e-Science Centre with EGI Resources for the Plasmasphere, Ionosphere and Thermosphere Research Community

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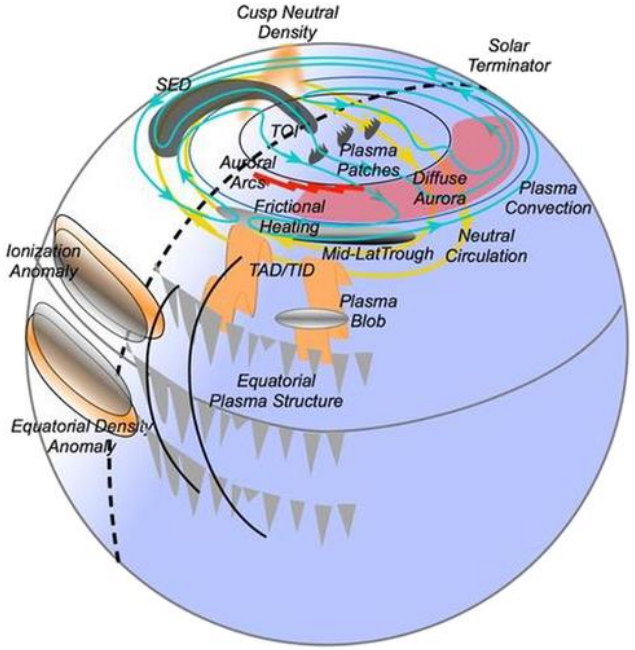
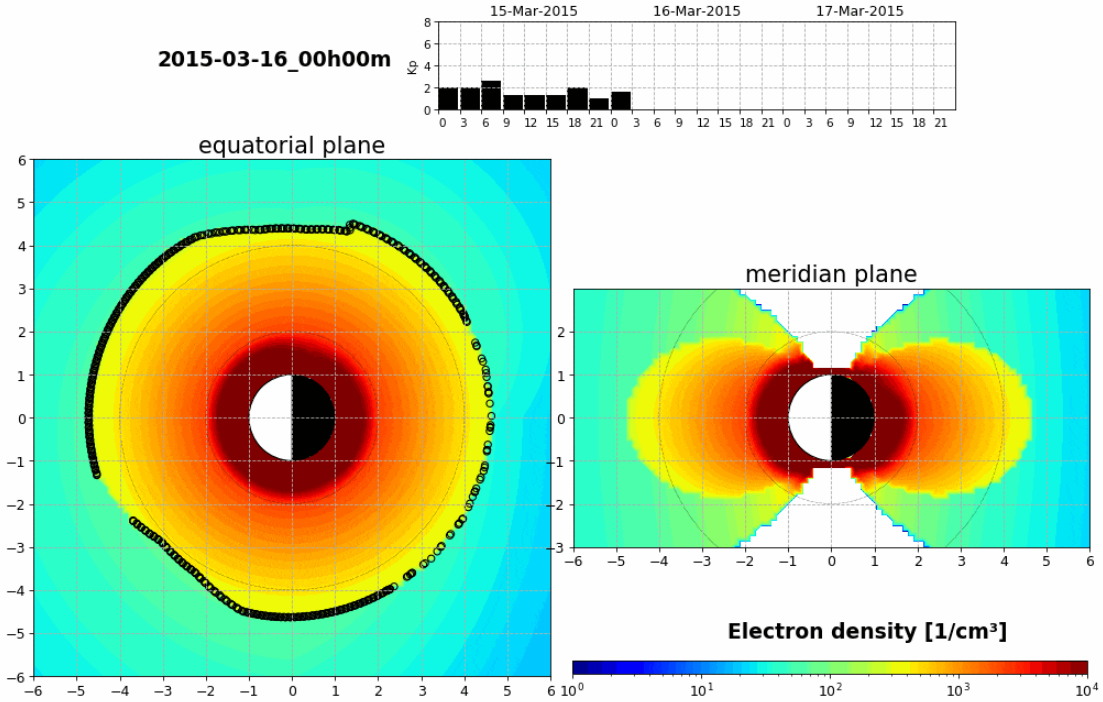
Scientific challenges

The Earth's Ionosphere, Thermosphere, and Plasmasphere is governed by the complex electrodynamic and photochemical system of the upper atmosphere coupled with variable electromagnetic fields and thermospheric winds.

