Advanced Data Chain Technologies for the Next Generation of Earth Observation Satellites Supporting On-Board Processing for Rapid Civil Alerts

M. Kerr[1], A. Fiengo[1], J. I. Bravo[1], R. Hinz[1], F. Membibre[1], A. Latorre[1], Helko Breit[2], Stefan Wiehle[2], Dominik Guenzel[2], Otto Koudelka[3], Franz Teschl[3], Enrico Magli[4], Tiziano Bianchi[4], Maurizio Martina[4], R. Freddi[5], M. Benetti[5], F. Milani[5], G. Curci[5], Cecilia Marcos[6]

[1]DEIMOS Space S.L.U., Tres Cantos – Madrid, Spain, Email: {murray.kerr, aniello.fiengo, juan-ignacio.bravo, robert.hinz, francisco.membibre, antonio.latorre}@deimos-space.com

[2]Deutsches Zentrum für Luft- und Raumfahrt e.V., Germany, Email: {helko.breit, stefan.wiehle, Dominik.Guenzel}@dlr.de

[3]Technische Universität Graz, Graz, Austria, Email: koudelka@tugraz.at, franz.teschl@tugraz.at

[4]Politecnico di Torino, Turin, Italy, Email: {enrico.magli, tiziano.bianchi, maurizio.martina}@polito.it

[5]OHB Italia Spa, Milan, Italy, Email: {rfreddi, mbenetti.ext, fmilani.ext, gcurci.ext}@cgspace.it

[6]Agencia Estatal de Meteorología, Spain – cmarcosm@aemet.es

The growing number of planned Earth Observation (EO) satellites, together with the increase in payload resolution and swath, brings to the fore the generation of unprecedented volumes of data that needs to be downloaded, processed and distributed with low latency. This creates a severe bottleneck problem, which overloads ground infrastructure, communications to ground, and hampers the provision of EO products to the End User with the required performances.

The EO-ALERT project (http://eo-alert-h2020.eu/), an H2020 European Union research activity, proposes the definition of **next-generation EO missions** by developing an **on-board high speed 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. EO-ALERT achieves, globally, latencies **below five minutes** for EO products delivery, reaching latencies **below 1 minute** in some scenarios.

The proposed architecture solves the above challenges through a combination of innovations in the on-board elements of the data chain and the communications link. Namely, the architecture introduces innovative technological solutions, including on-board **reconfigurable data handling**, on-board **image generation** and **processing** for generation of alerts (EO products) using **Artificial Intelligence (AI)**, **high-speed on-board avionics**, on-board **data compression and encryption using AI** and **reconfigurable high data rate communication** links to ground including a separate chain for alerts with minimum latency and global coverage. Those key technologies have been studied, developed, implemented in software/hardware (SW/HW) and verified against previously established technologies requirements to meet the identified user needs.

The paper presents the development of the innovative solutions defined during the project for each of the above mentioned technological areas and the results of the testing campaign of the individual SW/HW implementations within the context of two operational scenarios: **ship detection** and **extreme weather observation** (nowcasting), both requiring a high responsiveness to events to reduce the response time to few hours, or even to minutes, after an emergency situation arises.

The technologies have been experimentally evaluated during the project using relevant EO historical sensor data. The results demonstrate the maturity of the technologies, having now reached TRL 4-5. Generally, the results show that, when implemented using COTS components and available communication links, the proposed architecture can generate alerts with a **latency lower than five minutes**, which demonstrates the viability of the EO-ALERT concept. The paper also discusses the implementation on an Avionic Test Bench (ATB) for the validation of the integrated technologies chain.