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Operationalizing OGC Processes with Application Packages in ILIAD: A Service Deployment Pathway Towards EDITO

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Summary:

This contribution presents the integration of the EO Application Package model into the ILIAD Digital Twin of the Ocean architecture, using the OGC API Processes DRU specification. Built on the EOEPCA framework and OGC best practices and specifications, the approach enables standardized, containerized EO applications packaged with CWL to run across a wide range of infrastructures including Kubernetes and HPC. These applications are already in use across several platforms, and in ILIAD they have been applied to models such as oil spill forecasting, aquaculture, wave energy, and ship routing.

The EDITO platform supports OGC API Processes but is currently optimized for simpler workflows using environment variables. To enhance compatibility with EO Application Packages, ILIAD introduces a Kubernetes-based ADES implementation, enabling dynamic execution and integration with EDITO's object store and metadata catalog. The experience is also informing the evolution of the OGC Best Practice, and practical solutions for bridging architectural gaps will be discussed.

Abstract

As part of the ILIAD Digital Twin of the Ocean initiative, significant progress has been made in operationalizing standards-based Earth Observation (EO) services through the implementation of the OGC API Processes DRU (Data Retrieval and Utilization) API. This work is grounded in the European Space Agency (ESA) Earth Observation Exploitation Platform Common Architecture (EOEPCA), which defines a best practice (OGC 20-089) for packaging EO applications using the Common Workflow Language (CWL) and exposing them via OGC APIs.

This is a modular architecture where EO applications are encapsulated as non-interactive command-line tools, packaged using the Common Workflow Language (CWL), and executed in containerized environments. These applications can be run across a variety of infrastructures, from local environments to Kubernetes clusters and HPC systems, thanks to the use of standardized runners such as *cwltool*, *calrissian*, and *TOIL*. The application package supports orchestration through Directed Acyclic Graphs (DAGs), enabling fan-in/fan-out processing patterns to exploit distributed compute resources. Data inputs and outputs are described using the SpatioTemporal Asset Catalog (STAC), ensuring consistency in data staging and traceability. Exposing these applications via OGC API Processes interfaces enables seamless integration into digital twin architectures.

This architectural model has already been adopted across a growing number of EO platforms and initiatives, including the Euro Data Cube, the Geohazards and Urban

Thematic Exploitation Platforms (TEPs), the International Charter Mapper, the ESA-NASA Multi-Mission Algorithm and Analysis Platform (MAAP), the Copernicus LAC platform, and the IRIDE digital marketplace. These examples demonstrate the versatility and operational readiness of the EO Application Package model in supporting cloud-native, standards-based EO workflows.

In Iliad, this architecture enables pilots to standardise the deployment of services and models across various platforms and to support multiple execution scenarios. It caters to different environments, from personal computers to cloud infrastructures, Kubernetes clusters, and their deployment as a service leveraging the OGC API Processes specification, enabling consistent application deployment and execution across diverse computational settings. Several Iliad pilot models were packaged using this best practice such as fisheries forecast, oil spill (MEDSLIK II, Open DRIFT) models, aquaculture (Opendrift), tidal energy, wave energy, ship routing and jellyfish swarm forecast.

The EDITO platform currently supports the execution of EDITO Processes through OGC API Processes, providing a foundation for standardized service interaction. However, its current implementation is optimized for processes that use environment variables as input parameters, which poses challenges for integrating Application Packages designed to receive inputs via command-line arguments. As a result, certain classes of reusable EO workflows, such as those defined using CWL, require additional interface support to be seamlessly integrated. Addressing this compatibility gap is an important step toward enabling broader adoption of modular, containerized applications within the EDITO ecosystem.

To address this, ILIAD introduces an Application Deployment and Execution Service (ADES) that implements OGC API Processes Part 2. The ADES enables on-demand execution of containerized Application Packages within a Kubernetes environment. Executions are triggered through a standardized interface, with outputs automatically stored in EDITO's S3 object store and registered using the STAC metadata model. This enhancement significantly improves interoperability and flexibility within the EDITO ecosystem, enabling broader integration of scientific and operational workflows, and paving the way for scalable, standards-based Digital Twin services.

This experience within ILIAD is also contributing directly to the evolution of the OGC Best Practice for EO Application Packages (OGC 20-089). By applying the specification in a real-world operational context, integrated with both DRU and EDITO service architectures, the project has identified key implementation patterns, interoperability challenges, and interface improvements that are feeding back into the ongoing development of the standard. These insights are helping to ensure that the EO Application Package model continues to mature in alignment with the needs of Digital Twin initiatives and the broader EO community.

As part of this work, we will also present and discuss practical solutions being explored to bridge the gap between the two architectures, ensuring broader compatibility, improving workflow portability, and enhancing the overall usability of Application Packages in EDITO and other digital twin platforms.