

Abstract: PITHIA-NRF e-Science Centre – A Science Gateway based on Cloud-based Reference Architectures

Gabriele Pierantoni, Tamas Kiss, Alexander Bolotov
 School of Computer Science and Engineering
 University of Westminster, London UK
 {G.Pierantoni, T.Kiss, A.Bolotov}@westminster.ac.uk

ABSTRACT

Plasma instabilities, electromagnetic coupling and thermospheric wind-dynamics are the main physical mechanisms that lead to a coupled system that is composed of the Earth’s Ionosphere, Thermosphere, and Plasmasphere. These complex physical processes cause the variability of main physical characteristics in long and short terms. While we understand the broad features of this coupled system, we lack the depth of understanding of its variability that would allow scientists to build models with real predictive power. The PITHIA Network of Research Facilities (PITHIA-NRF) project [1], funded by the European Commission’s H2020 programme, aims at building a distributed network, integrating observing facilities, data collections, data processing tools and prediction models dedicated to ionosphere, thermosphere and plasmasphere research.

One of the core components of PITHIA-NRF is a science gateway, the PITHIA-NRF e-Science Centre, that supports the execution of various scientific applications on distributed computing infrastructures. When designing and implementing the gateway, we follow a novel approach, based on the dynamic creation and instantiation of cloud-based reference architectures. Reference architectures are composed of multiple application components or microservices, described in the form of a deployment descriptor, and can be automatically deployed and managed at run-time. A reference architecture can include various components, such as generic or custom GUIs, data analytics, machine learning, simulation or other scientific applications, databases, and any other components (application-level firewalls, data converters, load balancers, etc.) that are required to realise a particular user scenario.

Based on reference architectures, a generic a science gateway framework is currently being developed, as illustrated in Figure 1. The proposed gateway framework has two conceptually different major building blocks: the e-Science Centre and the various Reference Architectures. The e-Science Centre is a centrally deployed and maintained component that provides user management services, e-learning support, and the capability to store, search, compose and launch reference architectures. Reference Architectures (RA), on the other hand, are dynamically created and managed infrastructures

that are launched or destroyed on demand by a suitable cloud orchestrator.

The implementation of the PITHIA-NRF e-Science Centre is currently ongoing. When implementing the solution, we reuse and customise several existing components, developed in previous projects. MiCADO is utilised as a cloud orchestrator [2] and is responsible for deploying the reference architectures and managing their life-cycle based on user-defined policies. Each reference architecture has its own MiCADO orchestrator that is launched by the MiCADO (Reference Architecture) Launcher. As User Management and Reference Architecture Repository components we are customising the EMGUM (emGORA User Management) and EMGREPO (emGORA Repository of Executable Artefacts) components of the CloudiFacturing Platform, implemented within the EU CloudiFacturing project [3]. SMARTEST [4], a knowledge repository that assists and facilitates learning by representing knowledge and learning activities as graphs, is utilised as Knowledge Repository Exchange and Learning and provides embedded e-learning support [5]. The Reference Architecture Composer and the e-Science Center GUI are new components and will be developed in PITHIA-NRF. However, similar concepts, the Digital Marketplace of CloudiFacturing and the reference architecture composition solutions currently developed in the EU funded DIGITbrain project [6], will be reused.

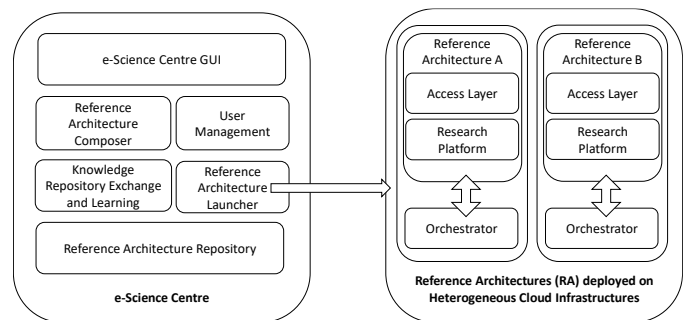


Figure 1 - High level architecture of the PITHIA e-Science Centre

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SMEs, by empowering a network of DIHs with an integrated digital platform that enables Manufacturing as a Service, project, No. 952071, European Commission (EU H2020); CloudiFacturing - Cloudification of Production Engineering for Predictive Digital Manufacturing, No. 768892, European Commission (EU H2020); and PITHIA-NRF - Plasmasphere Ionosphere Thermosphere Integrated Research Environment and Access services: a Network of Research Facilities No. 101007599, European Commission (EU H2020).

Keywords— *Science gateway, e-science centre, cloud-based reference architecture, cloud orchestration, e-learning.*

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