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Ystia Orchestrator and HEAppE Middleware for Earthquake and Tsunami HPC workflow management

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LEXIS Project



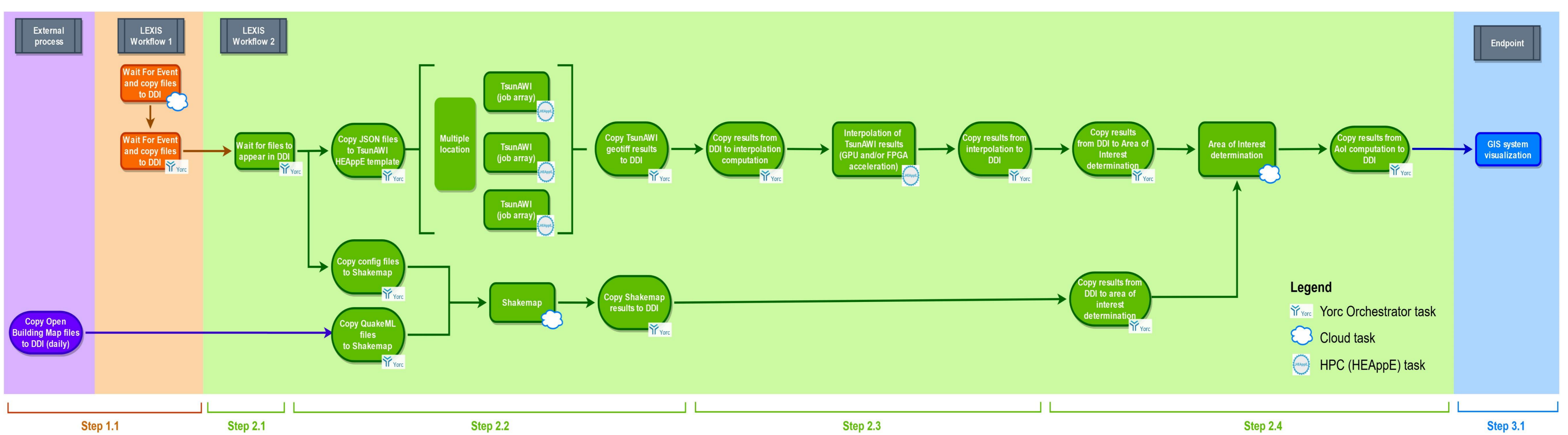
The LEXIS project¹ is developing an advanced engineering platform integrating **High-performance computing (HPC), Cloud, and Big Data**. The platform leverages large-scale geographically distributed resources from existing HPC infrastructures, employs Big Data analytics solutions and augments them with Cloud services. LEXIS platform is validated and tested by three large-scale socio-economic pilots from the industrial and scientific sectors (**Aeronautics, Weather and Climate, and Earthquake and Tsunami**). On top of this validation via the three pilots, the consortium intends to add another level of validation via opening the LEXIS Platform to various types of projects **from research organizations, industries, and others** in the framework of an **Open Call**.

LEXIS Workflow

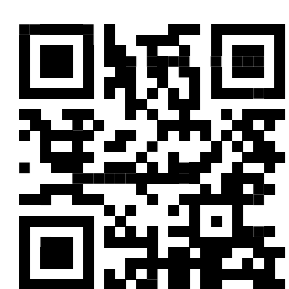
A workflow is a sequence of operations occurring on possibly different types of infrastructure, like for example running a job on the **HPC infrastructure** and then creating a **Virtual machine (VM)** in the cloud and deploying software on it. Policies (placement, failover, scalability) can also be specified to add automatically additional constraints to the workflow.

Workflows benefits:

- Does not contain any hard-coded lifecycle logic
- Allow a user to fully customize applications behavior
- Provide any custom workflow that can be executed at runtime

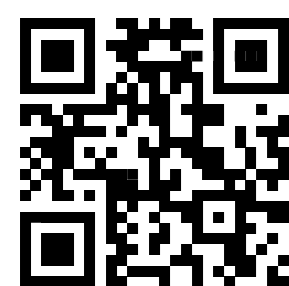


Ystia Orchestrator and HEAppE Middleware



Ystia Orchestrator (YORC²) and front-end (Alien4Cloud³)

- Is an open-source **TOSCA** (Topology and Orchestration Specification for Cloud Applications) orchestrator
- Supports applications/jobs lifecycle management over hybrid infrastructures (**HPC schedulers, Kubernetes, OpenStack, etc.**)
- Is built with **tasks/"stateless workers"** model allowing to scale it easily
- Could easily create applications and workflows, from an extensible **TOSCA components catalog**
- Provides **User Interface (UI)** and **REST API**