These physical processes are the source of many scientific, operational, societal, and environmental challenges that affect the smooth and uninterrupted operation of critical technological systems and of research infrastructures.

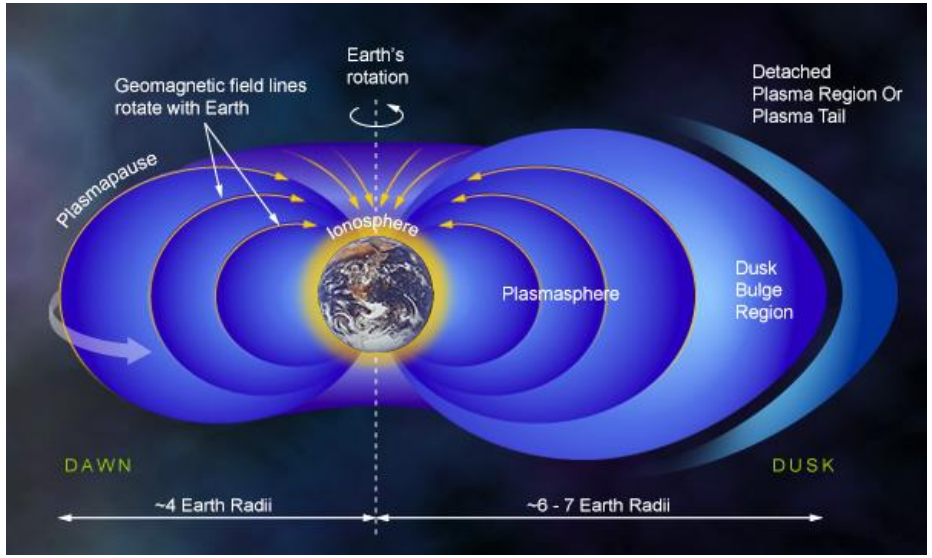


While we understand the broad features of the coupled ionosphere thermosphere plasmasphere system response, we lack the depth of understanding of its variability in long- and short-time scales that would allow us to build models with real predictive power.



Courtesy: BIRA-IASB

PITHIA-NRF project overview



- **PITHIA-NRF:** Plasmasphere Ionosphere Thermosphere Integrated Research Environment and Access services: a Network of Research Facilities
  - Build a **network of research facilities** that specifically supports the research community related to the study of the Earth's ionosphere, thermosphere and plasmasphere
  - **Integrate** observing facilities, data collections, data processing tools and prediction models
  - **Duration:** 4 years (April 2021 – March 2025) – EU H2020
  - **Funding:** EUR 5.4 Million
  - **22 project partners** – 20 scientific and 2 technical partners (UoW, EGI)

