EO-ALERT: A Novel Flight Segment Architecture for EO Satellites Providing Very Low Latency Data Products

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EO-ALERT is an EC H2020 project that proposes the definition and development of the next-generation EO data processing chain, based on a novel flight segment architecture that moves optimised key EO data processing elements from the ground segment to on-board the satellite, with the aim of delivering the EO product to the End User with very low latency (quasi-real-time).

EO-ALERT aims to provide the technological building blocks for this next-generation EO data processing chain, with a view to future autonomous EO satellites. The EO-ALERT satellite concept is based on the establishment of an on-board data handling and processing capability, that enables the generation of EO products on-board the satellite and their direct transfer to the End User. This overcomes the typical bottleneck problem with the raw data transfer to ground in the classical EO data chain, avoids the transfer of EO data that is not of value, and allows for the provision of EO data with very low latency; EO-ALERT targets the provision of EO products from observations, made globally, to the ground and End User, within 5 minutes.

In this manner, the EO-ALERT concept proposes a new breakdown of functions between the flight and ground segments, where the ground segment is apportioned the task of managing the mission and its objectives, while data processing is moved partially or totally onboard the satellite, with the processed data and EO products transferred to ground, directly to the End User.

The EO-ALERT satellite concept particularly supports those EO scenarios and mission concepts that are enabled or enhanced by the provision of EO products with very low latency. While such mission concepts are becoming ever more common in order to meet more demanding End User needs, in the EO-ALERT project, two such scenarios are considered in detail, being maritime surveillance and extreme weather monitoring.

The EO-ALERT project considers the challenge of providing very low latency EO products considering operational scenarios and requirements, through the incorporation of End Users in the scenarios definition and the system requirements. While the technological building blocks of EO-ALERT are generic, the EO-ALERT developments are made for two VHR missions, in the DEIMOS-2 VHR optical satellite and the TerraSAR-X VHR SAR satellite. These two satellite missions are used in the project for verification of the technologies and the overall data chain using real VHR satellite data. The two satellites are also used as experimental validation cases, to demonstrate the effectiveness of the EO-ALERT concept in real EO scenarios.

This paper provides an overview of the results achieved by the EO-ALERT project (http://eo-alert-h2020.eu/). The paper presents the proposed architecture, its performance, the hardware employed and the technologies developed, for both the two different user scenarios; ship detection (maritime surveillance) and extreme weather observation/nowcasting.

The proposed EO-ALERT satellite data handling architecture is shown to solve the very low latency EO data challenge through a combination of innovations in the on-board elements of the data chain and the communications. Namely, the architecture introduces innovative technological solutions, including on-board reconfigurable data handling, on-board image generation and processing for the generation of EO products and alerts, on-board data compression and encryption, high-speed on-board avionics, and reconfigurable high data rate communication links to ground, including a separate chain for raw data and for products and alerts, to allow the transfer of the latter with minimum latency and global coverage.

The EO-ALERT project is currently in its second year of execution, moving towards the verification of the individual technological building blocks in a real-time environment. The results to date show that, when implemented using COTS components and available and upcoming communication links, the proposed architecture can deliver EO products and alerts to ground with latencies lower than five minutes, for both SAR and Optical missions, demonstrating the viability of the EO-ALERT concept.

The EO-ALERT project pursues the development of the very low latency capability of the EO data chain at a system level, in order to achieve a medium-high TRL level (TRL 5/6) of the concept, supporting the uptake of the concept and its technologies in upcoming EO missions. While the employment of AI-based technologies is not a basic aim of the EO-ALERT project, the project does showcase some areas where AI-based technologies have been employed and provide benefits, and some of the challenges associated with their employment. As such, AI technology employment is not required in EO-ALERT. Rather its use is encouraged in an organic nature, to be exploited when this allows for improved system capabilities vrs cost, mass, power and TRL/risk.

Finally, the paper also discusses the implementation of an avionics test bench for testing the architecture with real EO data, from both the optical DEIMOS-2 and SAR TerraSAR-X missions. This testing with real EO data serves to demonstrate that the EO-ALERT concept, as a complete system and data chain, can meet the requirements of the considered scenarios in terms of detection performance, and critically latency. When proven, this will provide technological building blocks for upcoming European and international missions, and open new opportunities for the exploitation of civil EO products based on this novel flight segment architecture.