MESEO: MULTI-MISSION EFFICIENT AND SECURE HIGH-CAPACITY END-TO-END EARTH OBSERVATION SYSTEM FOR DISTRIBUTED PROCESSING.

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Introduction

The increasing volume of data generated by Earth Observation (EO) missions is highlighting limitations in traditional architectures, particularly in Payload Data Ground Segments (PDGS) (Figure 1), such as communication bottlenecks, high latencies, energy constraints, and a growing need to ensure data sovereignty. MESEO (Multi-mission Efficient and Secure High-Capacity End-to-End Earth Observation) [1] aims to design and demonstrate a multi-mission, open, and scalable EO End-to-End system, based on an EO Coordinator Centre that orchestrates distributed processing functions.

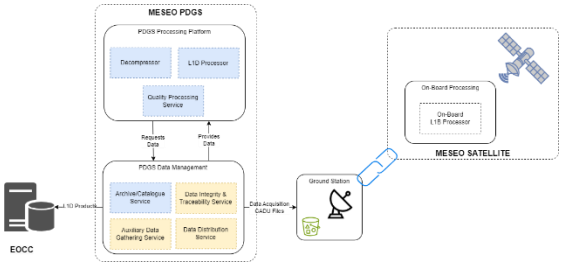


Figure 1. PDGS Elements

The proposal optimizes the entire EO chain —from the satellite to the end user— by improving quality of service, response times, and energy efficiency, and will be validated through pilot applications focused on methane monitoring and crop classification.

Methodology and Results

The MESEO approach is based on a distributed architecture whose core is the EO Coordinator Centre, a collaborative digital ecosystem that integrates heterogeneous Processing Functions registered by different stakeholders in the sector. These functions are exposed through interfaces harmonized interfaces that ensure interoperability and data sovereignty.

Each of the steps required to deliver a service is encapsulated in Processing Functions executable on space platforms, ground stations, or cloud infrastructures. Upon a user request, the EO Coordinator Centre dynamically selects the most suitable function, prioritizing latency or quality depending on the service requirements. This mechanism enables transparent, scalable, and multi-mission orchestration.

End-to-End Optimization and Bottleneck Reduction

MESEO systematically addresses the main bottlenecks present in legacy EO systems, such as downlink bandwidth limitations, overload in ground processing centers, and latencies associated with massive data transfers.

The strategy consists of redistributing processing capabilities across different "processing edges," both onboard and on the ground, reducing the volume of transmitted data and optimizing the use of computational and energy resources. This approach improves quality of service and the system's temporal responsiveness, from acquisition to delivery of the final product (Figure 2).

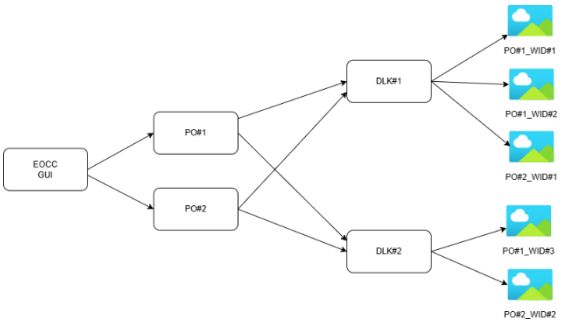


Figure 2. Task Planning. Methane Detection

Demonstration through Pilot Applications

The validation of the MESEO prototype will be carried out through two applications aligned with the European Green Deal [2]: methane emissions monitoring and crop classification. These applications will allow evaluation of the system's performance under different requirements in terms of latency, data volume, and final product quality.

The implementation and execution of the processing workflows rely on GMV's PRODIGI® technology [3], used as a framework for the orchestration and deployment of multi-mission processing chains within the MESEO ecosystem. PRODIGI will enable the chaining of the registered Processing Functions, facilitating their integration, dynamic activation, and monitoring under the control of the EO Coordinator Centre (see Figure 3).

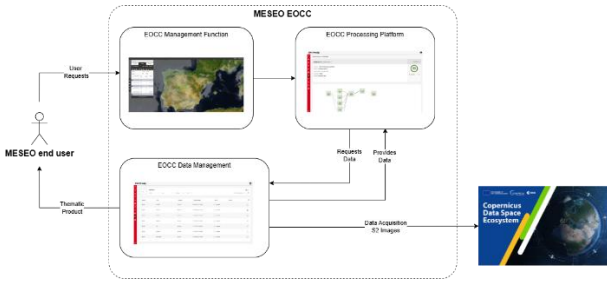


Figure 3. Workflow Orchestration and Execution: Example of a Distributed Processing System

The evaluation metrics will include reductions in end-to-end processing time, optimized bandwidth usage, and improved operational efficiency, demonstrating the viability of a distributed and coordinated architecture compared to traditional centralized models.

Conclusions

MESEO proposes a distributed, multi-mission End-to-End architecture that transforms EO data processing towards a collaborative and scalable model. The introduction of the EO Coordinator Centre and interoperable Processing Functions enables dynamic optimization of the entire chain, mitigating historical bottlenecks and improving efficiency and responsiveness.

The demonstration through environmental applications will validate the system's capability to deliver faster, more efficient services aligned with European sustainability objectives, laying the foundations for a new generation of secure, high-capacity EO systems.

References

[1] MESEO project Home - MESEO.

[2] European Green Deal. European Commission Policy Framework. Climate action and the Green Deal

[3] GMV® PRODIGI: GMV Prodigi® | GMV