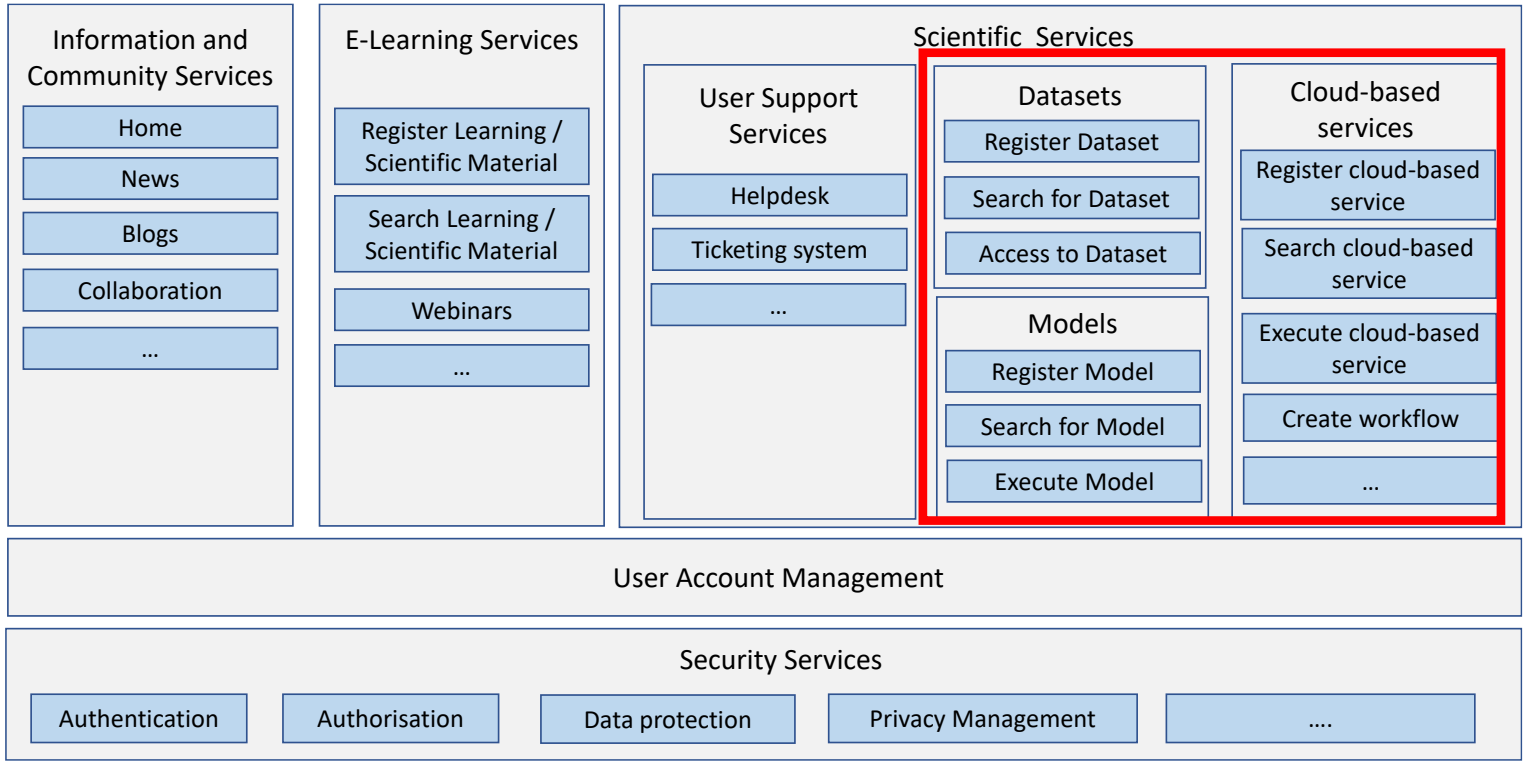
PITHIA-NRF e-Science Centre

- central **integration** tool for data, models and scientific services
- **integration** and **more efficient** utilisation of currently existing, heterogeneous and non-interoperable tools and services
- accessible via high-level adaptable **graphical user interfaces**
- supports the **learning process**
- exploits the power of **cloud-based** computational and data resources
- **basic functionalities**:
  - registration, cleaning and processing of Datasets
  - registration of Models acting on these Datasets
  - utilisation of applications and workflows implementing these Models

