

Date : 27 March 2025

Origin : CS GROUP - ROMANIA SA

Business : Tool Augmentation by User Enhancements and
Orchestration Follow-On (TAO-FO)

Title : **EXECUTIVE SUMMARY**

Reference : V23ESA0101/ES0027

Status : **APPROVED**

RESTRICTED

| | Last name / First name | Date | Signature |
|----------------|------------------------|------------|-----------|
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The TAO (Tool Augmentation by user enhancements and Orchestration) activity funded by ESA developed a lightweight, generic integration and distributed orchestration framework that allows to integrate commonly used toolboxes.

The objective of the TAO-FO activity was to technically evolve and functionally expand the TAO Platform from current TRL6 to TRL7, transitioning from a prototype framework to an operational environment.

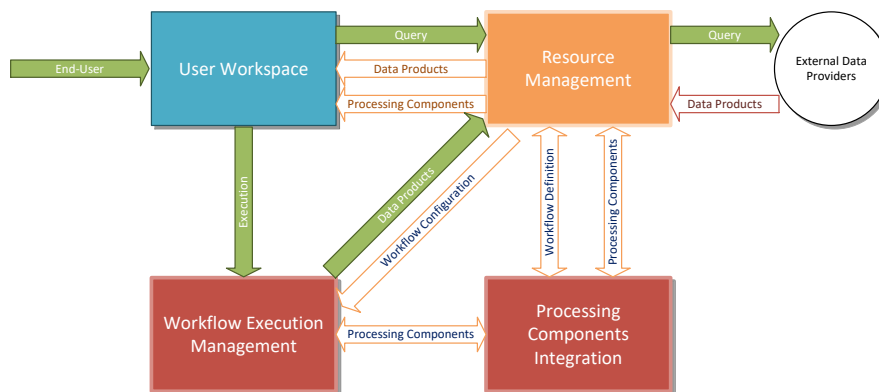
The main evolutions targeted development of new features for enhanced scientific research functionalities and flexibility, as well as system architecture evolutions for performance improvements and increased scalability and interoperability.

TAO allows to integrate commonly used toolboxes (such as, but not limited to, **SNAP**, **Orfeo Toolbox**, **GDAL**, **EnMAP Toolbox**, etc.). This framework allows for processing composition and distribution in such a way that end users could define by themselves processing workflows and easily integrate additional processing modules (by processing module it is understood either a standalone executable or a script).

In terms of use, the TAO platform provides a mean for orchestration of heterogeneous processing components and libraries to process scientific data. This is achieved in following steps:

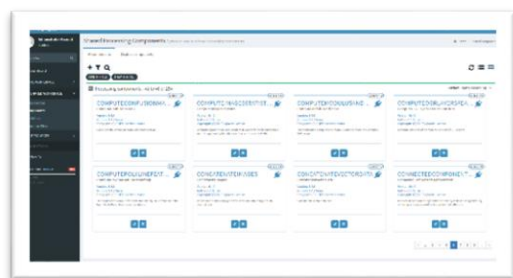
- Preparation of resources (including processing components) and data input
- Definition of a workflow as a processing chain
- Execution of workflows
- Retrieval / visualization of the results.

To have a simple view of the TAO platform, the platform model is split among four main macro-components. Such a macro-component is a logical collection of components with related functions. It has no direct relationship to the software implementation.



The key features of the TAO framework consist in:

- Visual **integration of EO processing toolboxes** (the user can perform such an integration by him-/her-self, without programming knowledge)
- A pre-configured set of **Docker containers** for **Orfeo Toolbox**, **SNAP**, **GDAL**, **EnMAP Toolbox**, **WeKEO WS** and **Python 2.7**



- **Visual definition of processing workflows** by simple drag-and-drop operations and easy parametrization of the workflow elements



- **Integration of user-defined algorithms**, written in Python (also in R is possible), in the processing workflows

- Visual definition of **execution topologies** (collection of machines onto which components are executed)

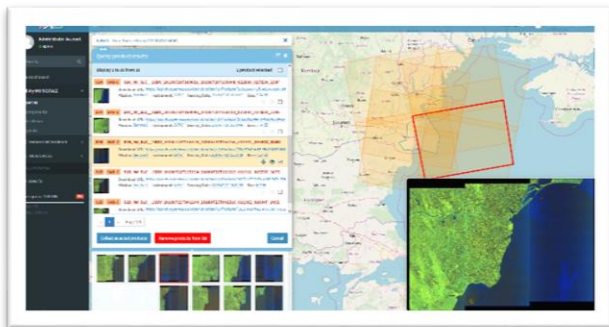
- **Orchestrated execution of workflows**, employing different



