

First Multicore Implementation for Spacecraft On-Board Image Compression

Enea Global Services designs, deploys, and validates an optimized multicore implementation for on-board image compression for the European Space Agency (ESA).



Enea Software Expertise for the Space Industry

Our team of experts excels at understanding the challenges and needs of our customers.

We help them accelerate their R&D cycles and bring innovative products to the market.

- ▶ RTOS Development & Porting
- ▶ Embedded Debug & Dev Tools
- ▶ Multi-Processor Support

- ▶ Device Driver Development
- ▶ Electronics Design & Prototyping
- ▶ Firmware Development

- ▶ DO-297 | DO-254 | DO-178 B
- ▶ ECSS-E-ST-40C
- ▶ ECSS-Q-T-80C

The Customer

The European Space Agency (ESA) is Europe's gateway to space. Its mission is to shape the development of Europe's space capability and ensure that investment in space continues to deliver benefits to the citizens of Europe and the world.

ESA's programs are designed to find out more about Earth, its immediate space environment, our Solar System and the Universe, as well as to develop satellite-based technologies and services, and to promote European industries.

The Challenge

Multicore hardware platforms are being increasingly used for spacecraft on-board software for faster and more efficient processing of data. In order to take full advantage of the high capabilities and performances offered by multicore architectures and underlying lower level software platforms such as RTOS (Real Time Operating Systems), existing space software implementations need to be optimized.

Space missions are using more and more multispectral and hyperspectral imaging instruments, which significantly increase the volume of raw data collected and transmitted to the ground. The requirement for this ESA project was to design an optimized multicore implementation of the compression algorithm for multispectral and hyperspectral images, and develop a benchmark to measure and compare the performances of the validated implementation.

17 Groups of Satellite Images used in the Project

- | | |
|-------------|---------------|
| ▪ AIRS | ▪ MODIS-250m |
| ▪ AVIRIS | ▪ MODIS-500m |
| ▪ CASI | ▪ MODIS-DAY |
| ▪ CRISM-FRT | ▪ MODIS-NIGHT |
| ▪ CRISM-HRL | ▪ PLEADES |
| ▪ CRISM-MSP | ▪ SFI |
| ▪ HYPERION | ▪ SPOT5 |
| ▪ LANDSAT | ▪ VEGETATION |
| ▪ M3 | |

The Solution

The objective was to design, port and validate the first space-ready multicore hardware and software platform optimized for on-board image compression.

As the prime contractor of this project implemented in an ESA program, Enea designed a fully optimized multicore implementation and a complete benchmark of the validated implementation.

The implementation process followed these steps:

- **Detailed analysis of existing multicore hardware and software platforms** available to define the best configuration solution.
- **Optimized multicore design and implementation** of the lossless compression algorithm for multispectral and hyperspectral images (according to ESA Draft Recommended Standard CCSDS 123.0-R-1).
- **Porting and validation** of the optimized implementation on several multicore hardware platforms:
 - A standard **x86 64-bit PC** architecture for reference
 - **LEON4** and **Freescale P4080**, using 2 space-proven operating systems, **PikeOS** and **RTEMS**
- **Design of a test framework** to validate the 3 setups and benchmark their hardware and software performances.

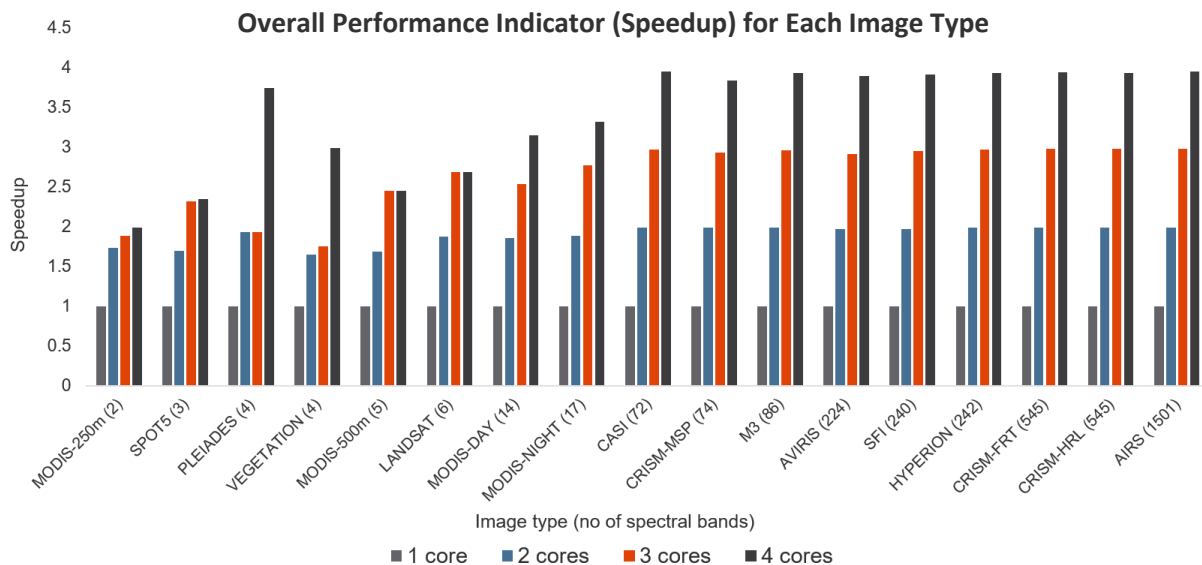
The Benefits

Throughout the project, ESA benefited from Enea's extensive expertise and strong reputation in embedded software, real-time operating systems, multicore support and implementation.

Enea created an optimum design that targeted proven, space-ready operating systems (PikeOS and RTEMS) and multicore hardware platforms (Freescale P4080 and LEON4), and that integrated with existing spacecraft on-board software framework. The benchmark of the validated implementation showed very good results, confirming the high value of using multicore technologies for on-board space software.

This project provides the European Space Agency with a pragmatic demonstration and a comparative analysis on the benefits of porting and optimizing strategic space implementations on various multicore platforms.

It also allows ESA to better understand and ascertain the behavior and performances of porting other spacecraft on-board software onto multicore architectures for future space missions and paves the way towards a promising future of multicore in space technologies.



Enea Global Services

Enea's professional service offering is based on flexible engagement and delivery models for all phases of a software life cycle, from feasibility and specification, to development, testing, integration, deployment, maintenance, support and training. Services range from on-site experts, to complete outsourcing of R&D activities.

Disclaimer: The view expressed herein can in no way be taken to reflect the official opinion of the European Space Agency.

Find out more on the Enea website!



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