E-Science Centre Functionalities

- **The e-Science Centre offers three main functionalities:**

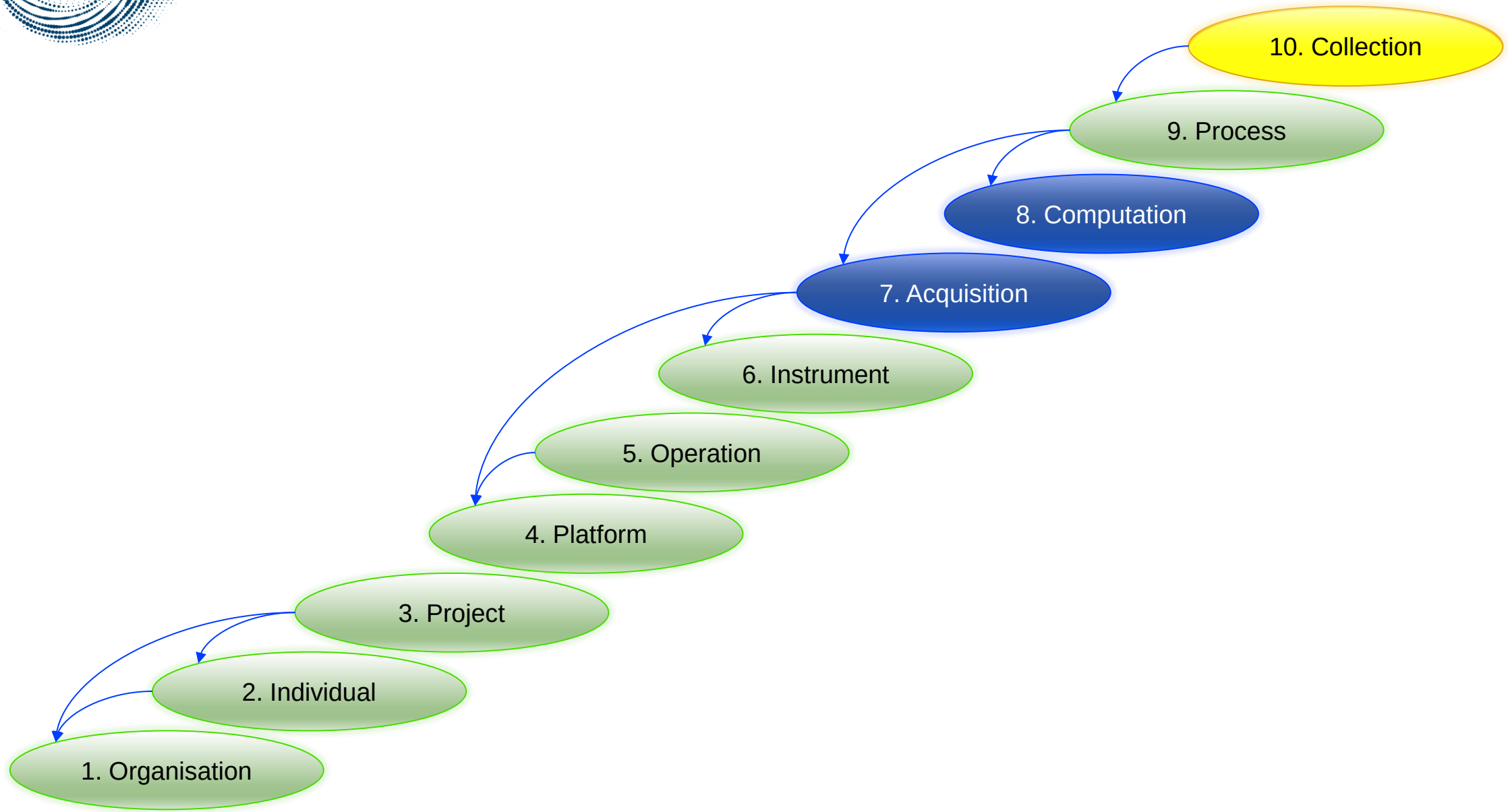
1. **Register** Models/Datasets
2. **Search** for Models/Datasets
3. **Interact** with Models/Datasets



Registration and search

- **Based on a domain ontology and standardised metadata**
  - ISO 19156 standard on Observations and Measurements
  - Augmented and tailored for space physics
  - Domain ontology developed in the FP7 ESPAS project
  - Simplified and modified for the requirements of PITHIA
- **Registration**
  - Prepare of 10 different types of XML files (e.g. Data Collection, Project, Individual, Organisation, Process, Instrument etc.)
  - Use terms of the ontology as standard vocabulary
  - Only Data Collections are registered, not individual data records
  - E-Science Centre:
    - ✓ Checks syntax of the XML
    - ✓ Validates against the schema
    - ✓ Validates against the ontology
    - ✓ Checks dependencies between the XML files
- **Search**
  - Uses terms of the ontology to narrow down Data Collections (Model or Measurement)

The 10 steps registration process



Current prototype

Digital Ionogram DataBase

Description

Digital Ionogram Database (DIDBase) collection contains vertical-incidence ionogram measurements and ionogram-derived information acquired by Global Ionosphere Radio Observatory (GIRO), https://giro.uml.edu, a network of ionosondes (high-frequency remote sensing sounders). Ionosondes detect echoes of the probing signal of varying frequency that correspond to reflections of the vertically transmitted signal from various locations in the ionosphere illuminated by the signal. Resulting image of the signal strength as function of the operating frequency and the time of flightis called ionogram. When viewed in the ionogram frame, signal echoes form traces that correspond to different plasma layers in the ionosphere. Interpretation of the ionograms allows derivation and computation of actionable numerical information for subsequent use in a variety of applied and research cases.