DRMAA-compliant Cluster Resource Manager software, such as Torque, SLURM, K8s or directly via SSH



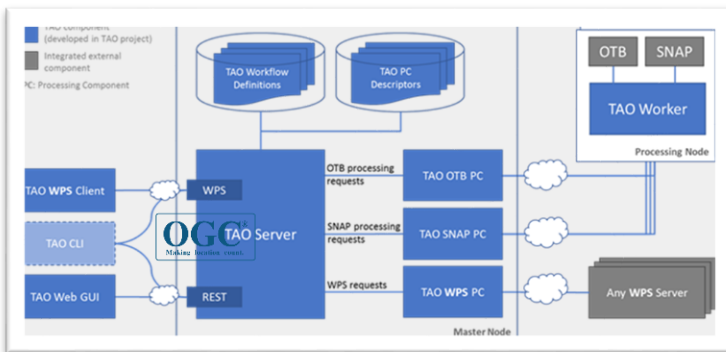
- Self-contained **containerized execution** of components on remote nodes so that they do not interfere with other components
- Visual **monitoring of executions** and topology nodes resources
- **User workspaces** to allow the visualization of the execution **results**, but also to allow users to upload various files that can be used in the workflow execution (such as **model files**, **shape files**, etc.)

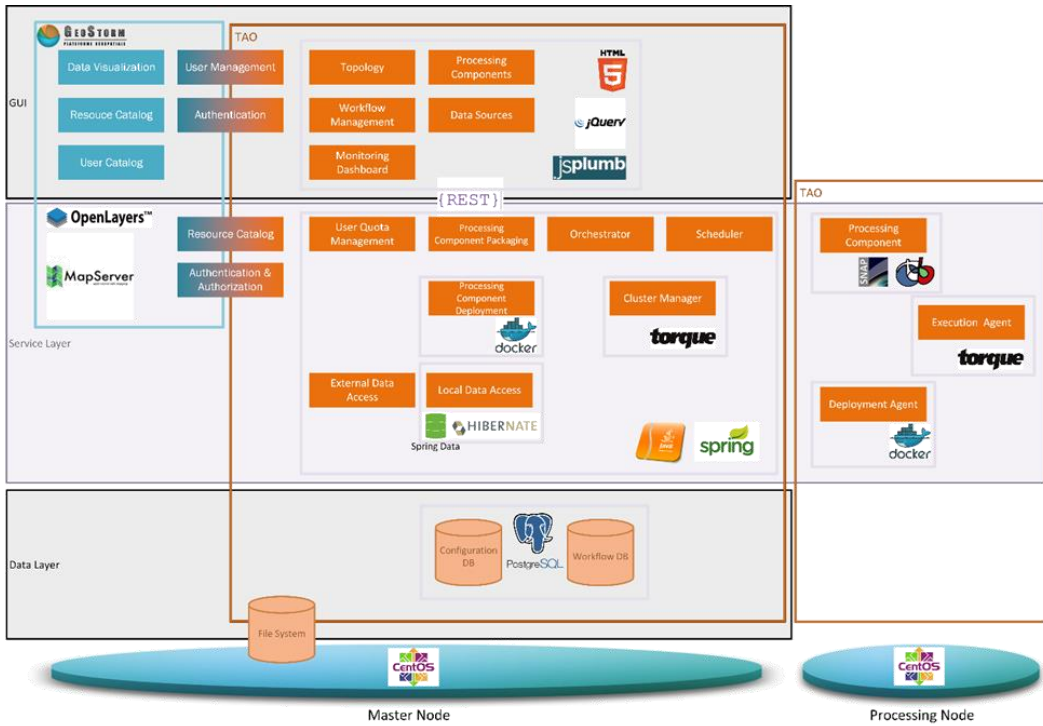


- **EO data sources abstraction framework** (plugin-based) that allows the querying and retrieval of EO data from different providers. Out-of-the-box, TAO comes with plugins for **Copernicus DAS**, **USGS Earth Explorer**, **NASA EarthData**, **ESA EOcat/FedEO**, **Alaska Satellite Facility**, for a various collection of sensors. Additionally, it allows the direct usage of EO products from DIAS product

archives

- **OGC standard interfaces** for exposing workflows as WPS services or via OGC API Processes endpoints.
- A rich **RESTful API** to control and manage all the TAO entities and services
- Visualization of results on a web map.
- The framework is **open source** under **GPLv3** license, and it is entirely written in the Java language. It was developed on the following technology stack:





The source code is available at: <https://github.com/tao-org>