Chapter 56
Cloud Computing for Earth Observation

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ABSTRACT

This chapter elaborates on the impact and benefits Cloud Computing may have on Earth Observation. Earth Observation satellites generate in fact Tera- to Peta-bytes of data, and Cloud Computing provides many capabilities that allow an efficient storage and exploitation of such data. Several scenarios related to Earth Observation activities are analyzed in order to identify the possible benefits from the adoption of Cloud Computing. As concrete proofs-of-concept, several activities related to Cloud Computing in the context of Earth Observation are exposed and discussed. Technical details are provided for a particular framework used by Earth Observation applications that has made the transition from using Grid services towards using Cloud services. A special attention is given to the avoidance of the vendor-lock-in problem.

INTRODUCTION

Nowadays Earth Observation satellites generate Tera to Peta bytes of raw data. When looking at the future, new high-resolution sensors, either multi-, super-, or hyperspectral, will lead to even higher data quantities to be processed. This huge amount of data needs to be stored, preserved, processed to higher levels and be distributed to the user communities.

The IT infrastructures for Earth Observation (EO) need to harness processors, applications and services and cope with peaks of demand of EO data (this demand can be data access and/or processing) that can lead to a reduction of the IT infrastructure QoS. Furthermore, the cost of these computing infrastructures is often very high, such that the required investments may not be motivated.

Earth Observation computing infrastructures have particular requirements often not easy to address:

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- Provide access to near-real time and historical data.
- Put data and processor together.
- Be able to ensure common functions.
- Allow on-demand processing.
- Be able to host "any" processor.
- Be sizeable, scalable, secure, and reliable.

The growing number of user communities develops applications that need to deal with the processing of large quantities of data. These applications can be global, regional, or local; they have alternative uses for the data at different resolutions; they require access to large historical and distributed archives (these have long term data and knowledge preservation issues) as well as access to near real-time data for processing, value adding and dissemination. In this context, the Cloud computing offer for elastic e-infrastructure use is attractive for the Earth observation communities. In what follows, we describe the steps that were made recently to adapt to the Cloud technologies at European initiatives.

The chapter is structured as follows. Meant as light introduction as well as motivating the actions that were undertaken and are partially reported in this chapter, Section 2 is shortly explaining the benefits of using Cloud technologies by Earth Observation communities. Thereafter, Section 3 is providing several hints about the on-going activities and recent results in the use Cloud Computing in Earth Observation in Europe. Section 4 starts with technical details, while exposing the functionality of a particular framework, namely *ify*, and its recent migration towards using Cloud resources. A special attention is provided to the avoidance of vendor lock-in problem using a platform that is ensuring the application code portability, namely mOSAIC. Same section is pointing towards real applications that are using the framework. Finally, some conclusions and future work are shortly described.

EARTH OBSERVATION ACTIVITIES THAT MAY BENEFIT FROM CLOUD COMPUTING

In what follows we analyze several Earth Observation typical activities having in mind the infrastructure needs. Some examples are shortly reported herein after. Others are present in literature as in (Markatchev et al, 2009) where an Interactive Application Service (IAS), a service providing to users on-demand access to applications interactively over the Internet, has been successfully deployed in the GeoChronos portal (http://geochronos.org/), a portal enabling members of the Earth observation science community to share applications and data. Other example is in (Golpayegani et al, 2009) where Cloud Computing solution for Satellite Data Processing on High End Compute Clusters is discussed. In recent literature, (Li et al, 2010) presents the design and implementation of a MODIS (http://earth.esa.int/MODIS/) satellite data re-projection and reduction pipeline in the Windows Azure cloud computing platform and (Wang et al, 2010) design and present a framework for retrieving, indexing, accessing and managing spatial data in the Cloud environment.In the following paragraphs other European Space Agency activities for the Earth Observation and benefits the Cloud Computing may have, are discussed in detail.

Earth Observation Mission Re-Processing

The Earth Observation mission re-processing targets improvements of the EO data quality. These improvements can be of different nature: radiometric, geo-location and spatial resolution, among others.

These improvements can be achieved with the development of new and enhanced algorithms, tuning of auxiliary parameters, processor re-design, instrument calibration, or threshold and scaling factor corrections.