Property	Value
om:phenomenonTime	None
om:resultTime	None
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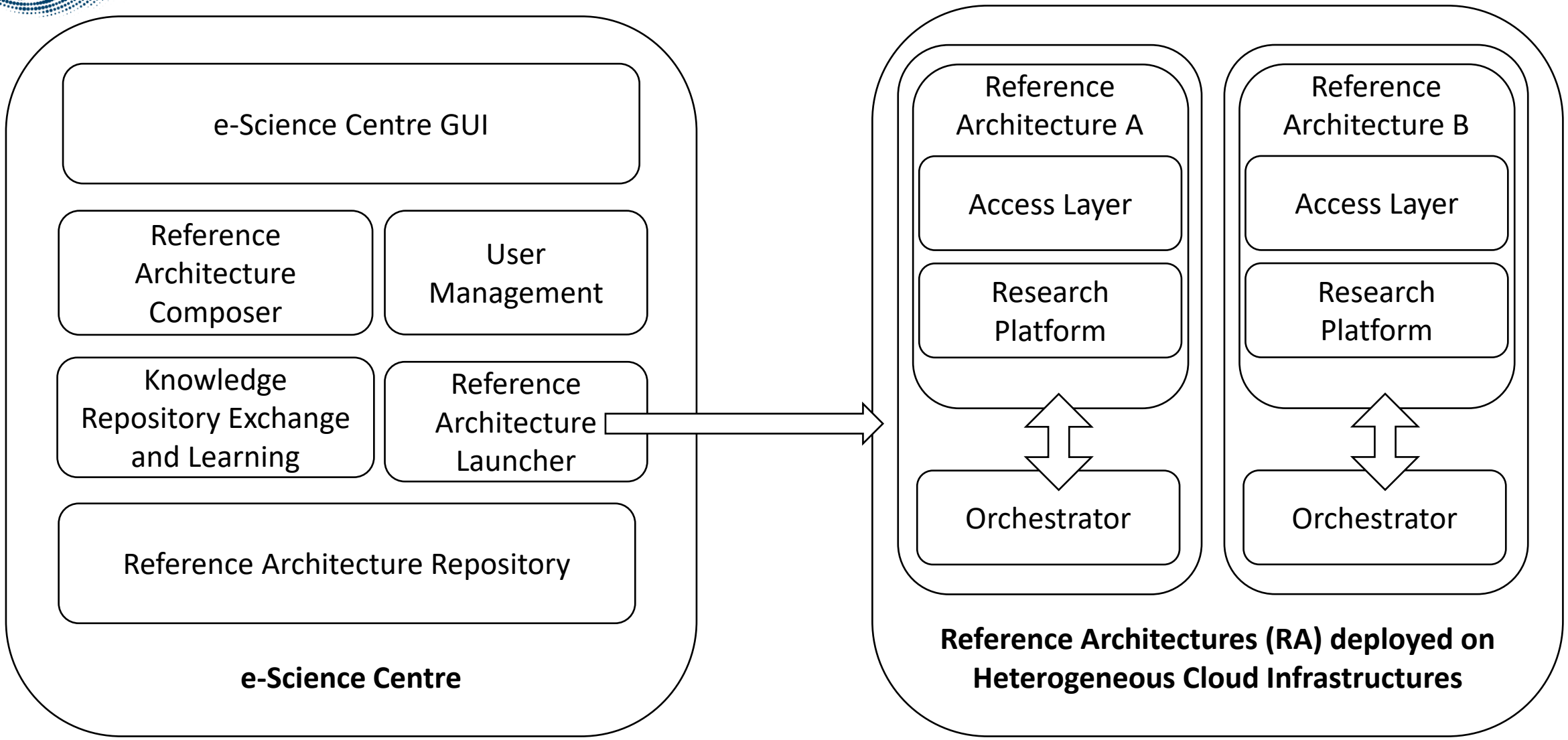
om:observedProperty	None
om:featureOfInterest.FeatureOfInterest.namedRegion.@xlink:href	https://metadata.pithia.eu/ontology/2.2/featureOfInterest/E-Region_of_Ionosphere
om:result	None
identifier.PITHIA_Identifier.localID	DataCollection_DIDBase_EvaluatedAutoscaling
identifier.PITHIA_Identifier.namespace	pithia
identifier.PITHIA_Identifier.version	1

