Peak2Cloud: Scientific Computing on the Cloud

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Peak2Cloud (P2C) is an Openstack-based private cloud for scientific and high performance computing. First, we present how P2C was configured and tested. Then we describe vcluster, a tool for rapidly deploying message-passing clusters on P2C. Lastly, we analyze some benchmark results on the performance of P2C deployed virtual clusters.

1. INTRODUCTION

Cloud computing has become a buzzword in today's modern computing, though there is no agreed upon meaning of the term. In 2011, NIST [Mell and Grance 2011] published a definition that is widely quoted and used. The popularity of cloud computing mainly comes from its ability to provision additional resources on demand with minimum intervention from the provider. It leverages advances in virtualization and web services technologies. For example, a website with a sudden increase in workload can start another server machine (possibly virtual) almost instantaneously to accommodate the additional load.

Cloud computing offers service models which include Software-as-a-Service(SaaS), Platform-as-a-Service(PaaS), and Infrastructure-as-a-Service(IaaS). IaaS allows the consumer to provision computing resources(hardware, network, storage) to run arbitrary software including operating systems [Mell and Grance 2011].

1.1. Openstack

Openstack an open source software framework for deploying clouds. [Sefraoui 2012] It is based on Nebula used by NASA. It provides a public interface that is compatible with Amazon EC2. There are several components of Openstack which are developed separately. Keystone is used to manage authorization and authentication. Glance manages the virtual machine images. The Nova component is used for managing compute nodes. Horizon provides a front-end to users to manage instances in the cloud.
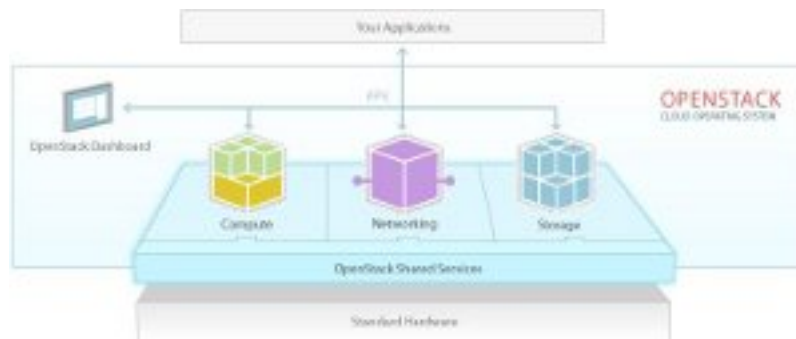
Fig. 1.   Openstack at a glance.

2. RELATED WORK

Studies have been published to evaluate the applicability of the cloud for scientific computing.

[Evangelinos and Hill 2008] found that Amazon's EC2 may be a credible solution for on-demand and small-sized HPC applications. They supported this conclusion by running a low-order coupled atmosphere-ocean simulation on EC2.

[Ekanayake and Fox 2010] presented performance analysis of HPC applications on virtualized resources. They concluded that cloud techonologies work well for pleasingly- parallel problems. The main limitation of cloud technologies is the high overhead for applications with complex communication patterns, even with large data sets.

[Jackson et al. 2010] compared the performance of conventional HPC platforms to Amazon EC2. Their results showed that EC2 is six times slower than a typical mid-range Linux cluster, and twenty times slower than a modern HPC system. This is mainly because of the communication overhead. They also noted that variability in performance can be significant due to the shared nature of the cloud environment.

[Zhai et al. 2011] conducted a comprehensive comparison of the performance of a baremetal cluster(connected using Infiniband) and a cluster deployed using Amazon's Cluster Compute Instances (CCI). The study also revealed that running MPI applications in the cloud yielded more positive results compared to published results. They also highlight the flexibility and elasticity advantage of using cloud.

[Mauch et al. 2013] presented the High Performance Cloud Computing (HPC2) model. This model enables the provisioning of elastic virtual clusters which avoids the initial cost for physically owned hardware. They also presented a novel architecture for HPC IaaS clouds which support InfiniBand with QoS mechanisms since existing platforms still use Ethernet.

[Expsito et al. 2013] concluded that HPC application scalability depends mainly on the communication performance. Their study involved the use of Amazon's EC2 Cluster Compute Instances (CCI) platform targeted to HPC applications. This platform provides access to a high-speed network(10 Gigabit Ethernet).

[Ludescher et al. 2013]

[Walker].

Most of these utilized the public cloud, specifically Amazon EC2 as their testbed.

Fig. 2.   Hardware

Fig. 3.   Hardware

3. METHODOLOGY

3.1. Hardware

P2C uses commercial-off-the-shelf(COTS) hardware. The cloud controller(1 unit) and compute nodes(2 units) is a four-core Intel(R) Core(TM) i3-2000 3.10GHz CPU with 4GB RAM and 100GB disk. A 1GBps, 16-port Dell PowerConnect 2716 switch connects the controller and the nodes.

3.2. Network Topology

3.3. vcluster

3.4. Benchmarks

4. RESULTS AND DISCUSSION

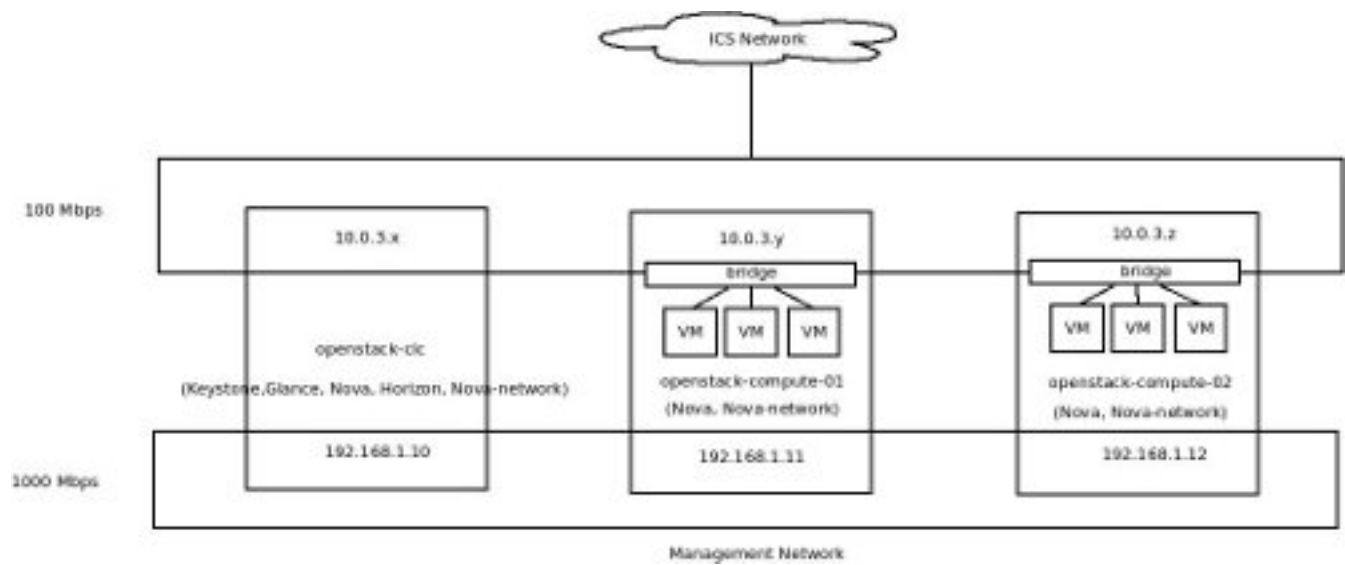## 5. CONCLUSIONS

ACKNOWLEDGMENTS

Fig. 4.   Network

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