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DemoGRAPE: A demonstrator of e-science potential in Antarctica / Pilosu, Luca; Ruiu, Pietro; Scionti, Alberto; Alfonsi, Lucilla; Spogli, Luca; Romano, Vincenzo; DAVIS, Fabio; LINTY, NICOLA UMBERTO; CILLIERS, Pierre; RILEY, Padraig; WARD, Jonathan; CORREIA, Emilia; HENRIQUE, Jose; BAVARO, Michele; CURRAN, James T.; FORTUNY GUASCH, Joaquim. - ELETTRONICO. - (2016), pp. 346-346. ((Intervento presentato al convegno XXXIV SCAR Open Science Conference 2016 tenutosi a Kuala Lumpur (Malaysia) nel 22-26 August 2016.

Availability:

This version is available at: 11583/2711699 since: 2018-08-07T12:27:13Z

Publisher:

Abu Samah, Azizan, & Baeseman, Jenny

Published

DOI:10.5281/zenodo.162116

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DemoGRAPE: A demonstrator of e-science potential in Antarctica

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The Earth's upper atmosphere presents a region particularly rich of ions and free electrons: the ionosphere. Such high concentration of free electrons makes the ionosphere the major natural contributor to the degraded quality of GNSS signals received at ground level. In polar regions, such as in Antarctica, this degradation can be stronger, creating serious problems in using GNSS devices for logistic and scientific purposes. In this context, the DemoGRAPE project developed a Cloud computing federated infrastructure to manage GNSS data and "ad hoc" applications coming from different teams in a multi-user environment. The proposed DemoGRAPE infrastructure shows its potential usefulness in several application scenarios, such as satellite navigation and space weather, as well as to support the investigation of polar cap dynamics, solid Earth and cryosphere evolution. In particular, data coming from two ionosphere monitoring stations (based on a GNSS signal acquisition system and on a software radio receiver and installed in two research stations in Antarctica) have been made available at the South African and Brazilian nodes of the IT infrastructure. Two data analysis tools have been fully integrated on virtualized machines in the Cloud computing infrastructure. The first is based on the well known GBSC (Ground Bases Scintillation Climatology) technique, while the second one use an innovative analysis method for the Software radio receiver data.

The proposed Cloud computing infrastructure leverages on the Docker technology and on a distributed storage system to allow data and tools to be shared within the federated environment. Docker provides a lightweight virtualization system which provides the substrate to efficiently run the "ad-hoc" applications, while the distributed storage system guarantees the availability of the data against failures. The entire infrastructure is managed by means of an ad-hoc console, which also exports a web-based graphic user interface.

Finally a demonstrator has been developed in order to validate and test the proposed architecture and show how it constitutes an opportunity to pioneer new potential services based on the GRAPE and international collaboration.

This paper shows the features and potential of the implemented infrastructure by means of the DemoGRAPE demonstrator.