Model execution options

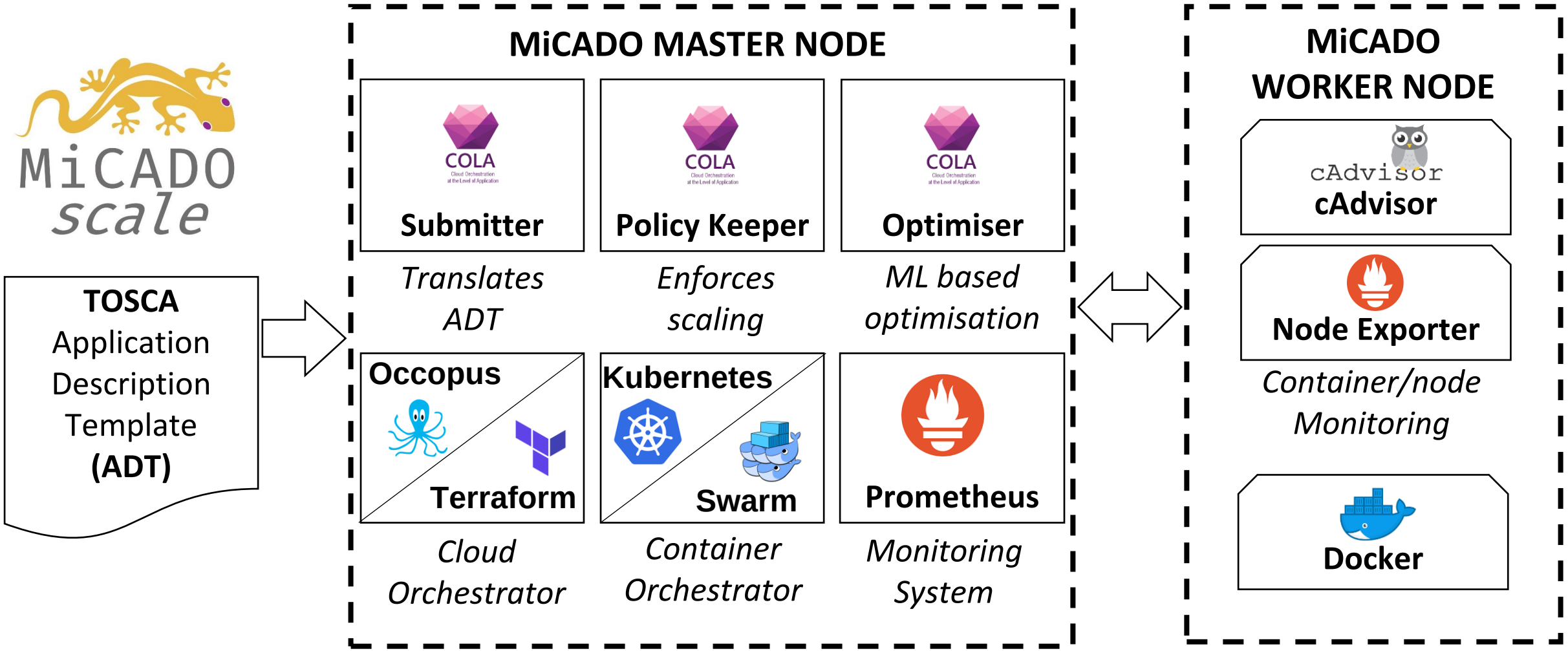
1. **Executed on PITHIA site/node from custom web-based user interface**
   - The Model runs/executes on the PITHIA Node providing the Model
   - Node provides custom web-based user interface to execute the Model
   - E-Science Centre only returns a link
2. **Executed on PITHIA site/node and accessed via API**
   - The Model runs/executes on the PITHIA Node providing the Model
   - E-Science Centre dynamically generates user interface based on the API specification of the Model
3. **Deployed and executed in the EGI cloud on-demand**
   - Model is deployed and run in the EGI cloud on-demand
   - Each user dynamically deploys and runs their own “copy”
4. **Download and execute Model on local computer**
   - User downloads a “copy” of the Model from the PITHIA node and executes on local computer

