. Thales Alenia Space was therefore able to integrate the code into their existing framework without having to modify it. The new process has already considerably boosted productivity, and is expected to produce further major benefits when earlier models are reused in future projects. ■

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