End-to-End Results for Almost-Real-Time Earth Observation from the EO-ALERT Project

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ABSTRACT

Satellite Earth Observation (EO) data is ubiquitously used in many applications, providing basic services to society, such as environment monitoring, emergency management and civilian security. Due to the increasing request of EO products by the market, the classical EO data chain generates a severe bottleneck problem, further exacerbated in constellations. A huge amount of EO raw data generated on-board the satellite must be transferred to ground, slowing down the EO product availability, increasing latency, and hampering the growth of applications in accordance with the increased user demand.

The EO-ALERT European Commission H2020 project (http://eo-alert-h2020.eu/) proposes the definition, development, and verification and validation through ground hardware and software testing, of a next-generation Earth Observation (EO) data processing chain. The proposed data processing chain is based on a novel flight segment architecture that moves EO data processing elements traditionally executed in the ground segment to on-board the satellite, with the aim of delivering EO products to the end user with very low latency. EO-ALERT achieves, globally, latencies below five minutes for EO products delivery, and below one minute in realistic scenarios.

The proposed EO-ALERT architecture is enabled by on-board processing, recent improvements in processing hardware using Commercial Off-The-Shelf (COTS) components, and persistent space-to-ground communications links. EO-ALERT combines innovations in the on-board elements of the data chain and the communications, namely: on-board reconfigurable data handling, on-board image generation and processing for the generation of alerts (EO products) using Machine Learning (ML) and Artificial Intelligence (AI), on-board AI-based data compression and encryption, high-speed on-board avionics, and reconfigurable high data rate communication links to ground, including a separate chain for alerts with minimum latency and global coverage.

This paper presents the proposed architecture, its hardware and software realization for the ground testing in a representative environment and its performance. The architecture's performance is evaluated considering two different user scenarios where very low latency (almost-real-time) EO product delivery is required: ship detection and extreme weather monitoring/nowcasting. The hardware testing results show that, when implemented using COTS components and available communication links, the proposed architecture can deliver alerts to the end user with a latency below five minutes, for both SAR and Optical missions, demonstrating the viability of the EO-ALERT architecture. In particular, in several test scenarios, for both the TerraSAR-X SAR and DEIMOS-2 Optical Very High Resolution (VHR) missions, hardware and software testing of the proposed architecture has shown it can deliver EO products and alerts to the end user globally, with latency lower than 1.5 minutes, opening unprecedented opportunities for the exploitation of civil EO products, especially in latency-sensitive scenarios, such as disaster management.