Deployed and executed in the EGI Cloud on-demand

A Science Gateways concept based on reference architectures

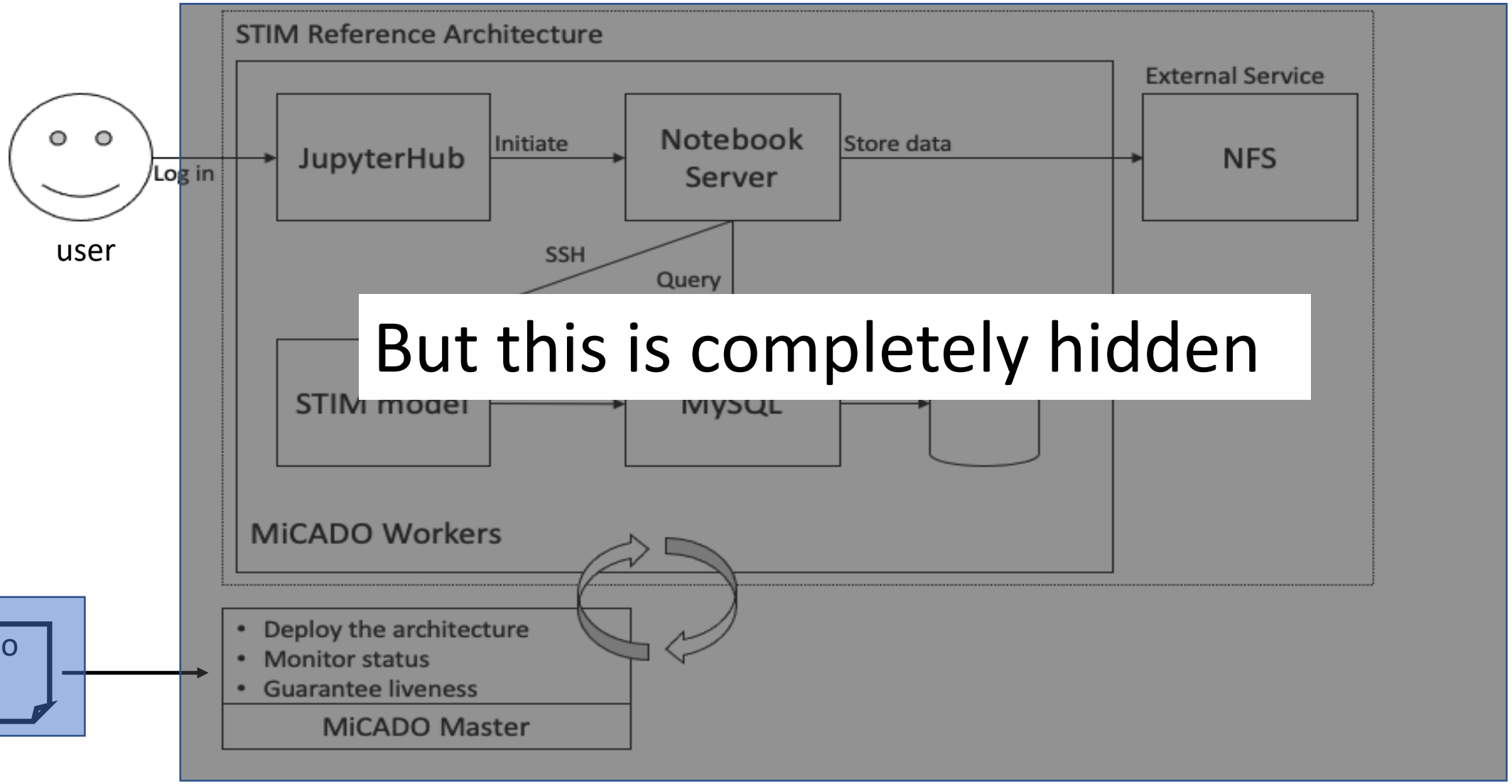


MiCADO multi-cloud orchestrator to deploy and manage complex microservice-based cloud applications



Deployed and executed in the EGI Cloud on-demand

A proof-of concept implementation



Micado ADT

And only the developer sees this

Thank you for your attention!
Any questions?

The PITHIA-NRF project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101007599