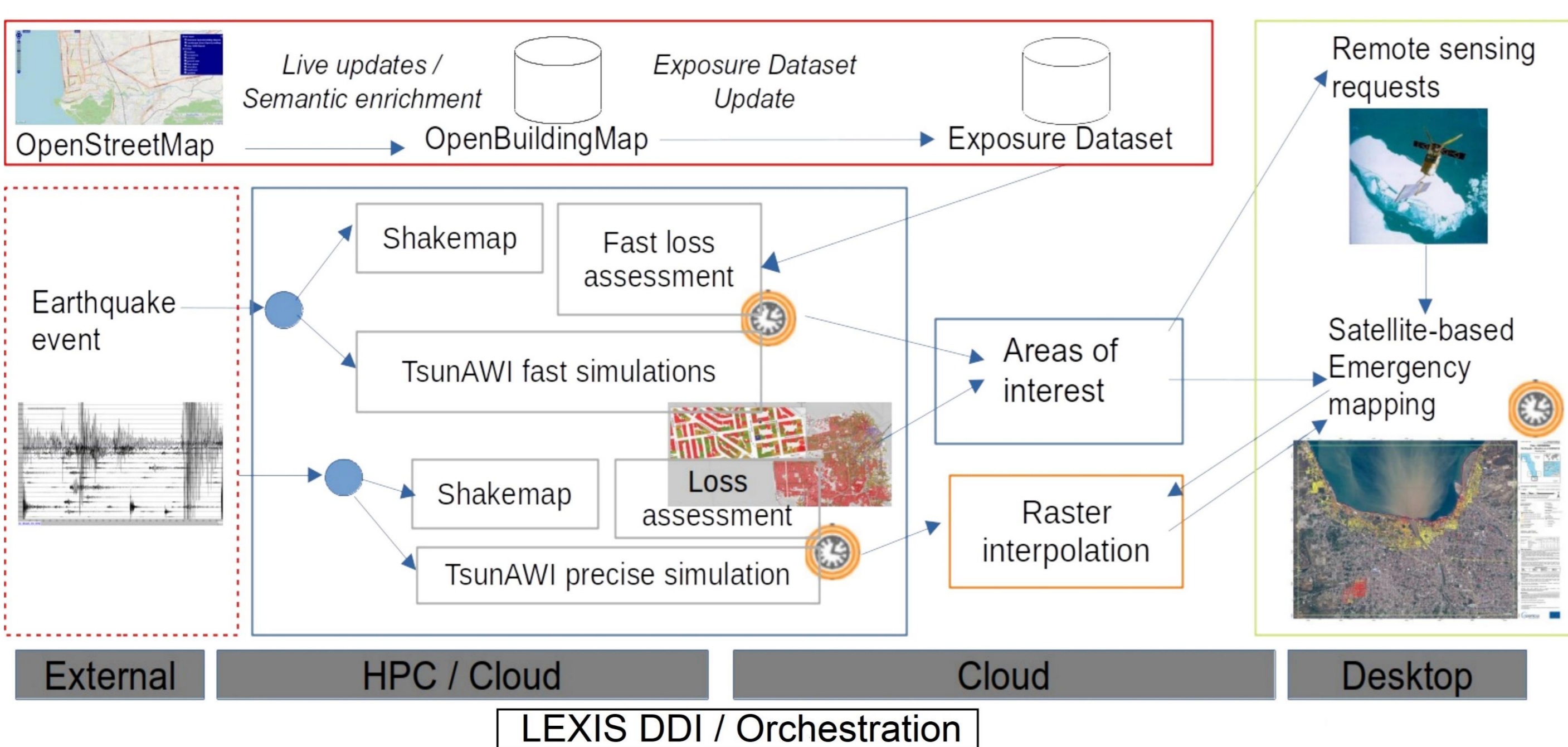
HEAppE Middleware⁴

- Is a concrete implementation of **HPC-as-a-Service concept**
- Offers a high-level abstraction and simplification in the area of HPC computing for regular users and novice users with no HPC knowledge whatsoever
- Provides an additional **secure access layer for HPC capabilities** (mapping mechanism between external user accounts and internal cluster accounts)
- Provides necessary functions for job management, monitoring and reporting, file transfer, user authentication and authorization, encryption, and various notification mechanisms
- Uses **PBS Professional**, and **Slurm** workload managers



Earthquake and Tsunami Workflows

The earthquake and tsunami large scale pilot in the LEXIS project is about running HPC and cloud computations in an **event triggered workflow under real-time deadlines over a unified infrastructure**. Upon arrival of an **earthquake event**, a first processing chain is triggered where, in parallel, a fast **tsunami simulation and loss estimates are computed**. Upon reception of the earthquake moment tensor, 10 minutes later, a second processing chain is started, with longer, more precise tsunami simulation and loss estimates. Both of those chains produces areas of interest shapes, which are used for **early warnings and early tasking of a satellite-based emergency mapping process**.



Achievements

To take advantage of the federation of resources from geographically distributed HPC infrastructures, the following innovations will be brought in LEXIS orchestration:

- **Dynamic orchestration:** select a location where to allocate resources needed in a workflow dynamically during the workflow execution, according to placement and legislative policies,
- **Job failover:** synchronize checkpointing data between locations, perform a failover to another location in case of a failure,
- **Uses job scalability and deadlines for urgent computing:** the ability to trigger changes or processing linked to world-time deadlines, such as cancel a job, or submit according to the time left before the deadline and possibility to submit the job in several locations, with options to cancel the job, when some of the jobs are calculated,
- **Gradual refinement of the calculation:** submit more jobs on several locations with different speed of computation and expected accuracy of results, have the first results faster of indicative quality, and other more precise results later



¹ <https://lexis-project.eu/web>
² <https://ystia.github.io>
³ <http://alien4cloud.github.io>
⁴ <http://heappe.eu>

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