HPC in Weather Forecast:
Moving to the Cloud

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ABSTRACT

Many traditional High-Performance Computing systems rely on hardware performance as well as compiler parallelization. The increased demand on computing resources rapidly escalates costs, which are the bigger limitation nowadays in both public and private sector. Cutting costs stimulates the research for new solutions, which are being opened by Cloud Computing. Virtualization becomes the key to migration and delivering intensive computing applications becomes more proficient than ever, thus providing the motivation for a change to the Cloud. This paper presents a case study of how to migrate an application and optimize performance without significant cost growth based on Cloud Computing applied to weather forecasting.

Keywords: *Cloud Computing, Computing Resources, High-Performance Computing, HPC, Migration, Virtualization, Weather Forecasting*

1. INTRODUCTION

Cloud Computing (CC) is representing a paradigm change in several areas: companies are changing to the pay-per-use model offered by Cloud Computing instead of building in-house datacenters. Datacenters are being replaced by dynamic, on-demand and flexible infrastructure that bursts to the Cloud to attach additional computing capacity. CC is becoming very suitable for solving scientific computing problems as they advertise providing virtually unlimited amount of computing resources on demand and nearly in real-time (Jakovits & Srirama, 2013) and high proficiency all along (Brown & Dinu, 2013; Roberto R. Expósito, Guillermo L. Taboada, Sabela Ramos, Jorge González-Domínguez, Juan Touriño, 2013).

Assembling a classic data cluster capable of a high throughput can be a hard mission. Budget issues, bureaucracy filling, hard-to-estimate needed capacity and a huddle of hardware installation which could last for weeks.

High Performance Computing (HPC) aims to solve problems normally unfeasible on a single computer via the use of large numbers

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of clusters, datacenters, or supercomputers (Bunch & Krintz, 2011). These dedicated datacenters, with a fixed throughput capacity, can be constrained with capacity and also become obsolete in a couple of years. Cloud bursting (Bunch & Krintz, 2011) allows to maximize the utilization of HPC clusters and adds capacity beyond their limit (Voss, Barker, Asgari-Targhi, van Ballegooijen, & Sommerville, 2013).

Lending computational capacity from an external provider allows the users to benefit from the typical Cloud scalability, facing peak demands in a cost-effective manner. It also can implement a high availability strategy, transforming a standard infrastructure into an agile provisioning platform (Voss et al., 2013). Public Clouds are rather immature for HPC, being oriented to business applications (Ghoshal, Canon, & Ramakrishnan, 2011; He, Zhou, Kobler, Duffy, & McGlynn, 2010), even though lately some providers tried to increase HPC services and support offers (Barr, 2011). Private Clouds emerge with a new managing perspective, controlling different hardware and taking advantage of existing hardware and facilities. A dynamic shared HPC infrastructure offers resources available on demand on pre-settled basis and is much more cost effective for a university to operate than public providers (Carlyle, Harrell, & Smith, 2010). Private Cloud has almost all the benefits of a public Cloud but instead of being a pay-per-use solution, costs are shared with other user groups; the environment supervision is also easier to manage. Although it can be hard to implement, because of network, software and hardware constraints, inside a well-known campus it can be an excellent opportunity to expand and utilize resources to their full capacity.

Hybrid Clouds can merge the very best of public and private Clouds. The private infrastructure is used on regular resource consumption, with usually lower internal costs, scaling out for public Cloud(s) when usage goes beyond in-house resources. Public and private Clouds are quickly evolving to enable combined scenarios based on dynamic optimizations for performance and price. Many applications run on public Cloud as it provides an attractive choice to a datacenter infrastructure. However, by several reasons as ethics, applications and data may be forced to locate behind the local firewall, so Cloud investments must be planned to allow a hybrid solution as well.

When migrating to the Cloud, the choice is not limited to public or private, since the best of both can blend. A hybrid Cloud strategy is able to retain high-valued features like cost optimization, service diversity, patterns and risk mitigation although performance is generally lower.

Migrating traditional HPC applications to the Cloud is not a straight process. Running systems need to be virtualized in order to create templates, operating systems need tuning with the new infrastructure and software requires adaptation to Cloud specifications. However, CC offers many potential benefits to HPC developers and users. It facilitates dynamic acquisition of computing and storage resources and access to scalable services; moreover, Cloud platforms abstract away the underlying system and automate deployment and control of supported software and service (Bunch & Krintz, 2011); such configurations can last more than a few weeks in traditional datacenters. In addition, they have a very balanced cost-performance ratio (Juve, Deelman, Berriman, Berman, & Maechling, 2012), though it is not yet able to compete with traditional HPC supercomputers (Saini et al., 2012). The Cloud holds great promise for the scientific computing community as it can be a cheap alternative to supercomputers and specialized clusters, more reliable platform than grids, and more scalable platform than the largest commodity clusters (Jakovits & Srirama, 2013).

The main idea of this paper is to demonstrate how to build a hybrid infrastructure to support real case HPC applications, using a weather forecast as a proof of concept. It can be roughly defined as a community cluster, a HPC cluster managed by a faculty group and centrally operated by an institution, maintained for the benefit of the many research groups that own the nodes in the cluster as well as the broader

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